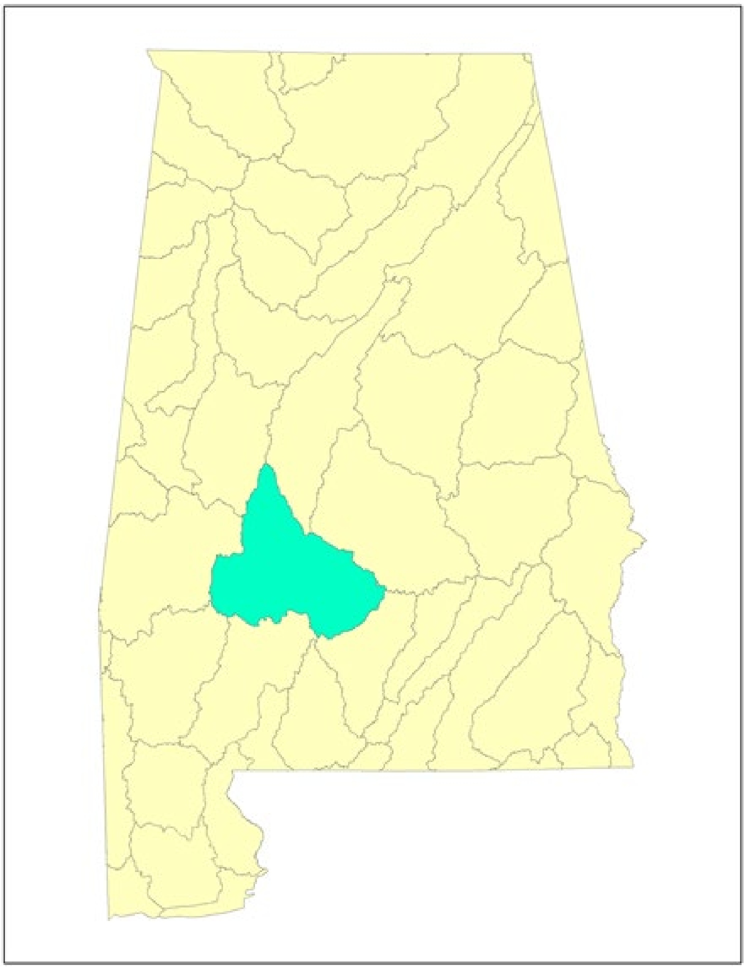
Middle Alabama River Basin Sustainable Irrigation Adoption Project

Draft Watershed Project Plan-EA

Preliminary – Subject to Revision



Prepared by

United States Department of Agriculture, Natural Resources Conservation Service

in cooperation with

Alabama Soil and Water Conservation Committee

October 2024

Abstract - Draft Watershed Project Plan-Environmental Assessment

For the Middle Alabama River Basin Sustainable Irrigation Adoption Project in Butler, Dallas, Clarke, Lowndes, Marengo, Monroe, Perry, and Wilcox Counties of Alabama.
Prepared by the United States Department of Agriculture – Natural Resources Conservation Service

Lead Agency: United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), Alabama.

Sponsoring Local Organization (SLO): Alabama Soil and Water Conservation Committee (ASWCC)

Authority: The Watershed Plan - Environmental Assessment (Plan) has been prepared under the Authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) as amended and supplemented. The Plan was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (Public Law 91-190, 42 United States Code [U.S.C] 43221 et seq.) and the Code of Federal Regulations [CFR] by which NRCS implements NEPA at 7 CFR Part 650 (42 U.S.C. 4321 et seq.).

Abstract: This document is intended to fulfill requirements of the NEPA and 7 CFR Part 650 to be considered for authorization of Public Law 83-566 (PL 83-566) funding for irrigation adoption within the Middle Alabama River Basin. 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.

Comments: The NRCS completed this Plan in accordance with the NEPA and 7 CFR Part 650, Section 306108 ("Section 106") of the National Historic Preservation Act (NHPA) of 1966 (Public Law 89-665, as amended by Public Law 96-515), and NRCS guidelines and standards (NRCS Title 390, National Watershed Program Manual [NWPM], Part 500). Comments and inquiries should be provided to the NRCS by November 28, 2024.

To submit comments, send an email to vernon.abney@usda.gov or via U.S. Mail to:

NRCS Alabama State Office
Attention: Vernon Abney, State Conservation Engineer
3381 Skyway Dr., Auburn, AL 36830-6443

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Office of Management and Budget (OMB) Fact Sheet

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<tr><td colspan="3">Summary Watershed Project Plan-Environmental Assessment for
Middle Alabama Basin Sustainable Irrigation Adoption Project
Butler, Clarke, Conecuh, Dallas, Lowndes, Marengo, Monroe, Perry, and Wilcox Counties
Alabama 1st, 2nd, and 7th Congressional Districts</td></tr>
<tr><td>Authorization</td><td colspan="2">Public Law 83-566 Stat. 666 as amended (16 U.S.C. Section 1001 et seq.) 1954.</td></tr>
<tr><td>Lead Sponsor</td><td colspan="2">Alabama Soil and Water Conservation Committee (ASWCC)</td></tr>
<tr><td>Proposed Action</td><td colspan="2">To protect existing farmland, agricultural labor, and valuable resource inputs, the proposed action would utilize allocated PL 83-566 funds to install irrigation infrastructure on non-irrigated agricultural land within the Middle Alabama River Basin Area (henceforth referred to as Middle AL Basin).</td></tr>
<tr><td>Purpose and Need</td><td colspan="2">There is a need in the Middle AL Basin to promote sustainable on-farm irrigation that protects the ecosystems and natural resources of the basin and ensures that farmers can manage drought stresses effectively by developing diffused, or decentralized, on-farm irrigation systems through the authorized purpose of Agricultural Water Management.

The need for irrigation is expected to increase as it lowers the risk of crop failures or reduced yields from unpredictable and untimely precipitation patterns. Climate change predictions support the need for irrigation adoption to improve agriculture resilience to droughts and unpredictable precipitation patterns.</td></tr>
<tr><td>Description of the Preferred Alternative</td><td colspan="2">The project would support the sustainable adoption of supplemental irrigation within the Middle AL Basin. Using University of Alabama in Huntsville (UAH) state irrigation survey data from 2005-2021, center pivot irrigated acreage has increased in the Middle AL Basin from a low of 258 acres (about 0.11 percent of total agricultural area) to 2,858 acres in 2021 (roughly 1.27 percent of total agricultural area) (Handyside, 2017). Most of this increase in irrigated land occurred during 2011-2013 (1,050-acre increase). Despite the variability involved in calculating the yearly average, the Sustainable Irrigation Adoption (SIA) Alternative is projected to increase that rate of irrigation adoption until available program funds are expended. Depending on farmer application needs, this alternative will allocate funding for the development or additions to water delivery/supply infrastructure and/or irrigation application equipment at the farm level; provided that previously rainfed acres are converted to newly irrigated acres.</td></tr>
<tr><td>Project Measures</td><td colspan="2">The irrigation practices proposed for cost-share include low pressure center pivots, micro-irrigation, linear/lateral irrigation, tow/traveler irrigation, plasticulture, and hand-moved/solid set sprinklers. Power systems available for cost-share may include but are not limited to phased electricity and power units. The sources of water that will potentially be used for the diffused irrigation systems include surface stream and/or groundwater, depending on what sources are available at the specific site level.

The type of irrigation infrastructure and necessary practices (e.g., pipes, pumps, power, application equipment, well development) and water source selected will vary depending on specific site location and project applicant needs.</td></tr>
<tr><td colspan="3">Resource Information</td></tr>
<tr><td colspan="3">Project Area</td></tr>
<tr><td>Watershed Names</td><td colspan="2">Middle Alabama Basin</td></tr>
<tr><td>8-digit Hydrologic Unit</td><td colspan="2">03150203</td></tr>
<tr><td>General Coordinates of the Watershed</td><td colspan="2">32.10873, -87.22244</td></tr>
<tr><td>Sub-watersheds: 12-</td><td>Number of HUC-12 Watersheds Overlapping the Middle</td><td>HUC-12 Watersheds with</td></tr>
</table>

digit Hydrologic Unit Code (HUC-12)	Alabama Basin Area	Existing Agriculture
	49	49
Climate and Topography	The project area is located in a warm temperate climate that is humid with hot summers. The average annual precipitation is 55 inches, with the maximum monthly value recorded in March at about 5.5 inches, and the minimum monthly value recorded in October at about 3.4 inches. The lowest average minimum temperatures occur in December and January, with values between 35 and 36 ºF. The highest average maximum temperatures occur in July and August with values approaching 92 ºF. Topography is generally characterized by gently rolling hills, sharp ridges, prairies, and alluvial flood plains. Elevation in the project area ranges from 33 to 591 feet.	

Land Use in the Middle AL Basin (total 1,425,869 acres)	**Use**	**Acres**	**Percentage of the Basin**
	Agriculture	225,156	16%
	Developed	39,950	3%
	Open Water	29,080	2%
	Wetlands	269,789	19%
	Forested Land	784,169	55%
	Shrubland	77,173	5%
	Barren	553	0%

Land Ownership in Alabama	**Owner**	**Percentage**
	Private	92.9%
	State-Local	7.1%

Population and Demographics		**Alabama**	**Middle AL Basin**
	Population	4,903,185	~148,000
	Population Below Poverty Rate	15.5%	27.3%
	Per Capita Income	$27,928	$19,019

Agricultural Production Land - Irrigation	**Type**	**Acres**	**Percentage of Total Land**	**Percentage of Total Agricultural Land**
	Irrigated Land (center pivot)	2,494	0.17%	1%
	Non-Irrigated Land	222,662	15.6%	99%

Agricultural Production Demographics within Middle AL Basin	Prime Farmland in Project Area	439,373
	Farmland of Statewide Importance	4,589
	Change in farmland acreage from 2012-2017	3.4%
	Change in number of farms from 2012-2017	3.7%
	Socially disadvantaged principal producers (%)	35%
	Full-time Operators (averaged)	35%
	Part-time Operators (averaged)	62.1%

Relevant Resource Concerns	Resource concerns identified through scoping are loss of farmland, underutilized agricultural resource inputs, water conservation and quality, groundwater, threatened and endangered species, soil resources, cultural and historic resources, socioeconomics, and land use.
Alternatives	
Alternatives Considered	Four alternatives were considered; two were eliminated from full analysis due to cost, logistics, existing technology and regulations, and environmental reasons. The No Action Alternative and SIA above current adoption Alternative were analyzed in full.

No Action Alternative	Under the No Action Alternative, the increase of agricultural land under new irrigation may occur. Using UAH state irrigation survey data from 2005-2021, center pivot irrigated acreage has increased in the Middle AL Basin from a low of 258 acres (about 0.11 percent of total agricultural area) to 2,858 acres in 2021 (roughly 1.27 percent of total agricultural area) (Handyside, 2017). Most of this increase in irrigated land occurred during 2011-2013 (1,050-acre increase). The need for the project would persist indefinitely, considering the lack of available cost-share for irrigation adoption. Taking into account the disparities presented by other factors such as land conversion, it cannot be assumed that irrigation adoption trends will remain constant over time.
Proposed Action	Under the SIA Alternative, PL 83-566 funding will be offered as cost-share by the SLO to support the implementation of site-specific infrastructural needs to put currently dry production land under irrigation. Funding is available to meet farmers' needs for power, pumps, pipes, developing or expanding upon existing water sources, and the following application equipment practices; low pressure center pivots, micro-irrigation, linear/lateral irrigation, tow/traveler irrigation, plasticulture, and hand-moved/solid set sprinklers, as well as telemetry and remote operation of irrigation practices along with irrigation prescriptions and scheduling assistances for a period of three years. The funding provided will depend on project applications and requirements and will be capped at $250,000 per individual producer. The SIE alternative is also the Preferred Alternative.
Mitigation, Minimization, and Avoidance Measures	Expanding irrigation will increase withdrawals from both surface and groundwater sources. However, the volume of water use anticipated considering the resources available is considered a minor use of the overall quantity of water available in the basin. In order to protect stream ecosystems and the overtaxing of surface water supplies, a novel flow duration methodology will be used. Withdrawals within any particular HUC-12 will be limited to the estimated streamflow volume that is exceeded 90% of the time during the growing season months minus the minimum 7-day, 10-year average flow volume. Additionally, an analysis of groundwater found that basin aquifers, such as the Eutaw and Ripley aquifers, could support 50 to 80 times more irrigated acreage than currently exists without reducing annual recharge rates by more than 10%, even if all irrigation was sourced from aquifers. Minimization measures include site selection criteria that promote use of existing, underutilized water sources. Other minimization measures include priority selection of farms with demonstrated conservation practices (e.g., cover crops, conservation tillage, and irrigation efficiency technologies) and best management practices. Once a potential site has been identified for project implementation, authorized NRCS personnel will conduct a site-specific environmental evaluation using the NRCS-CPA-52 form. This evaluation will determine risks to riparian, wetland, fish and aquatic species, soil erosion, water quantity/quality, invasive species, cultural resources and historic properties while also determining any additional mitigation features necessary. If there are no extraordinary circumstances present, the federal action will be tiered to this Plan-EA. Additionally, Alabama NRCS will invite the US Fish & Wildlife Service for on-site consultations if a T&E species is identified during the CPA-52 Process. The NRCS and USFWS have developed a protocol to address T&E Species. This programmatic agreement will be followed, utilizing a decision diagram, conservation practice matrix with potential effects, and recommended courses of action. This Plan-EA analysis involves a broad land treatment area (the Middle AL Basin) considered a "special case" under NRCS cultural resources policies and procedures. As such, the general conservation plan and practices (undertakings) proposed in this Plan cannot be tied to precise geographic locations for the installation of conservation practices (APE). Additional planning will be initiated at the field office level with accelerated technical assistance and is dependent on the participation and cooperation of the landowner(s) and producer(s). Further identification and evaluation of cultural resources

	and historic properties in compliance with "Section 106" of the NHPA and will be accomplished once landowner and producer participants are identified and NRCS-AL's site-specific Environmental Evaluation (EE) process is initiated (beginning with the Environmental Evaluation Worksheet [NRCS-CPA-52] and the NRCS-AL Cultural Resources Review form) and will follow review procedures outlined in the SPPA. NRCS-AL will then provide the proposed APE, identification of historic properties and/or scope of identification efforts, and assessment of effects to the AHC, Indian Tribes, and other consulting parties. This approach minimizes the potential for adverse effects to cultural resources and historic properties as it will follow the processes and procedures outlined in the SPPA and in compliance with 36 CFR Part 800 of the regulations implementing the NHPA. Technical assistance funding is available for mitigation measures if necessary.				
Project costs – Agricultural Water Management	**PL 83-566 funds**		**Other Funds (Producer Share)**		**Total**
	Amount ($)	Share (%)	Amount ($)	Share (%)	Amount ($)
Irrigation Equipment	$6,225,000	65%	$3,426,000	35%	$9,651,000
Engineering/Construction	Not Applicable				
Technical assistance	$389,000	100%	$0	0%	$389,000
SUBTOTAL COSTS	$6,614,000	65%	$3,426,000	35%	$10,040,000
Total OM&R	$0	0%	$10,673,000	100%	$10,673,000
Permitting	Any permitting costs will be borne by the applicant.				
TOTAL COSTS	$6,614,000	32%	$14,099,000	68%	$20,713,000
Project Benefits					
Project Benefits	Implementation of sustainable irrigation, the Preferred Alternative, would improve plant health and vigor, soil health, and protect water quality through the reduction of crop biomass loss. Irrigated crops produce more organic matter when combined with conservation practices, improving soil health. This contributes to better water-holding capacity and more efficient water availability, further reducing resource input requirements. Sustainable irrigation will protect water quality through improved use of nutrients compared to rainfed crops during a drought.				
Number of Direct Beneficiaries	The number of direct beneficiaries will depend on the number of entities that apply for program assistance and the amount of funding requested. Each applicant will be limited to $250,000. Based on the median farm size within this basin (117 acres) and estimated funding, as few as 37 farms may receive direct project funding.				
Other Beneficial Effects- Physical Terms	Secondarily, expanding irrigation would sustain farmland, protect labor, and decrease damages to crop yields.				
Damage Reduction Benefits	Implementation of the Preferred Alternative would provide supplemental irrigation during critical months of the growing season, thereby reducing crop loss resulting from decreased plant health and vigor. Inadequate precipitation for rainfed crops can lead to a production deficit for farmers in the Basin, which occurs when yields fall below the sustainable threshold (e.g., 110 bu/acre for corn). Historical data for the month of June indicate that decreased corn yields in rainfed systems are correlated to precipitation deficits approximately 60 percent of the time.				
Total Annualized Monetized Benefits	$725,000				
Total Annualized Monetized Costs	$794,000				

Annual Monetized Net Benefits	($69,000)	
Benefit-Cost Ratio	0.91	
Installation Period	4 years	
Project Life	30 years	
Period of Analysis	34 years	
Funding Schedule		
Year	Other Funds	Total
2025-2035	$3,426,000	$10,040,000

Environmental Effects

Air Quality – The Preferred Alternative is anticipated to have negligible or temporary effects on air quality from an increase of N_2O emissions resulting from the enhanced fertilizer applications which are usually done in conjunction with crop irrigation. Considering the average farm size in the Middle AL Basin, rainfed and irrigated scenarios, model results indicate 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. In addition, small increases in NO_2 emissions would occur if engines (diesel, natural gas) were used to drive generators. Given the relatively small areas and increase in application rates, impacts on overall air quality would be negligible or temporary.

Cultural and Historic Resources – This Plan analysis addresses a broad land treatment area (the Middle AL Basin) and as such, is considered a "special case" under NRCS cultural resources policies and procedures. In this Plan, NRCS-AL is proposing the general number and type of conservation practices (or "undertakings") that may be required on existing agricultural land in the treatment area (Middle AL Basin) to meet the stated project objectives. The Preferred Alternative involves five proposed conservation practices ("undertakings") that NRCS-AL has determined have the potential to affect subsurface (archaeological) cultural resources and historic properties as they are likely to exceed the existing depth of tillage or previous disturbance. However, the planning and installation sequence with this type of project does not allow NRCS-AL to tie the general conservation plan and practices (undertakings) proposed in this Plan to an exact Area of Potential Effects (APE) until landowner and producer participants in the project are identified. In accordance with NRCS cultural resources policies and procedures concerning "special cases," a general overview of previously identified cultural and historic resources in the Middle AL Basin treatment area is provided to inform the planning and decision-making process. Further identification and evaluation of cultural resources and historic properties in compliance with "Section 106" of the National Historic Preservation Act (NHPA) will be accomplished once landowner and producer participants are identified and NRCS-AL's site-specific Environmental Evaluation (EE) process is initiated (beginning with the Environmental Evaluation Worksheet [NRCS-CPA-52] and the NRCS-AL Cultural Resources Review form [Appendix E, Figure E-17]) and will follow review procedures outlined in the State-based Prototype Programmatic Agreement (SPPA; NRCS-AL, 2017:5-7). NRCS-AL will then provide the proposed APE, identification of historic properties and/or scope of identification efforts, and assessment of effects to the Alabama Historical Commission (AHC), Indian Tribes, and other consulting parties, as appropriate, in a format that complies with the NHPA in accordance with the State-based Prototype Programmatic Agreement (SPPA). Whenever possible, NRCS policy is to avoid effects to cultural resources and historic properties by either moving the conservation practice (or "undertaking") to another area, changing the work limits, changing to an acceptable alternative practice or measure, or modifying the practice design [see NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.10(C)]. The site-specific evaluation and review process should ensure there are no known or heretofore unknown cultural resources and historic properties that are adversely affected.

Geology & Soils – The Preferred Alternative would result in minor soil disturbance during the installation period. However, these effects will be short-term and localized to the irrigation installation site. Effects would be further minimized through implementation of soil stabilization measures during installation. The Preferred Alternative may result in increased runoff that could also carry sediment. Effects will be mitigated through NRCS conservation practices as part of the site selection process. Irrigated crops produce more organic matter when combined with conservation practices (emphasized in the site selection criteria) which improves soil health. This contributes to better water-holding capacity and more efficient water availability, further reducing resource input requirements. Sites identified for implementation will also undergo onsite evaluations as outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52) to identify and resolve additional mitigation measures required to reduce erosion. Anticipated effects are expected to be minor.

Land Use – The Preferred Alternative would sustain existing land use of agricultural land.. The project is designed to utilize existing farmland. The Preferred Alternative will encourage and promote continued agricultural land use in the basin area through the adoption of irrigation and minimization of risk of crop loss.

Public Safety – The Preferred Alternative may result in temporary safety risks during installation, operation and maintenance of the system due to heavy equipment, high-voltage electricity and use of petroleum products. Any short-term risks to public health and safety could be mitigated. Installing irrigation systems on existing farmland should not result in any permanent change to transportation routes. Expanding irrigation has the potential to create minor delays on local roads during installation. However, these would be brief.

Recreation – The Preferred Alternative is anticipated to have no effect/neutral effect on recreation. Considering the potential project areas are already designated and being used for agricultural production currently, there are no changes to recreational opportunities in the proposed project area.

Socioeconomics – A benefit cost analysis has been performed to evaluate the costs and benefits of increasing on-farm irrigation systems compared to the No Action Alternative. The Net Benefit (Average Annual Equivalent) is estimated with a benefit cost ratio of 0.9.

Vegetation – The Preferred Alternative would have negligible to minor impacts on vegetation. Irrigation implementation would be done on already established agricultural land and is expected to improve the health and vigor of the agricultural crops. Because center pivot coverage areas may not fit exactly to the shape of the crop fields, the project has some potential to create changes in habitat conditions which can have a range of impacts on T&E plant species. The extent of potential impacts on T&E species is difficult to evaluate until specific project sites have been identified by the NRCS and the SLO. Measures have been and will continue to be taken to prevent negative impact on T&E populations. Formal Endangered Species Act Section 7(a) consultation will occur, if necessary, to develop or negotiate reasonable and prudent measures to mitigate potential negative impacts, including cumulative effects. Based on this approach, the anticipated effects are expected to be of no impact to minor in intensity.

Visual Resources – The Preferred Alternative would have negligible to minor effect on the landscape. Existing farmland in the project area is not designated scenic and the irrigation features do not attract additional attention to the landscape.

Water Quantity – The Preferred Alternative would have minor effects on both the surface and groundwater supply. The withdrawal of water from streams for irrigation will lead to reduced flow in streams. It may also affect the statistical frequency of events such as hydrologic droughts and floods. Irrigation withdrawals typically occur during the growing season (spring-summer) and increase during dry or drought conditions. Withdrawals during a drought may exacerbate already low stream flows. This could result in impacts to in-stream and riparian habitats. Under the preferred alternative, any surface water withdrawals will be constrained to areas that are deemed sustainable using the Irrigation Potential Assessment (IPA). Streams near the watershed boundaries and stream orders that are less than 4 are not generally suitable for direct in-season surface water withdrawal. The IPA identifies areas where a more sustainable water source should be considered (i.e., groundwater or surface storage). Thus, as part plan implementation, impacts and risk to the overall surface water availability and environmental low flows will be

<table>
<tr><td colspan="2">minimal.

Water Quality - The Preferred Alternative may have minor effects on both surface and groundwater quality. Currently there are six 303(d)-listed streams in the basin, although only one of these streams is listed as impaired due to agricultural activity. Water quality could be impacted by increased nutrient runoff into surface waters, increased turbidity due to sediment transport and/or biological productivity, or nutrient leaching into groundwater due to irrigation applied in excess of field capacity. If irrigation is applied using best management practices, negative impacts are not anticipated. Supplemental irrigation can improve water quality through improved nutrient use efficiency of nutrients compared to rainfed crops during a drought. Projections for increased sediments or nutrients carried by surface waters are minor assuming the soil moisture is maintained at or below field capacity.

Wetlands and Riparian Areas – The Preferred Alternative is anticipated to have no adverse impacts on wetlands. The groundwater analyses previously described show that the water table in the region will not be adversely impacted so that the depth and extent of wetlands should remain unchanged. The planned spray and drip irrigation systems will not cause erosion and associated sediment transfer that could fill wetlands and reduce water quality. Expanded irrigation may result in slight increases of runoff and nutrient loads at some sites near existing wetlands. However, supplemental irrigation can improve water quality through improved nutrient use efficiency compared to rainfed crops during a drought. Installation of irrigation systems and related items may temporarily impact wetlands by increasing erosion and runoff from short-term construction activities to access water resources for irrigation. An on-farm evaluation (EE) per NRCS-CPA-52 will be required on a case-by-case basis to determine impacts and any required mitigation measures. Also, NRCS Conservation Measures as defined in the “Alabama NRCS Practice Effects on Threatened and Endangered Species” may be required to determine if additional mitigation measures are needed.

Wild and Scenic River - There would be no effects from the Preferred Alternative on the Wild and Scenic River or State Scenic Waterways designation. There are no Wild and Scenic Rivers in or directly downstream of the project basin.

Wildlife Resources – For the Preferred Alternative, all available data concerning Threatened and Endangered species (T&E), Species of Greatest Conservation Need (SGCN), and Migratory Bird Treaty Act (MBTA)/Bald and Golden Eagle Protection Act (BGEPA) species has been provided and would be used as guidance and overview as specific project sites are identified. After selection, each site will also undergo onsite evaluations as outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52). Expanding irrigation will involve practices that may require consultation with the U.S. Fish and Wildlife Service (USFWS). The SHU data will help inform NRCS personnel during specific project site evaluations of possible conflict or intersection. As outlined in the Alabama USFWS-NRCS Informal ESA Consultation, NRCS will determine if project implementation will have “no effect” or “may affect – not likely to adversely affect.” Refer to “Alabama NRCS Practice Effects on Threatened and Endangered Species” (see Appendix E, Table E-1 and Figure E-15). NRCS and the USFWS will consider cumulative effects where surface water withdrawals might impact streamflow volumes in a watershed to a degree that T&E species might be affected. Some projects will require consultation, including those which might cause cumulative effects. Based on this approach, with informal and formal consultation with the USFWS, the anticipated effects are expected to be negligible to minor.</td></tr>
<tr><td>Major Conclusions</td><td>Implementation of the Preferred Alternative would support the modernization of agricultural production and land use in this basin by protecting plant health and vigor, improving soil health, and protecting water quality by supplementing soils with poor water holding capacity during periods of uneven rainfall distribution, improve recovery of water stressed systems, and improve reliability of available water for farmers.</td></tr>
<tr><td>Areas of Controversy</td><td>There have been no areas of significant controversy identified. A few minor issues were raised in the scoping, assessment, and comment phases of the planning process. Areas of concern are addressed in the plan and will be mitigated following NRCS protocol to avoid controversy.</td></tr>
<tr><td>Issues to be Resolved</td><td>None</td></tr>
</table>

Evidence of Unusual Congressional or Local Interest	None
Compliance	Is this report in compliance with executive orders, public laws, and other statutes governing the formulation of water resource projects? Yes __X__ No_____

1. Introduction

Although the Southeast receives more annual rainfall than most of the United States (U.S.), it is still subject to periodic droughts, making the rainfall distribution throughout the year non-ideal for agricultural production (Limaye et al., 2004). A lack of widespread irrigation in the Middle Alabama Basin (*henceforth referred to as the Middle AL Basin*) increases crop failure risk and impacts to the environment.

Farmers in the project area, as well as throughout Alabama, experience either annual or seasonal periods of severe drought. These periods of drought impact the ability of farmers to produce crops reliably. Farmers commit their land, labor, and resources to producing a crop and face unreasonable risk due to a lack of precipitation. Without the ability to irrigate, one of the most critical plant growth variables (i.e., soil moisture) is left to chance. Conservation practices such as no-till cultivation and cover crops can provide limited protection from drought. Improved soils may allow a crop to survive three additional days without rain, but droughts often last longer. This region experiences “flash droughts” with no precipitation and high temperatures that may last between 7 and 14 days. A period this long without adequate soil moisture can lead to a complete crop loss.

Annual precipitation rates over 50 inches can provide the illusion of ample water, but the variability of precipitation during the growing season (March – July) and water lost due to evapotranspiration causes unsustainable damage during critical stages of growth. For example, the month of June is a critical growth period for corn because it is the beginning of the silking stage, which directly influences kernel weight and number. As corn is very sensitive during this time and can be directly compromised by factors such as drought and extreme heat, overall plant health can be predicted by the amount of precipitation and evapotranspiration during the month of June. If evapotranspiration is greater than the amount of precipitation, there is a precipitation deficit, and rainfed crops may become stressed due to inadequate precipitation.

While farmers may be successful in producing a sustainable crop in some years without irrigation, the long-term data reveal that low (or failed) rainfed crop yields are not sustainable. The sustainable yield threshold for corn in the Middle AL Basin is about 110 bushels per acre. This was calculated by averaging the United States Department of Agriculture – Economic Research Service (USDA-ERS) break-even yields for all costs and variable costs from 1996-2021. Below this threshold, farmers are in a production deficit since the commitment of land, labor, and resources is impaired or even lost for the growing season. Figure 1 displays June precipitation minus evapotranspiration averages 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). 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% of the time correlating to low yields. This analysis is described in more detail in Section 1.3.1.1. of Appendix D.

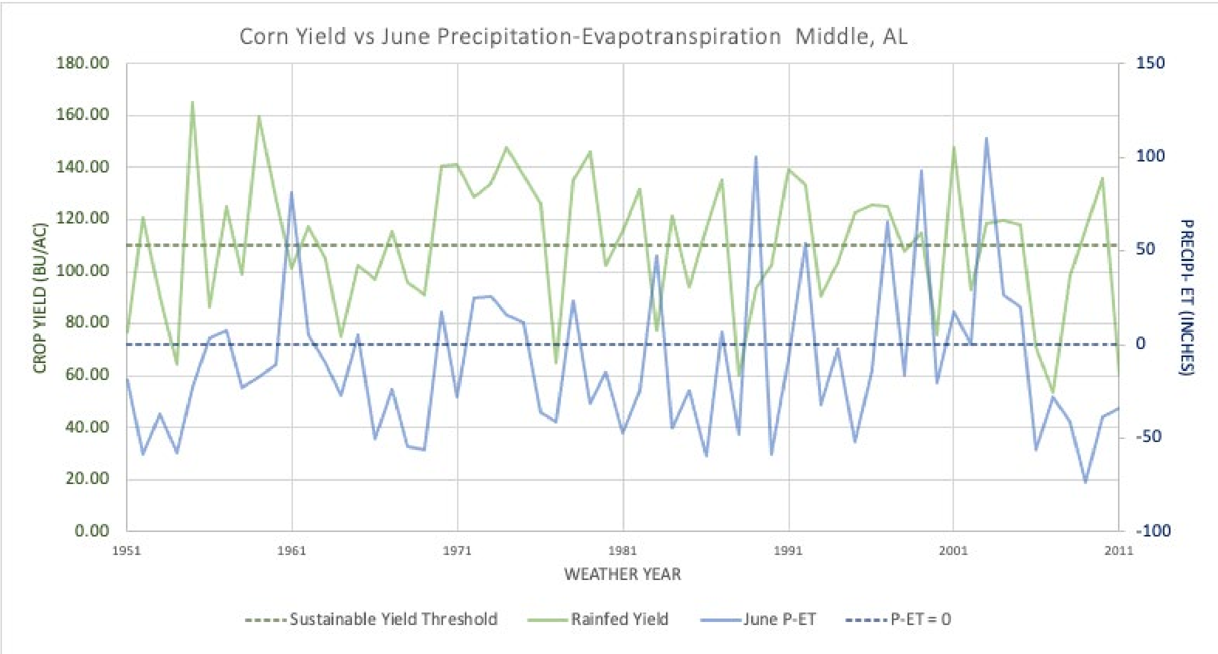

Figure 1. Corn Yields

While the annual precipitation rate in Alabama averages over 50 inches, annual rates typically ranged from 45 to 65 inches since 1900 with rates as low as 35 inches in some years. Growing season precipitation is highly variable, and climate change is expected to intensify the hydrologic cycle. Though there is still a lot of uncertainty, trends for growing season precipitation show an inclination towards slightly drier conditions (Carter et al, 2018). Irrigation can be a key climate adaptation strategy to bolster resilience (Rosa et al., 2020). Based on historical rainfall data, farmers will continue to face high rainfall amount and frequency variability. Investment in irrigation infrastructure in the Middle AL Basin will ensure farmers are able to mitigate the risk of crop loss due to climate variability.

Equally important as sustainable crop yields, irrigation has substantial impacts on soil health and water quality A crop that does not mature properly due to lack of moisture does not uptake nutrients, contributing to residual nutrients to be lost to surface or groundwater during rains. The impacts of irrigation on nutrient export and instream water quality depend on a range of factors, chiefly among them climate and soils (Hoos and McMahon 2009, Preston et al., 2011). In addition, the amount and timing of the inputs is also critical (Andres and Cuchi 2010, Cavero and Aragues 2003). Previous studies have shown that irrigation has the potential to increase or decrease nitrogen loads in streams, depending on the major transport mechanism (Liang et al. 1991; Allaire-Leung et al. 2001; Mahmood et al., 1998; Stites and Kraft, 2001; Domagalski et al., 2008; Merchan et al., 2013; Phene & Beale 1976; Hama et al. 2011, Negm 2017, Singh 2020). Fertilizer inputs are exported to nearby streams by both overland and subsurface transport. Many of studies that attribute a decrease in nitrogen loading due to irrigation cite the increased denitrification due to the increased soil moisture. Others have shown that irrigation can increase ground water leaching. Irrigated crops have been shown to have better nutrient use efficiency, especially in times of drought or in critical growth stages where rainfall is limited (19–21). A study in Alabama (Ellenburg et al. 2023, Ellenburg 2011) in clay soils, confirmed overland flow as the major transport mechanism (Hoos and McMahon 2009) and showed that irrigation had an overall minimal effect on N export and decreased nitrogen runoff in dry years despite irrigation receiving nearly double the amount of fertilizer. Additionally, the lack of healthy biomass contributes to more soil erosion and delivery of increasing sediment loads into the hydrologic system too. Additionally, a crop that does not mature reduces the amount of organic matter available for incorporation into the soil. Organic matter is linked to improved soil nutrient and moisture levels mitigating production loss.

Due to the widespread need for reduced agricultural production losses, considerations of water quality, and improvements in soil health, the development and management of water resources for agricultural uses in this basin is needed. The Alabama Natural Resources Conservation Service (NRCS) is working with the SLO, Alabama Soil and Water Conservation Committee (ASWCC), to allocate Public Law 83-566 “Watershed Protection and Flood Prevention Act” (henceforth referred to as *PL 83-566*) funding to support this ongoing need.

1.1. Decision Framework

This Watershed Plan-Environmental Assessment has been prepared to assess and disclose the potential effects of the proposed action. The Plan is required to request federal funding through the Watershed Protection and Flood Prevention Program, Public Law 83-566, authorized by Congress in 1954. This program is managed by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). Through this program, NRCS provides technical and financial assistance to project sponsors such as states, local governments, and Tribes to plan and implement authorized watershed project plans. The authorized purposes for these plans include watershed protection, flood mitigation, water quality improvements, soil erosion reduction, hydropower, irrigation, agricultural water management, sediment control, fish and wildlife enhancement, and rural, municipal, and industrial water supply. As the lead federal agency for this Plan, NRCS is responsible for review and issuance of a decision in accordance with the National Environmental Policy Act (NEPA). NEPA requires that Environmental Impact Statements (EISs) are completed for projects using federal funds that significantly affect the quality of the human and natural environment (individually or cumulatively). When a proposed project is not likely to result in significant impacts requiring an EIS, but the activity has not been categorically excluded from NEPA, an agency can prepare an EA to assist them in determining whether an EIS is needed (see 40 Code of Federal Regulations [CFR] 1501.4 and 1508.9; 7 CFR 650.8). For purposes of NEPA compliance, the intent of this Plan is to provide a programmatic platform for the implementation of the proposed action. The ASWCC partnered with NRCS to implement the Sustainable Irrigation Adoption Project within the Middle AL Basin under the watershed authority of the PL 83-566 program. In instances where agencies lack project-level discretion, or when multiple related actions can be better analyzed under one decision document, a programmatic level analysis may be applied. A programmatic level evaluation is applied under the following circumstances:

1. An agency funds project-level activities but has limited discretion in designing site-specific alternatives for addressing water resources issues.
2. An agency funds another entity to carry out projects or issue grants to address a specific water resources challenge; or
3. An agency proposes a set of similar projects analyzed under one decision document. Such projects may include those that individually do not have consequential water resources effects but have cumulative effects on water resources.

Tiering is a staged approach to NEPA as described in the Council on Environmental Quality’s Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1501.11) and the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (PR&G; DM 9500-013 7(c)). Broad programs and issues are described in initial analyses, while site-specific proposals and impacts are described in subsequent site-specific studies. The tiered process permits the lead agency to focus on issues that are ripe for decision and exclude from consideration issues already decided or not yet ripe. Tiering eliminates repetitive discussions of the same issues across site specific project groups through incorporation by reference to the general discussions. Tiering is appropriate when the sequence from an EIS or EA is:

1. from a programmatic, plan, or policy EIS or EA to a program, plan, or policy statement of narrower scope or to a site-specific statement or assessment.
2. from an environmental impact statement or environmental assessment on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or assessment at a later stage (such as environmental mitigation). Tiering in such cases is appropriate when it helps the lead agency to focus on the issues that are ripe for decision and exclude from consideration issues already decided or not yet ripe.

Due to the broad spatial scale of this analysis and the multi-year project group approach, this Plan does not identify the specific details associated with the engineering design and construction activities that would be required to implement the proposed action. Instead, this document intends to present an analysis in enough detail to allow implementation of a proposed action within the designated project area with minimal additional NEPA analysis.

Consistent with the tiering process as described above, before implementing each site-specific project, an onsite Environmental Evaluation (EE) review would occur using Form NRCS-CPA-52, the Environmental Evaluation Worksheet. The EE process will determine if that project site meets applicable project specifications, and whether the site-specific environmental effects are consistent with those as described and developed in this Plan. This process provides information for the Responsible Federal Official to determine if the proposed action has been adequately analyzed, and if the conditions and environmental effects described in the Plan are still valid. Where the impacts of the narrower project-specific action are adequately identified and analyzed in the broader NEPA document, no further analysis would occur, and the Plan would be used for purposes of the pending action.

A separate site-specific supplemental EA would be prepared if it is determined that the Plan is not sufficiently comprehensive, is not adequate to support further decisions, or if resource concerns or effects have not been adequately evaluated through the programmatic approach.

This Plan has been prepared in accordance with applicable Council on Environmental Quality's regulations for implementing NEPA (40 CFR 1500–1508), USDA's NEPA regulations (7 CFR Part 650), NRCS Title 190 General Manual Part 410, and NRCS' National Environmental Compliance Handbook Title 190 Part 610 (May 2016). This Plan has also been prepared in accordance with the Principles and Requirements for Federal Investments in Water Resources finalized in December 2014 along with the Interagency Guidelines and Agency Specific Procedures established in Department Manual (DM) 9500-013. These documents comprise the Guidance for Conducting Analysis Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Resource Investments (PR&G; USDA 2017). The PR&G revised and replaced the 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. The PR&G constitutes the comprehensive policy and guidance for federal investments in water resources.

The Plan meets the NRCS program policy of the 2015 NRCS National Watershed Program Manual (NWPM) and guidance of the 2014 NRCS National Watershed Program Handbook (NWPH) and serves to fulfill the NEPA and NRCS environmental review requirements for the proposed action. The Plan was prepared in compliance with the NHPA and NRCS cultural resources review policies and procedures.

1.2. Project Treatment Area

The Middle AL Basin encompasses 1,425,869 acres. The potential treatment area for project implementation will occur on existing agricultural land with no current irrigation present. This simplifies the potential project acreage to 225,156 acres, approximately 16 percent of the entire area of the Basin. The Middle AL Basin also encompasses all or portions of 49 HUC-12 sub-watersheds in Alabama. The project treatment area overlaps the following Alabama counties: Butler, Clarke, Conecuh, Dallas, Lowndes, Marengo, Monroe, Perry, and Wilcox (Figure 2). However, Conecuh is not included in this Plan as only 102 acres is within the treatment area and is currently non-agriculture forested land which is ineligible for this program. Most of the basin is in the 7th congressional district. Portions of the southeastern corner of the basin are in the 1st and 2nd congressional districts (Figure 3; U.S. Census Bureau, 2021).

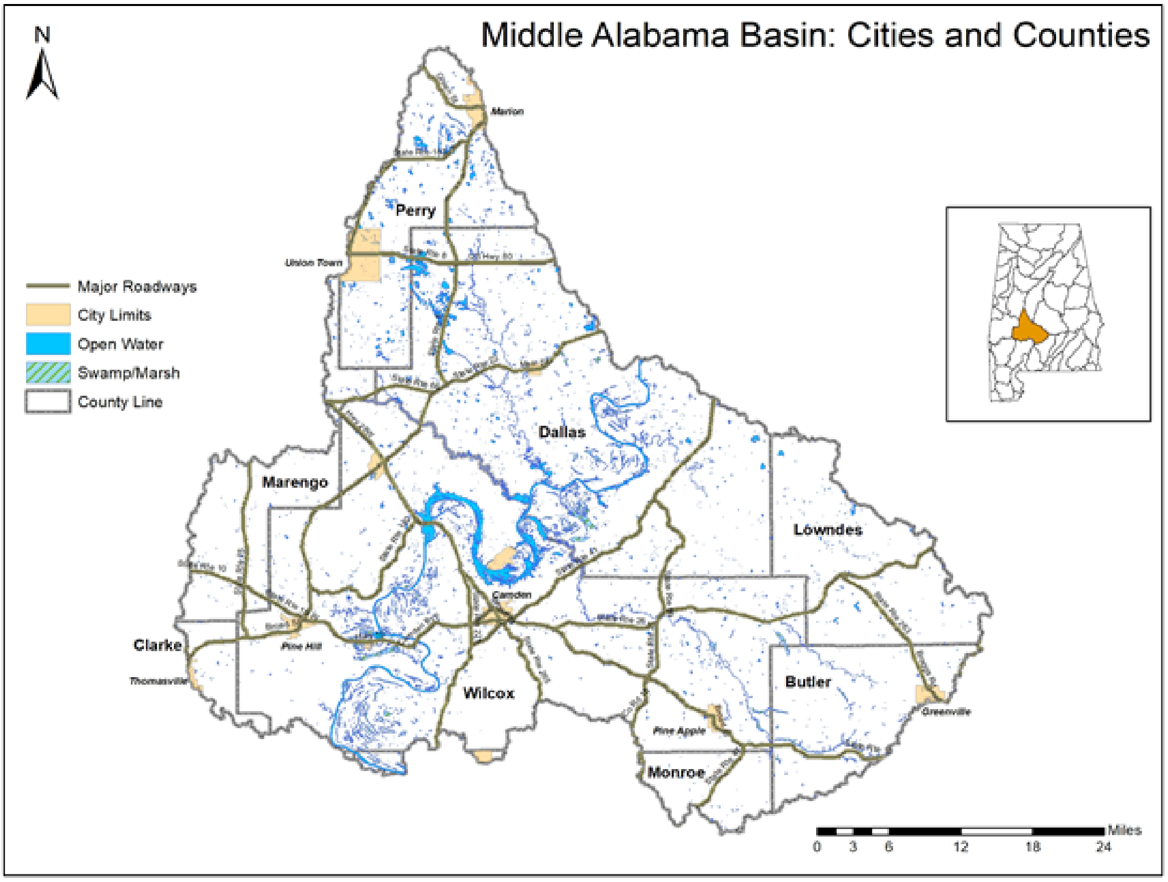

Figure 2. Map of the Middle AL Basin and Areas within Alabama counties

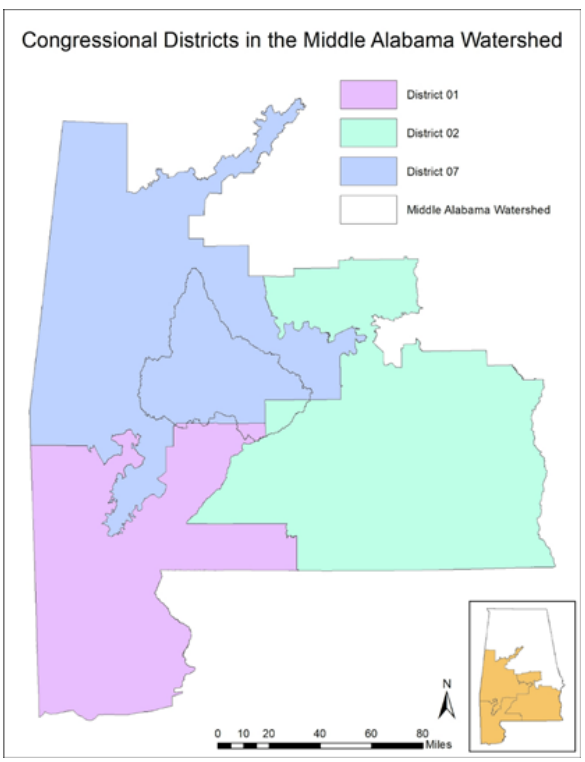

Figure 3. Map of Congressional Districts that Overlap the Middle AL Basin

2. Purpose and Need for Action

There is a need in the Middle AL Basin to promote sustainable on-farm irrigation that protects the ecosystems and natural resources of the basin and ensures that farmers can manage drought stresses effectively by developing diffused, or decentralized, on-farm irrigation systems through the authorized purpose of agricultural water management. The status of irrigation on harvested cropland in the Middle AL Basin area is considerably minor compared to Alabama's neighboring states. Just 6% of all harvested cropland in the counties in which the Middle AL Basin overlaps is irrigated (12,506 acres of 211,885 total harvested acres), and just 6% of all harvested cropland in the state is irrigated (National Agriculture Statistical Service [NASS], 2019a, pp. 345). In the neighboring states of Georgia and Mississippi, 35% and 43%, respectively, of all harvested cropland is irrigated.

The need for irrigation is expected to increase as it lowers the risk of crop failures or reduced yields from unpredictable and untimely precipitation patterns. Though still a fraction of neighboring states, irrigation was the fastest growing water withdrawal sector in Alabama between 2010 and 2015 with an increase of 11% in estimated withdrawal volume (Harper et al., n.d.), and irrigated acreage in Alabama increased by 26% from 2012 to 2017 according to USDA (NASS, 2019b). Therefore, there is a need to promote sustainable on-farm irrigation to both protect the environment and natural resources of the basin and to ensure that farmers can manage drought stresses effectively. This approach will bolster the resilience of the local agriculture economy as well as of U.S. agricultural productivity in the uncertainty of climate variability while protecting and promoting the ecosystem services of the basin.

To meet NRCS requirements for federal investments in a water resources project, the project must meet the Federal Objective set forth in the Water Resources Development Act of 2007 (42 U.S.C. §1962-3) as follows:

> "...National Water Resources Planning Policy - It is the policy of the United States that all water resources projects should reflect national priorities, encourage economic development, and protect the environment by:
>
> > (1) seeking to maximize sustainable economic development; (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems."

In addition to the purpose and need stated above, the project must also promote the Federal Guiding Principles identified in the 2017 Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (PR&G). The project should seek to meet the following six Guiding Principles:

1) Healthy and Resilient Ecosystems
2) Sustainable Economic Development
3) Floodplains
4) Public Safety
5) Environmental Justice
6) Watershed Approach

The proposed project is eligible for funding under PL 83-566 requirements as an "Authorized Project Purpose, Agricultural Water Management" which includes drainage, ground water recharge, irrigation, water conservation, water quality improvement, and agricultural (including rural communities) water supply.

2.1. Project Basin Problems and Resource Concerns

2.1.1. Flash Droughts

Though the plentiful rainfall across the state (>55 in/year on average) diminishes the amount of irrigation needed, supplemental irrigation has been shown to substantially increase yields, reduce risk of crop loss, and enhance farmers' resilience (Molnar et al., 2011; Ayars et al., 2006). Even short-term droughts during the growing season (March through August) can cause unsustainable damage during critical stages of growth. A combination of abnormally high temperatures and low precipitation rates can cause rapid onset of droughts known as flash droughts.

These short-term droughts are less likely to affect the regional hydrology, and thus a moderate amount of irrigation (4 inches/season on average) has the potential to protect crops during important growth stages (Hook et al., 2005). Without supplemental irrigation, these short-term droughts can have serious impacts on agriculture as has been seen as recently as 2019 (Schubert et al., 2021). For example, soil moisture is critical during the silking stage of a corn crop because it directly influences kernel weight and number. The silking stage usually occurs in late June for the Middle AL Basin. If evapotranspiration during this period is greater than the amount of precipitation, there is a precipitation deficit and rainfed crops will become stressed once any stored moisture is used. Climatology shows these short-term droughts are not uncommon across the State (Seager et al., 2009). In fact, long-term data reveal that precipitation deficits may have caused many unsustainable corn crop yields over the past five decades. The sustainable yield threshold for corn is about 110 bushels per acre. This was calculated by averaging the USDA ERS break-even yields for all costs and variable costs. Below this threshold, farmers are in a production deficit since the commitment of land, labor, and resources are impaired or even lost for the growing season.

While not a primary focus, crop insurance information provides insight into the risk of production loss that farmers face in this basin. Alabama crop insurers paid $45.9 million to cover crop losses in 2021 (NCIS, 2021). The average crop insurance indemnities for crop losses occurring within the Middle AL Basin between the years 2007 and 2021 were equal to $3,760,179 (USDA, n.d.). These crop insurance claims were primarily associated with drought and unfavorable climate conditions during the growing season. Furthermore, the anticipated reduction of both crop insurance dependency and the risk of crop losses, as well as an increase in financial security during times of need, may incentivize farmers to retain land ownership and continue agricultural production. However, only existing agricultural land is eligible for this project and, therefore, the land use in this area is not expected to change. Although Federal support of the existing agricultural production in this basin may incentivize farmers to continue providing a reliable food source needed for the future, potential land use changes are not a goal of this project and are not expanded upon further in this Programmatic Plan.

2.1.2. Soil Health and Water Quality

Properly managed irrigation can also protect basin water quality by reducing risk of nutrient and sediment runoff. A crop that does not mature properly due to lack of moisture does not uptake nutrients as planned, which allows residual nutrients from applied fertilizers to be lost to surface or groundwater during rains and an increase in soil erosion. Research has demonstrated that the risk of nitrate leaching into groundwater increases significantly in agricultural grasslands on clay-heavy soils when fertilized in a year with a drought period (Klaus, 2020). It is hypothesized that increased nitrate leaching through the topsoil during drought events is caused by larger macropores in the topsoil which develop during long drought periods. It has also been observed that nitrate concentrations in rivers can spike significantly following a prolonged drought once drainage from farmland resumes (Morecroft, 2006). In the Middle AL Basin, the primary transport mechanisms for on-farm nutrient loss are overland flow and subsurface drainage (Hoos and McMahon, 2009). This is due to fertilizer application applied early in the season and being transported by heavy rains in the spring and early summer and to some extent residual deep percolation during fallow periods. Ellenburg (2011) found that irrigation watered in the nutrients more effectively and resulted in a net reduction in nutrient loss. Properly managed irrigation can maintain adequate soil moisture levels in times of dry or drought conditions to prevent increased nitrate loss from the soil.

2.2. Project Basin Resources and Opportunities

The following list of resource opportunities would be realized through the implementation of the project:

- Improve soil health by preventing crop loss due to droughts.
- Improve water quality by reducing nutrient runoff because of crop loss.
- Improve the economic stability of the region by reducing risk of crop failures.
- Increase harvested crop yield and production efficiencies.

3. Summary of Scoping

3.1.1. Public Surveys

A survey with ten questions was distributed at each of the three scoping meetings. Likert-scale questions provided insight on how farmers perceive a need for irrigation in the area, while supplemental questions provided information as to why they selected one answer over another. This survey also provided an estimate of the types of production that occurs on farms in the basin and the irrigation infrastructure that farmers predict they will need. Results from the survey completed at the farmer scoping meetings can be found in Figures E4–E12 of Appendix E.

3.2. Identification of Resource Concerns

Main resource concerns identified throughout the scoping process included aquatic resources, groundwater, soils, surface water, water quality and quantity, threatened and endangered (T&E) species, and cultural resources and historic properties. Table 1 provides a summary of resource concerns and their relevance to the proposed action. Resources determined to be non-relevant were eliminated from detailed study, and resources determined relevant have been carried forward for analysis. In addition, PR&G requires transparent comparison of the effects of the alternatives for their contribution to the objective and guiding principles. Trade-offs with respect to the environmental, economic, and social goals are evaluated in Section 5.4.

Table 1. Summary of Resource Concerns

Resource	Relevant to the proposed action?		Justification
	Yes	No	
Air			
Air quality	X		Increased irrigation is associated with increased fertilizer application which may impact air quality. In addition, small increases in NO2 emissions would occur if engines (diesel, natural gas) were used to drive generators.
Clean Air Act		X	The Middle AL Basin is not located in a nonattainment area. All project induced impacts to air quality would be minor and of short duration and will not breach limits set by the Clean Air Act.
Geology and Soils			
Upland erosion	X		Potential for increased soil loss due to irrigation runoff.
Stream bank erosion	X		Potential for stream bank erosion during installation of surface water intake.
Sedimentation	X		Potential for additional runoff by increasing irrigation; may lead to more sediment transport.
Prime and unique farmland	X		Potential for protection and enhancement by increasing irrigation.
Human Environment			
Environmental justice	X		Project intended to benefit subject populations. Environmental Justice Groups are present in the basin, but no adverse impacts are anticipated by the project. Compliance with E.O. 12898.
Cultural and Historic Resources	X		Five proposed conservation practices have the potential to affect subsurface (e.g., archaeological) cultural resources and historic properties.
Land use		X	No impact. The land use in the project area is not expected to change due to the project.

Table 1. Summary of Resource Concerns

Resource	Relevant to the proposed action?		Justification
	Yes	No	
Land Ownership		X	No impact. The land ownership in the area will not change as a result of the project.
Financial feasibility	X		The project has potential to improve farm finances.
National parks and monuments		X	No impact.
Parklands		X	None impacted by the study. Project implementation will only be done on existing agricultural land.
Public safety		X	Minimal potential for injuries during temporary project construction and maintenance.
Recreation trails		X	None impacted by the study. Project implementation will only be done on existing, privately-owned agricultural land. There aren't any known public recreation trails in the basin.
Visual resources		X	Not impacted by the study.
Climate		X	Not impacted by the study. However, A lack of widespread irrigation in the Middle AL Basin increases crop failure risk and impacts to the environment.
Socioeconomics			
Local and regional economy			The local and regional economy is expected to benefit from this project. Actions proposed by this Plan recommends sustainable groundwater and surface water withdrawals that will cause minimal to no effect on competing interests.
National economic efficiency (NEE)	X		Federally assisted plan will attempt to improve economic efficiency.
Vegetation			
Invasive species/Noxious weeds		X	With implementation of BMPs the spread of noxious weeds and invasive species during construction would be minimized. Crop management techniques are expected to remove invasive species that would be of concern.
Forest Resources		X	Forest resources will not be impacted by this project.
Threatened or endangered species	X		Potential to "may affect." Impacts to both water quality and quantity may impact threatened & endangered aquatic species.
Natural areas		X	Project will have no effect on natural areas in the basin.
Riparian areas	X		Riparian areas may be affected by surface water intakes. Potential for stream bank erosion during installation of surface water intake.
Water			
Floodplain management		X	This project is not likely to increase risk of flood loss, or impact floods on human safety, health, and welfare, as stated in Executive Order 11988. Also, it will not result in any changes to existing floodplain ordinances.
Surface water quality	X		Potential for additional on-farm pollution runoff.
Surface water quantity	X		Potential for excess water withdrawal.
Groundwater quality	X		Potential for groundwater leaching.
Groundwater quantity	X		Potential for excess groundwater withdrawal.

Table 1. Summary of Resource Concerns

Resource	Relevant to the proposed action? Yes	No	Justification
Public water supply		X	Minimal potential to affect public water supply. Sites identified for implementation will undergo onsite evaluations as outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52) to identify any potential localized risk to water supply.
Wild and scenic rivers		X	There are no segments protected by the Wild and Scenic Rivers act or any segments listed in the Nationwide Rivers Inventory in this watershed.
Clean Water Act	X		Nationwide or individual permits may be required for projects if determined by NRCS consultation.
Wetlands	X		Potential for limited impact through additional runoff. Pipelines and center pivot tracts may need to cross small wetlands and would be evaluated for minimal effect exemptions.
Water Bodies (including waters of the U.S.)	X		Potential withdrawals for irrigation could have an impact on both the quantity and quality of a water body.
Coastal zone management areas		X	None in project area.
Fish and Wildlife			
Threatened and Endangered species	X		Potential to “may affect.” Impacts to both water quality and quantity may impact threatened and endangered aquatic species.
Essential fish habitat		X	None present in the project area.
General wildlife and wildlife habitat	X		Potential for affecting wildlife habitat through irrigation runoff that may cause erosion and sediment/nutrient transport.
Migratory Bird Treaty Act		X	No impact on these populations.
Invasive species		X	Project will not affect populations or re-location of invasive species.
Bald and Golden Eagle Protection Act		X	No impact on these populations.
Coral reefs		X	None in project area
Ecosystem Services			
Provisioning services	X		Provisioning services such as water supply and crops could be impacted by the proposed action.
Regulating services	X		Regulating services such as water purification and erosion control could be impacted by the proposed action.
Cultural services	X		Cultural services such as recreational services and appreciation of farming heritage could be impacted by the proposed action.

4. Affected Environment

Social, physical, ecological, and biological environment of the project area that may be affected by project implementation are described in this section. The project area and its political boundaries are defined in Section 1.1. Effects the project alternatives may have on ecosystem services, where applicable, are also described in this section as described in the PR&G (USDA, 2017). The ecosystem services concept describes the comprehensive set of benefits that people receive from a healthy, functioning ecosystem. Per federal guidance, ecosystem services in this Plan are assessed based on three of the four service categories (USDA, 2017):

1) Provisioning services: tangible goods provided for direct human use and consumption, such as food, fiber, water, timber, or biomass.
2) Regulating services: services that maintain a world in which it is possible for people to live, providing critical benefits that buffer against environmental catastrophe—examples include flood and disease control, water filtration, climate stabilization, or crop pollination.
3) Cultural services: services that make the world a place in which people want to live— examples include spiritual, aesthetic viewsheds, or tribal values; and
4) Supporting services: services that refer to the underlying processes maintaining conditions for life on Earth, including nutrient cycling, soil formation, and primary production.

This document does not evaluate supporting services because they give rise to and support the final ecosystem services described throughout the Plan.

4.1. Climate

4.1.1. Monthly Normals

A 75+ year dataset (Livneh et al. 2014) was used to characterize the climate over the Middle Alabama Basin. The climate dataset has an original horizontal resolution of 1/16 degrees which contains daily values of minimum temperature, maximum temperature, and precipitation for the period 1915-2011. This daily data was area weighted to the Middle AL Basin. These data were further averaged to monthly values for the 30-year period 1981-2010 which is the current period for climate normals in the U.S. These average monthly temperature values are displayed in Figure 4. The lowest average monthly minimum temperatures occur in December and January with values near 35^{o} F. The highest average monthly maximum temperatures occur in July and August with values near 90^{o} F. The average annual precipitation is about 55 inches with the maximum average monthly value occurring in March (about 5.5 inches) and the minimum average monthly value occurring in October (about 3.4 inches), as shown below in Figure 5.

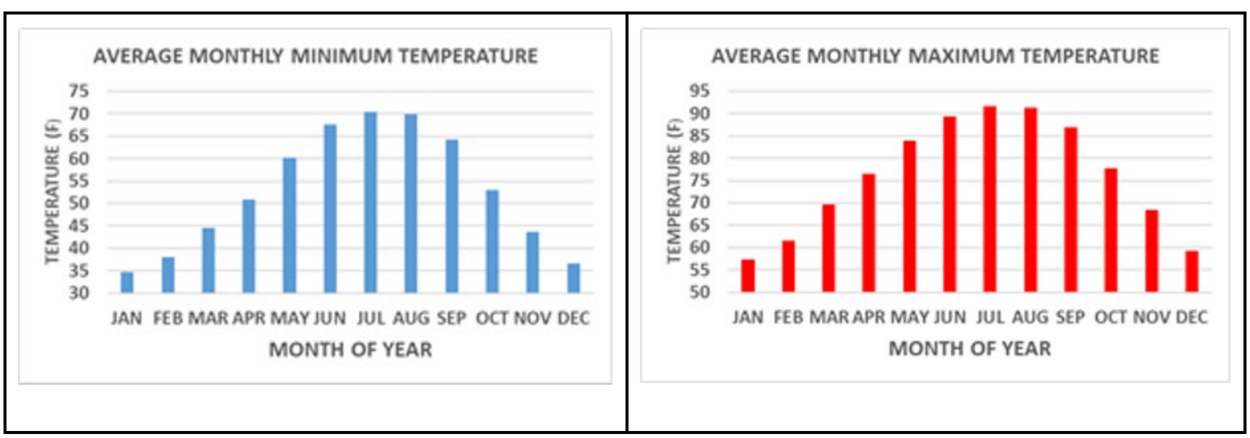

Figure 4: Average Monthly Minimum Temperature (left) and Maximum Temperature (right) for the Middle AL Basin (1981-2010)

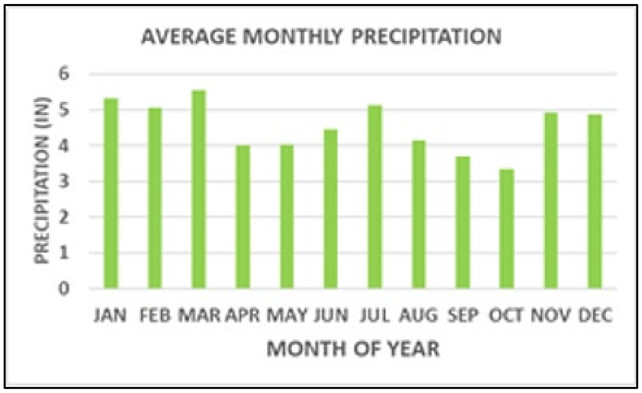

Figure 5: Average Monthly Precipitation for the Middle AL Basin (1981-2010)

4.1.2. Daily Precipitation

The daily precipitation data from 1981-2010 for the Middle AL Basin were sorted from smallest to largest and the cumulative distribution function was calculated and shown in Figure 6. The period comprises 10,957 days which, when divided by 30 years, gives an average year length of 365.23 days, which is equivalent to 100 percent of the data. The vertical axis in Figure 6 is labeled with respect to the "average day" rather than percentages. The 1-inch threshold is at about day 356 which leads to the conclusion that about 98 percent of the time daily precipitation amounts are 1 inch or less. The National Weather Service threshold for measurable precipitation at a given location is 0.01 inches. This threshold is at about day 173, so about 187 days of the year have values at or above this amount.

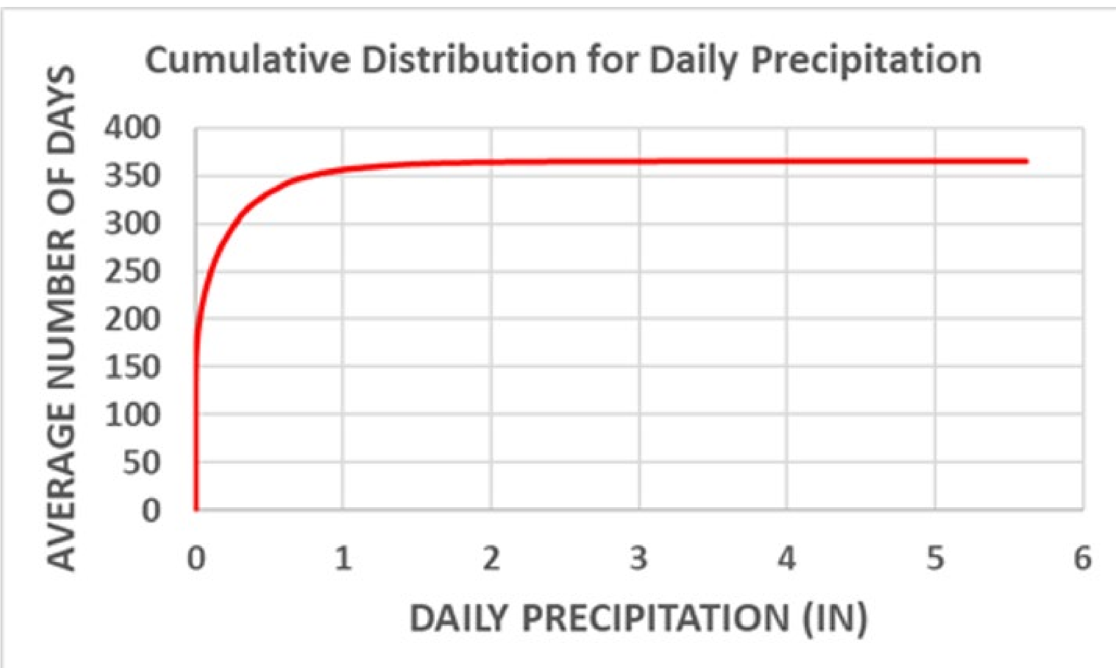

Figure 6: Cumulative Distribution Function for Daily Precipitation Values for the Middle AL Basin (1981-2010)

4.1.3. Historical and Projected Climate Trends

Alabama experienced above average temperatures in the 1930s and 1950s, followed by cooler temperatures in the 1960s and 1970s. Observed temperature since the 1900s show little if any overall warming over the past century (Carter et al., 2018). Though the Southeast U.S. has been warming at a similar rate as the rest of the United States since the 1960s, the Middle AL Basin region still shows little to no warming in summertime temperatures (Region 4, from Figure 7 in Christy, 2021). The biggest trend in temperature in Alabama over the past century is in nighttime temperatures with average daily minimum temperatures increasing three times faster than average daily maximum temperatures (Carter et al., 2018) with fewer record low temperatures than at any decade in the past century (Christy, 2021). Climate models predict that temperatures will rise 2-3 °F over the next 50 years (Carter et al., 2018), however there is some uncertainty as the models have often over estimated temperature in Alabama (Christy, 2021).

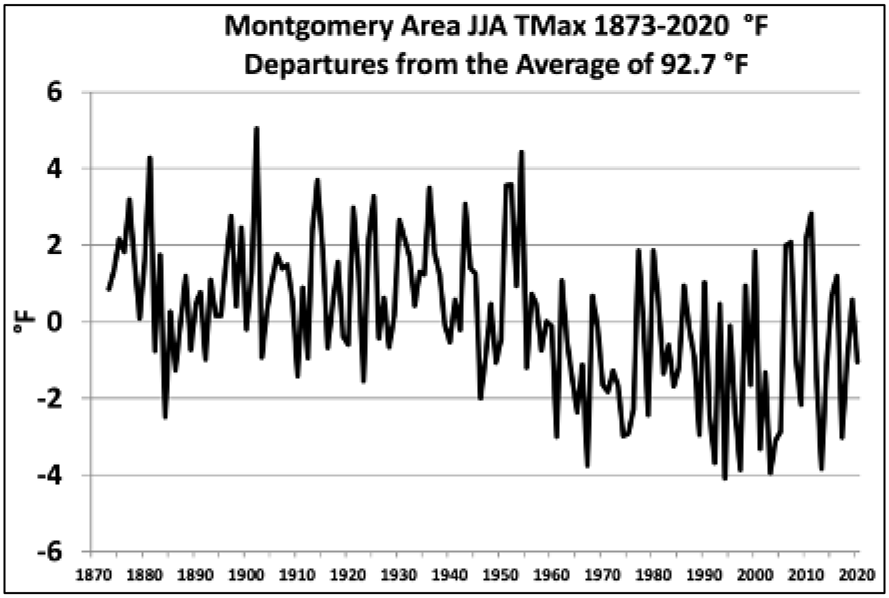

Figure 7: Summer (June, July, August) average daily high temperature for the Montgomery region in Alabama (From Christy, 2021)

Over the instrumental record, Alabama precipitation amounts show a slight positive trend of about 2.8 in/century, with differences from year to year ranging from 35 to 55 inches. Future projects show this trend to continue, with higher confidence in increases in the winter months. There is confidence (supported by historical trends) that heavy precipitation is becoming more intense (Carter et al., 2018). For Alabama, this relates to a +13 mm and +14 mm trend in the wettest days and wettest 2-day amounts, respectively (McKitrick and Christy, 2019).

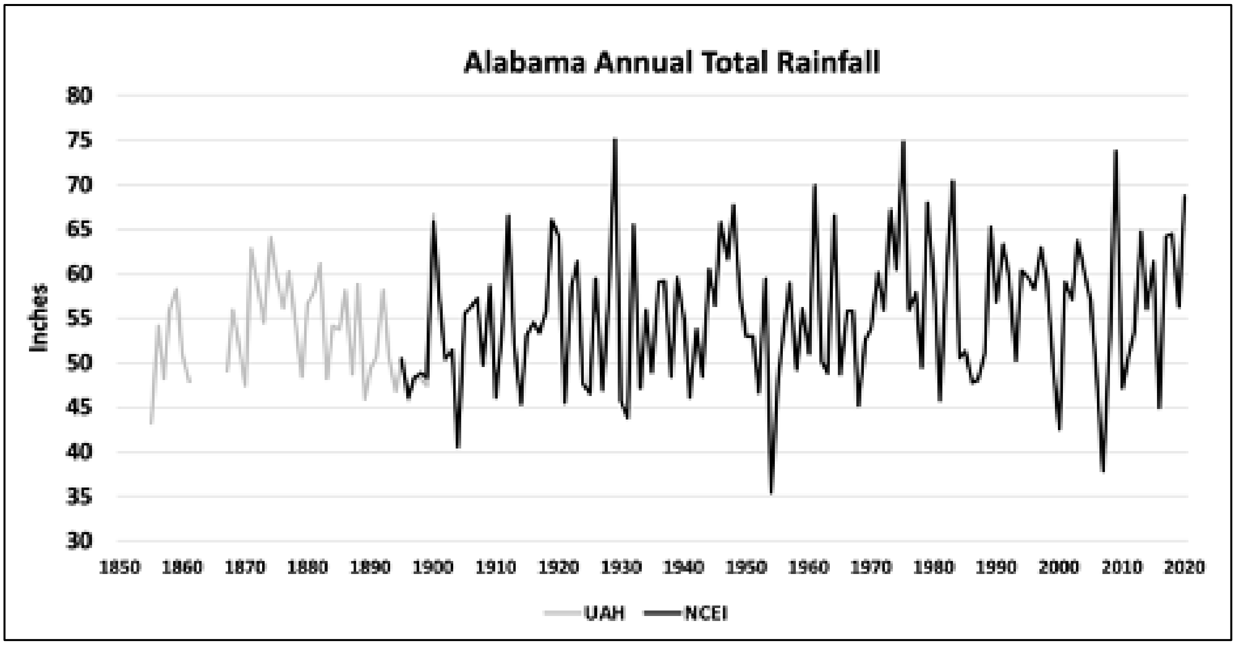

Figure 8. Annual total of geographically averaged precipitation over the state.
UAH assembled data prior to 1901 (gray) to begin the time series in 1855 to supplement NOAA/NCEI data starting in 1895. There are six years of overlapping data between UAH and NOAA/NCEI which produced a correlation of +0.999 between the two datasets (Christy, 2021).

Droughts are common across the state, with several major droughts occurring within the past decade. Figure 9 showcases the reconstruction of a common drought metric, the Standardized Precipitation Index, over Wilcox County in the Middle AL Basin. The figure shows the departure from normal of 9-month cumulative precipitation over the past century, representing longer-term hydrologic droughts.

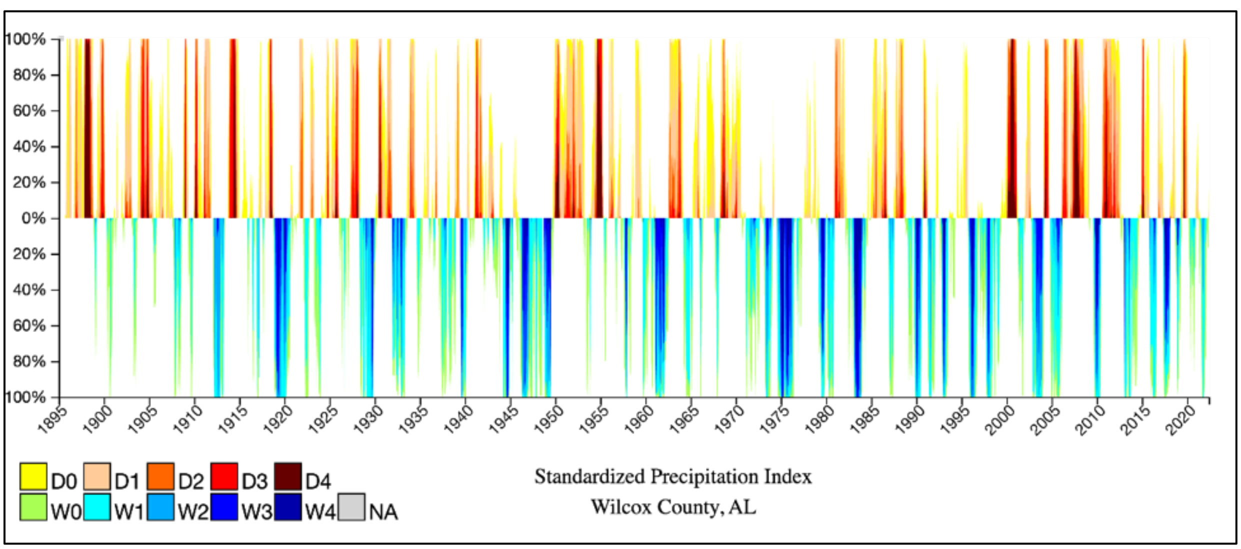

Figure 9: Standardized Precipitation Index for Wilcox County AL from 1985-2021 showing the occurrence of drought (color) and the percent of the county that experienced the conditions (y-axis).
Colors correlate to the U.S. Drought Monitor percentiles: D0 = Abnormally Dry; D1 = Moderate Drought; D2 = Severe Drought; D3 = Extreme Drought; D4 = Exceptional Drought; W0 = Abnormally Wet; W1= Moderately Wet; W2 = Severely Wet; W3 = Extremely Wet; W4 = Exceptionally Wet

In Alabama, growing season precipitation (May-July) is highly variable, with average monthly totals ranging from less than one inch to more than 15 inches and a standard deviation of 2.5 inches. Climate change is expected to intensify the hydrologic cycle. Future trends for growing season precipitation show an inclination towards slightly drier conditions (Carter et al, 2018), however, the variability in summertime precipitation is most critical for agriculture, where crops like corn need consistent moisture during important growth stages throughout the growing season.

With a rapid hydrologic cycle, the ecosystems in the Middle AL Basin have evolved to use the ample amounts of water, making short-term deficits of precipitation especially important for shallow rooted vegetation. When average precipitation is less than average evapotranspiration, plants may become stressed. In months where ET is greater than precipitation, conditions can be agriculturally "dry" due to a precipitation deficit. The opposite can be said when average evapotranspiration is less than average precipitation and can be considered "wet" due to adequate precipitation. Figure 10 shows the percent of time these conditions (wet vs dry) occur of the growing season months for a 96-year period form 1916 - 2011. Data indicate a lack of adequate water for crops during the growing season in the Middle AL Basin. More details on this analysis and further explanations can be found in Appendix D Section 4.

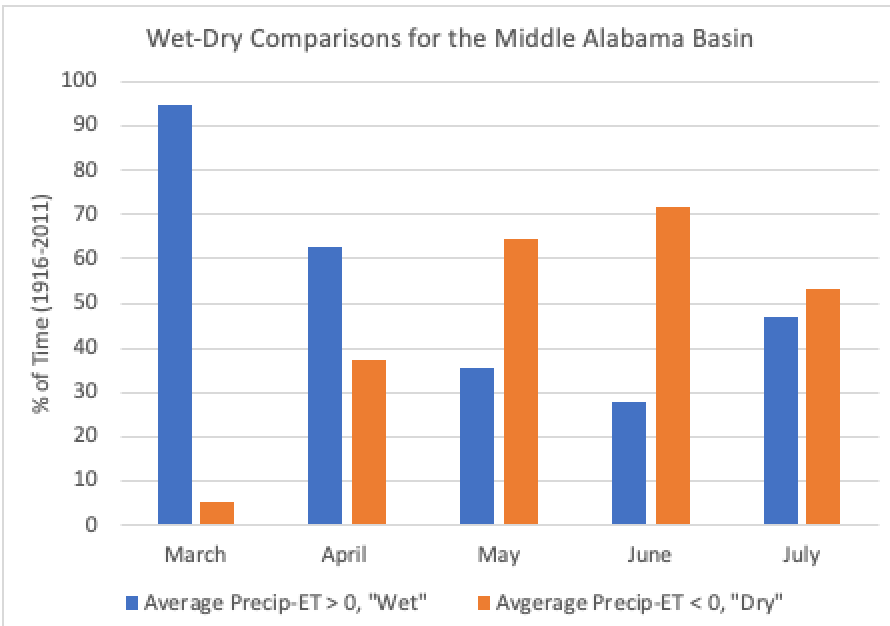

Figure 10: Percentage of Time that Months During the Growing Season (March –July) Were Wet or Dry 1916–2011

4.2. Agriculture

4.2.1. Recent Change in Agricultural Production

Agricultural production data such as farm size and number of farms were assessed by county using information from 2017 Census of Agriculture (USDA NASS).

There were 3,395 farms in the counties that overlap the Middle AL Basin in 2017 (Table 2; USDA NASS, 2019*a*). Dallas County had the most farms with 528, while Wilcox County had the least with 318 farms. The eight counties had a total of 1,232,325 acres of farmland. The number of farms across Alabama from 2012 to 2017 decreased by 6.1 percent, but the number farms in the counties of the Middle AL Basin increased by 3.8%. The number of farms in Clarke County increased by 21.7 percent increase and lowest in Perry County with a decrease of 10.3 percent. In total, the counties within the basin experienced an increase of 94 farms from 2012 to 2017.

Dallas County had the most farmland acreage with 263,114 acres and Clarke County had the least with 64,589 acres. The total acreage for farmland in Alabama is 8,580,940 acres. The percent change in farmland acreage from 2012 to 2017 in Alabama decreased by 3.6 percent. Within the counties making up the Middle AL Basin, change in farmland acreage ranged from 38.2 percent in Wilcox County to a decrease of 10.9 percent in Marengo County (U.S. Census Bureau, 2021). Nonetheless, there was an increase in the change of acreage within Clarke County and Perry County. Overall, the counties within the basin experienced an increase of 40,654 acres between 2012 and 2017.

Table 2. Change in Agricultural Land and Farms of Counties in the Middle AL Basin and Alabama from 2012 to 2017

County	Number of Farms			Land in Farms (acres)		
	2012	2017	Percent Change	2012	2017	Percent Change
Butler	407	420	3.2%	88,398	84,382	-4.5%
Clarke	263	320	21.7%	47,496	64,589	36.0%
Dallas	506	528	4.4%	255,114	263,114	3.1%
Lowndes	441	512	16.1%	217,760	202,907	-6.8%
Marengo	499	471	-5.6%	165,436	147,375	-10.9%
Monroe	480	477	-0.6%	140,597	141,456	0.6%
Perry	389	349	-10.3%	157,250	163,224	3.8%
Wilcox	316	318	0.63%	119,620	165,278	38.2%
Total of counties	3,301	3,395	2.8%	1,191,671	1,232,325	3.4%
Alabama	43,223	40,592	-6.1%	8,902,654	8,580,940	-3.6%

Note: Data retrieved from USDA NASS, 2019a, pp. 315–334.

4.2.2. Agricultural Crops

From 2018 to 2019, both Dallas and Perry Counties produced between 50,000-1,499,999 bu of corn (USDA NASS, 2017). In addition, Dallas County also produced 145,000 bu of soybeans in 2019 (USDA NASS, 2017). According to USDA's Ag Census, the eight counties of the basin account for 4 percent of State agricultural sales. Lowndes County is ranked 8th in the state for nursery, greenhouse, floriculture, and sod sales, as well as ranking 1st in cattle and calf sales. Dallas County ranks 13th in the state for vegetables, melons, potatoes, and sweet potatoes, and Butler County ranks 15th for fruit, nut, and berry sales (USDA NASS, 2017).

4.2.3. Irrigation Status

The area of irrigated land in the Middle AL Basin area and Alabama is minor compared to Alabama's neighboring states (Table 3; USDA NASS, 2019b, pp. 383–393). A map of existing irrigation density by sub-watershed is depicted in Appendix C, Figure C-4, and locations of existing center pivots within the Middle AL Basin are depicted in Appendix C, Figure C-5.

Table 3. Irrigation Status of Counties in the Middle AL Basin, Alabama, Neighboring States, and The United States in 2017

Description	Counties in Middle AL Basin[1]	Alabama[2]	Florida[2]	Georgia[2]	Mississippi[2]
Number of farms with irrigation	137	1,891	11,228	6,191	2,561

Acres irrigated at least once in the past five years	20,633	168,394	1,749,073	1,485,829	1,979,093

[1]Data includes entire counties of Butler, Clarke, Dallas, Lowndes, Marengo, Monroe, Perry, and Wilcox; USDA NASS, 2019a, pp. 345–350.
[2]USDA NASS, 2019b, pp. 383–393.

An important factor in irrigation efficiency is irrigation scheduling. Table 4 depicts data from the 2018 Irrigation and Water Management Surveys (USDA NASS, 2019c, p. 88) on methods used by farms in Alabama to determine when to irrigate. The vast majority of farms with irrigation, 93%, selected "Condition of crop," while 42% of farms selected "Feel of soil." Using a "Personal calendar schedule" was selected by 9% of farms, and "Soil moisture sensing device" was selected by 8%.

Table 4. Methods Used by Farms in Alabama in Deciding When to Irrigate in 2018

Method	Number of farms[1]	Percent of irrigated farms
Farms reporting any method	1,069	100%
Condition of crop	991	93%
Feel of soil	452	42%
Soil moisture sensing device	82	8%
Plant moisture sensing device	2	0.2%
Commercial or government scheduling service	11	1%
Reports on daily crop-water evapotranspiration (ET)	7	0.7%
Scheduled by water delivery organization	27	3%
Personal calendar schedule	100	9%
Computer simulation models	0	0%
When neighbors begin to irrigate	11	1%

Note: Data retrieved from USDA NASS, 2019c, p. 88.
[1]Respondents could select more than one method.

In 2018, 408 farms, or 38% of farms with irrigation, in Alabama discontinued irrigation since the previous year (Table 5; USDA NASS, 2019c, pp. 97–99). As reported in Section 2.1, rainfall quantity and seasonal distribution in Alabama is variable. In some years, when rainfall is sufficient, irrigation may not be needed or beneficial. A plurality of farms that discontinued irrigation, 75%, reported "sufficient soil moisture" as a reason for discontinuing irrigation in the 2018 season. Of farms that discontinued irrigation since the previous year, 126 farms reported the discontinuance to be permanent. That is 31% of farms that discontinued irrigation since the previous year and 12% of all irrigated farms in 2018. Among farms that stopped using irrigation since last year, 25% cited "Irrigation is uneconomical" as a reason. This suggests that in years with sufficient rainfall, farmers find it hard to justify the cost of maintaining irrigation systems. Only 12% of farms cited a "shortage of groundwater" as a reason for discontinuing irrigation, with none mentioning a "shortage of surface water." These findings indicate that water availability is rarely a barrier to irrigation use in Alabama; rather, the primary obstacle is the cost.

Table 5. Discontinuance of Irrigation and Reasons for Discontinuance Among Irrigated Farms in Alabama in 2018

Discontinuance description	Number of farms[1]	Percent of farms that discontinued irrigation since previous year

Farms reporting discontinued irrigation since previous year	408	100%
Farms reporting discontinuance to be permanent	126	31%
Reasons for discontinuance		
Sufficient soil moisture	308	75%
Shortage of surface water	0	0%
Shortage of groundwater	50	12%
Irrigation is uneconomical	100	25%
Loss of water rights	0	0%
Sold or leased water rights or annual water allocation	N/A[2]	0%
Sold or leased irrigated land or irrigated area under protection	0	0%
Restrictions on water use	0	0%
Converted to non-agricultural uses	0	0%
Converted to agricultural enterprise not requiring irrigation	0	0%
Available surface water too salty	0	0%
Other or unspecified	25	6%

Note: Data retrieved from USDA NASS, 2019c, pp. 97–99.
[1]Respondents could select more than one method.
[2]Not applicable.

4.2.3.1. Irrigation Adoption

Using UAH state irrigation survey data from 2005-2021, center pivot irrigated acreage has increased in the Middle AL Basin from a low of 228 acres in 2006 (about 0.11 percent of total agricultural area) to 2,858 acres in 2021 (roughly 1.27 percent of total agricultural area) (Handyside, 2017). Most of this increase in irrigated land occurred during 2011-2013 (1,050-acre increase).

4.2.3.2. Conservation Practices

The adoption of agricultural conservation practices is promoted throughout the Middle AL Basin from efforts by NRCS-AL, ACES, and ALSWCC. These efforts include extension and outreach programs, farmer meetings, promoting variable rate irrigation and soil health research, and financial assistance for best management practices (BMPs).

In the eight counties of the basin, approximately 35,494 acres of cropland in 2017 were operated using conservation tillage (no-till), and 20,813 acres of cover crops were planted on cropland (Table 6; USDA NASS 2019a, pp. 536–546).

Table 6. Conservation Tillage and Cover Crop Usage in the Middle AL Basin in 2017

County	Number of Cropland Operations with Conservation Tillage, No-Till[1]	Acres of Cropland with Conservation Tillage, No-Till[1]	Acres of Cropland with Cover Crops Planted[1]
Butler	30	3,455	167
Clarke	12	138	598
Dallas	30	11,512	9,442

Table 6. Conservation Tillage and Cover Crop Usage in the Middle AL Basin in 2017

County	Number of Cropland Operations with Conservation Tillage, No-Till[1]	Acres of Cropland with Conservation Tillage, No-Till[1]	Acres of Cropland with Cover Crops Planted[1]
Lowndes	20	5,352	658
Marengo	17	5,418	1,151
Monroe	31	5,034	4,652
Perry	19	4,346	3,780
Wilcox	7	239	365
Alabama	**2,709**	**765,356**	**229,097**
United States	**279,370**	**104,452,339**	**15,390,674**

Note: County and Alabama data retrieved from USDA NASS, 2019a, pp. 536–546. United States data retrevied from USDA NASS, 2019b, p. 643.
[1]Data includes Butler, Clarke, Dallas, Lowndes, Marengo, Monroe, Perry, and Wilcox Counties.

Alabama is notably competitive in the use of conservation tillage and cover crops in comparison with neighboring states (Table 7; USDA NASS, 2019b).

Table 7. Comparison of BMPs Among Alabama and Neighboring States

Best Management Practice	Alabama	Florida	Mississippi	Georgia
Acres of cropland[1]	2,818,783	2,825,803	4,960,620	4,372,134
Acres of conservation tillage, no-till[2]	765,356	244,994	637,181	748,083
Acres of cover crops planted[2] (excluding CRP[3])	229,097	141,848	139,639	530,888
Percentage of cropland with conservation tillage present	27%	9%	13%	17%
Percentage of cropland with cover crops planted	8%	5%	3%	12%

[1]USDA NASS, 2019b, pp. 253–263.
[2]USDA NASS, 2019b, pp. 643–653.
[3]Conservation Reserve Program.

4.2.4. Prime Farmland

According to the NRCS, prime farmland is described as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding" (Soil Science Division, 2017).

There are 439,373 acres of prime farmland within the boundaries of the Middle AL Basin. This represents approximately 31 percent of the entire basin. In addition, a portion (4,589 acres) of farmland of statewide importance is found within the basin (Appendix C, Figure C-6). The NRCS defines land that does not meet the criteria for prime or unique farmland as farmland of statewide importance to produce food, feed, fiber, forage, and oilseed crops.

4.2.5. Ecosystem Services

Provisional service; crops for food, fuel, and fiber. Farmers in the Middle AL Basin face high risk of reduced plant health and vigor as rainfall amounts throughout the growing season remain unpredictable. Healthy crops improve the efficiency of fertilizer uptake by plants and stabilize soils in fields thereby reducing nutrient and sediment runoff into the hydrologic system. As described in Section 4.5.2, agricultural land receiving water from the Alabama River and its tributaries as well as from the various aquifers is delivered to agricultural, municipal, and industrial patrons. The provision of this water allows lands to be maintained for agricultural production. Feeding grasses, including hay and pasture, contribute to the production of meat and dairy food. This water is also used to grow crops and food for people within the community.

Cultural service; farming heritage, sense of place and connection. Farmers in the Middle AL Basin face many challenges. One major challenge in this area is heirs' property. Heirs' property is land that is jointly owned by descendants of a deceased person whose estate did not clear probate. The heirs have the right to use the property, but they do not have clear or marketable title to the property. Farmers who work on such properties are limited in the benefits of cultural services from farming. The USDA Heirs' Property Relending Program is available and will be utilized to help interested producers resolve land ownership and succession issues on agricultural land.

4.3. Land Use and Cover

Current land use in the Middle AL Basin comprises the following categories: forest (55 percent), agriculture (16 percent), shrubland (5 percent), wetlands (19 percent), open water (2 percent), and barren land (0 percent). The breakdown of the basin land use is depicted in Table 8. Furthermore, the areas of the varying land usages are illustrated in Appendix C, Figure C-3.

Table 8. Land Use and Acreage in the Middle AL Basin

		Acres	Percentage of Watershed[1,2]
Total Acreage of Basin		1,425,869	100%
Agricultural Production	**Total**	225,156	16%
	Irrigated	2,494	1%
	Rainfed	222,662	98%
Forested Land		784,169	55%
Developed Land		39,950	3%
Open Water		29,080	2%
Wetlands		269,789	19%
Shrubland[3]		77,173	5%
Barren[4]		553	0%

[1]Data retrieved from USDA NASS, 2020b.
[2] The percentages of each land use category were rounded to the nearest whole, thus, the sum of all the parts may differ from 100%.
[3] Shrubland is a region dominated by bushes or small trees.
[4] Barren land is land where plant growth may be sparse, stunted, and/or contain limited biodiversity.

4.4. Geology and Soils

4.4.1. Geology

The Middle AL Basin lies within the East Gulf Coastal Plain physiographic section of Alabama. Geologic units underlying the Coastal Plain are of sedimentary origin and consist of sand, gravel, limestone, and clay. The East Gulf Coastal Plain comprises over 50 percent of the land area in Alabama. The Middle AL Basin consists of six physiographic districts: Fall Line Hills, Alluvial, Black Belt, Chunnenuggee Hills, Southern Red Hills, and Lime Hills. See Appendix C, Figure C-7 for a generalized map of the geology of the Middle AL Basin.

4.4.1.1. Physiographic Districts of the Middle AL Basin

A very small portion of the Fall Line Hills physiographic district is found in the most northern part of the Middle AL Basin, in Perry County (Figure 11). The region forms a major south to southeast boundary to the Highland Rim, Cumberland Plateau, Alabama Valley and Ridge, and the Piedmont Upland. Streams draining the Fall Line Hills are well sustained due to the extensive sand and gravel aquifers below that contribute to flow. Topography in the area is rugged with steep slopes (GSA, 2018).

The Black Belt is located immediately below the Fall Line Hills district and is an undulating, deeply weathered plain, developed on chalk, marl, and limestone. This bedrock material weathers into fertile soils with shrink-swell properties. This unique region can be attributed to the thin soils and impermeable rocks. Small streams in this district often go dry while flow in larger streams may also be reduced. These features contribute to the overall dryness of the region, and once provided suitable habitat as grasslands (GSA, 2018).

The Chunnenuggee Hills district consists of a series of pine-forested sand hills and cuestas developed on chalk and more resistant beds of clay, siltstone, and sandstone. The Tombigbee and Alabama Rivers of the Mobile River Basin traverse the Chunnenuggee Hills (GSA, 2018).

The Southern Red Hills, characterized by cuesta ridges with steep north slopes and gentle back slopes, can be delineated into the Flatwoods and the Buhrstone Hills. The Flatwoods is developed on dark clays in marls, leading to stiff, plastic soils and making it difficult to locate groundwater in the area. The Buhrstone is characterized by rugged terrain, developed on hardened claystone and sandstone. Streams in the area have high gradient, rock bottoms, and swift flows (GSA, 2018).

The resistant limestones of west Alabama led to the Lime Hills district. Streams cutting through alluvial sediments give way to interesting aquatic habitats, with the stream beds closely resembling those of the Buhrstone Hills (GSA, 2018).

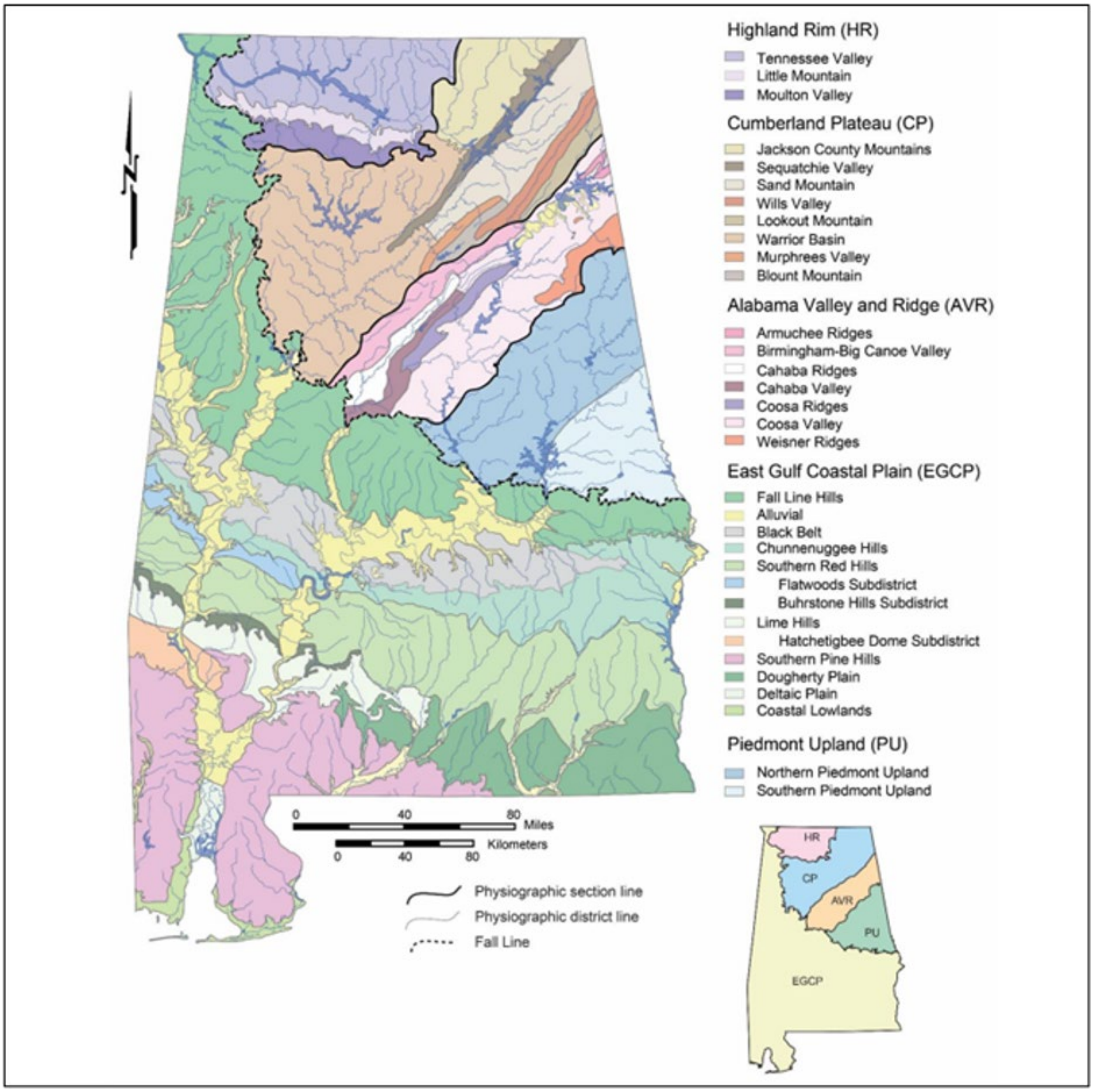

Figure 11. Physiographic Regions of Alabama

4.4.2. Soils

The Middle AL Basin consists of Coastal Plain, Blackland Prairie, and Major Flood Plains and Terraces soils (Figure 12). Soils in the Basin are composed of high clay content which often results in excess runoff after large-scale precipitation events. Historically, this area consisted of prairie lands and to a small extent, small grains. Rainfed agriculture suffers from the considerable amounts of montmorillonite clay, which have a low water holding capacity, and also tend to shrink and swell with changes in soil moisture. Thus, during dry summer periods, inadequate rainfall can make cultivation difficult, if not impossible.

The Major Flood Plains and Terraces soils are not extensive but important when they are found along streams and rivers (Mitchell & Loerch, 2008). They are derived from alluvium deposited by the streams. The Cahaba, Annemaine, and Urbo series represent major soils of this area. Production within the typical area consisting of these soils include cultivated crops on the nearly level terraces and bottomland hardwood forest on the flood plain of streams (Mitchell & Loerch, 2008).

The East Gulf Coastal Plain province incorporates the Black Belt, which is composed of sedimentary soils derived either directly from ocean sediments, or from sediments modified by stream action (Rankin, H. T., 1994). The Black Belt of Alabama is generally considered to be a prairie with low slopes. Many of the soils are alkaline, but around half of the area is composed of acid soils that are commonly forested. Alkaline and acid soils are sometimes intricately mixed. Many soils in the Black Belt are characterized as vertisols. They are high in montmorillonite clay, and they shrink and swell with changes in soil moisture. The shrinking and swelling causes slippage within the soil mass. Turbulence in some of the Black Belt soils produces an irregular boundary between the dark surface layer and the lighter colored subsoil. Shrinkage cracks are common in soils of the Black Belt during drought. These soils are unstable in road cuts, and generally have low strength when wet. Soils of the Black Belt region were formed from calcareous sediments, or from clay and sandy clay sediments overlying calcareous materials. The calcareous deposit known as Selma chalk extends beneath younger sediments of the Gulf Coastal Plain (Dixon & Nash, 1968).

Sumter soils, which are typical of the alkaline soils, are clayey throughout and have a dark-colored surface layer with a yellow-colored subsoil. Oktibbeha soils are acidic and clayey throughout, consisting of red subsoil layers overlying chalk. The clayey Wilcox, Vaiden, and Mayhew soils are the dominant soils of the rolling pine woodlands along the southern edge of the Prairie. They are acidic and are somewhat poorly drained or poorly drained. These soils contain a high percentage of smectitic clays and shrink and crack when dry or swell when wet. While soybeans are the main crop of this region, most of these soils are used for timber production and pasture (Mitchell & Loerch, 2008).

Soil type data specific to the Middle AL Basin was mapped using the State Soil Geographic Dataset (STATSGO) and the NRCS Soil Survey Geographic Database (SSURGO), as shown in Appendix C, Figures C-8 and C-9, respectively.

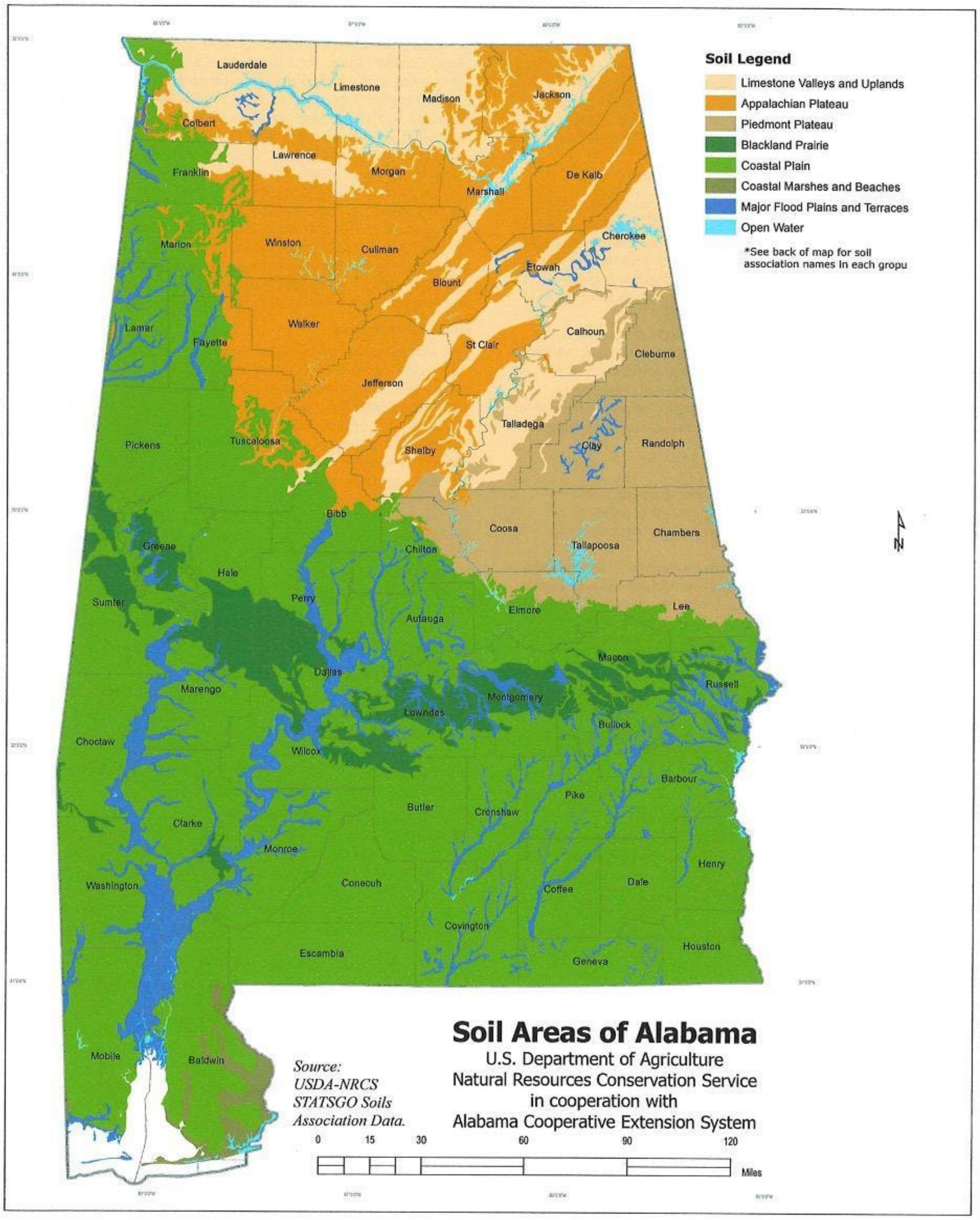

Figure 12: Soil Areas of Alabama

4.4.2.1. Soil Classification Capability Class

Using the Soil Classification Capability Class demarcations, the Middle AL Basin captures a section of each grade ranging from one through eight, as shown in Appendix C, Figure C-10. Soils classified one through four are generally considered "good" for both rainfed and irrigated crop production. While soil class one is preferred with "few limitations that restrict their use" (USDA NRCS, 2001), class four is described as "severe limitations that reduce the choice of plants or that require very careful management or both" (USDA NRCS, 2001). Any soils classified as five or greater are not considered suitable for crop production, but rather for pasture, rangeland, forestland, or wildlife habitat (USDA NRCS, 2001). Soil from capability classes one through four make up the northern section of the Basin, which includes both Perry and Dallas Counties. The areas where the capability classes are higher than four are largely situated in the southern section of the Basin. These capability classes generally correlate with the type and quality of agriculture that exists within these regions of the basin.

4.5. Vegetation

4.5.1. General Vegetation

The Middle AL Basin lies in the East Gulf Coastal Plan physiographic section of Alabama, and much of it overlaps with the Black Belt Prairie Region (Black Belt). This region is characterized by weathered rolling plains of low relief developed on chalk and marl of the Cretaceous Selma chalk formation. The region is biologically distinct compared to other physiographic districts in the East Gulf Coastal Plain. Before human settlement, the Black Belt region contained hardwood and mixed hardwood/pine forests in the acidic soils of the lowland and prairies in the alkaline soils of the uplands (Schotz & Barbour, 2009). The Black Belt prairies are a particularly unique habitat complex with distinctive flora. Prairies once covered thousands of acres in this region, but only scattered remnants of these prairies remain due to land use changes. While much of the natural vegetation in the basin has been converted to agricultural uses, the vegetation still reflects the distinctive flora composition of the Black Belt prairies that once dotted the landscape (NatureServe, 2014). While only scattered remnants of the native Black Belt prairies remain, prairie forbs and grasses persist in small openings and at the edges of more heavily forested areas. In such areas, Indiangrass (*Sorghastrum nutans*) and Little Bluestem (*Schizachyrium scoparium*) are the dominant grass species. Commonly found non-grass prairie species include Spreading Aster (*Symphyotrichum patens*), Rice Button aster (*Symphyotrichum dumosum*), White and Purple Prairie Clovers (*Dalea candida* and *D. purpurea*), Scale Blazing Star (*Liatris squarrosa),* and Grayhead Coneflower (*Ratibida pinnata*). The hardwood forests are dominated by Post Oak (*Quercus stellata*), Chinkapin Oak (*Quercus muehlenbergii*)*,* and Blackjack Oak (*Quercus marilandica*). Other commonly found hardwood trees include Mockernut Hickory, Pignut Hickory, and White Ash. Small trees and woody shrubs found in the understory include Eastern Redbud (*Cercis canadensis* var. *canadensis*), Engelmann's Hawthorn (*Crataegus engelmannii*), Common Persimmon (*Diospyros virginiana*), Possumhaw (*Ilex decidua*), Chickasaw Plum (*Prunus angustifolia*), Carolina Buckthorn (*Frangula caroliniana*), and Buckthorn Bumelia (*Sideroxylon lycioides*).

4.5.2. Federally Listed Plant Species

There are two T&E plant species that potentially occur in the Middle AL Basin: Georgia rockcress (*Arabis georgiana*) and Price's potato-bean (*Apios priceana*). The project area overlaps with CH for Georgia rockcress (USFWS, 2020). T&E Plants can be seen in Appendix C, Figure C-11. Additionally, there are 75 plant species designated by the State of Alabama as S1 (Critically Imperiled) or S2 (Imperiled) that have been documented in counties that overlap the project area (ANHP, 2019). This list includes 52 herbaceous species, 7 shrubs, 9 trees, and 7 vines (Table 9).

Table 9. State Listed Plant Species that Potentially Occur in the Middle AL Basin

Common Name	Species	State Rank[1]
Herbs		
Log fern	*Dryopteris celsa*	S2
Appalachian quillwort	*Isoetes appalachiana*	S1
Louisiana quillwort	*Isoetes louisianensis*	S1
Riddell's spike-moss	*Bryodesma arenicola* ssp. *riddellii*	S2
Dwarf burhead	*Helanthium tenellum*	S1
Impressed-nerve sedge	*Carex impressinervia*	S1
Social sedge	*Carex socialis*	S2
Water bulrush	*Schoenoplectus subterminalis*	S1
Lattion jointgrass	*Coelorachis tessellata*	S1
Inland rush	*Juncus interior*	S1
Stout rush	*Juncus nodatus*	S1
Southern nodding trillium	*Trillium rugelii*	S2

Table 9. State Listed Plant Species that Potentially Occur in the Middle AL Basin

Common Name	Species	State Rank[1]
Small white lady's-slipper	*Cypripedium candidum*	S1
Southern lady's-slipper	*Cypripedium kentuckiense*	S1
Harper's wild ginger	*Hexastylis harperi*	S2
Swamp thistle	*Cirsium muticum*	S1
Eggert's sunflower	*Helianthus eggertii*	S2
Florida Keys hempweed	*Mikania cordifolia*	S2
Barbed rattlesnake-root	*Nabalus barbatus*	S1S2
Pinnate-lobed black-eyed Susan	*Rudbeckia triloba* var. *pinnatiloba*	S2S3
Old Cahaba rosinweed	*Silphium perplexum*	S1
Carolina crownbeard	*Verbesina walteri*	S1
Georgia rockcress	*Arabis georgiana*	S1
Spreading rockcress	*Arabis patens*	S1
Coastal plain nailwort	*Paronychia herniarioides*	S1
Ovate catchfly	*Silene ovata*	S2
Royal catchfly	*Silene regia*	S2
Pale umbrella-wort	*Mirabilis albida*	S2
Yellowleaf tinker's-weed	*Triosteum angustifolium*	S1
Canadian milkvetch	*Astragalus canadensis*	S1
Florida milkvetch	*Astragalus obcordatus*	S1
Hoary milkvetch	*Astragalus villosus*	S2
Apalachicola wild indigo	*Baptisia megacarpa*	S2
Cream tick-trefoil	*Desmodium ochroleucum*	S2
Soft false gromwell	*Lithospermum molle*	S2
Large-flowered pennyroyal	*Dicerandra fumella*	S2
Drummond's pennyroyal	*Hedeoma drummondii*	S2
Harper's grooved-yellow flax	*Linum sulcatum* var. *harperi*	S1
Brilliant hibiscus	*Hibiscus coccineus*	S1
Vari-leaf evening-primrose	*Oenothera heterophylla*	S2
Heart-leaved plantain	*Plantago cordata*	S2
Culver's root	*Veronicastrum virginicum*	S1
Featherfoil	*Hottonia inflata*	S2
Alabama larkspur	*Delphinium alabamicum*	S2
Southern meadowrue	*Thalictrum debile*	S2
Southern lepuropetalon	*Lepuropetalon spathulatum*	S2
Prairie false-foxglove	*Agalinis heterophylla*	S2
Ridge-stem false-foxglove	*Agalinis oligophylla*	S1
Wherry's phlox	*Phlox pulchra*	S1
Carpenter's ground-cherry	*Calliphysalis carpenteri*	S1
Pretty St. John's-wort	*Hypericum nudiflorum*	S2
Canada violet	*Viola canadensis*	S2

Table 9. State Listed Plant Species that Potentially Occur in the Middle AL Basin

Common Name	Species	State Rank[1]
Shrubs		
Swamp buckthorn	*Sideroxylon thornei*	S1
Orange azalea	*Rhododendron austrinum*	S2S3
Red Hills azalea	*Rhododendron colemanii*	S1
Carolina rhododendron	*Rhododendron minus*	S2
Allegheny-spurge	*Pachysandra procumbens*	S2S3
Mississippi witch hazel	*Hamamelis ovalis*	S1
Lance-leaved buckthorn	*Rhamnus lanceolata* var. *glabrata*	S2
Trees		
Oglethorpe oak	*Quercus oglethorpensis*	S1
Bog spicebush	*Lindera subcoriacea*	S1
Ash's hawthorn	*Crataegus ashei*	S1
Three-flowered hawthorn	*Crataegus triflora*	S2
Florida willow	*Salix floridana*	S1
Northern prickley ash	*Zanthoxylum americanum*	S1
Loblolly bay	*Gordonia lasianthus*	S1
Silky camellia	*Stewartia malacodendron*	S2S3
Pond pine	*Pinus serotina*	S1
Vines		
Price's potato-bean	*Apios priceana*	S2
Baldwin's milkvine	*Matelea baldwyniana*	S1
Bay starvine	*Schisandra glabra*	S2
Mustang grape	*Vitis mustangensis*	S1
Creeping morning-glory	*Evolvulus sericeus*	S1
Water southern Morning-glory	*Stylisma aquatica*	S2
Pickering's morning-glory	*Stylisma pickeringii*	S1

[1]State Rank abbreviations: S1 = Critically Imperiled, S2 = Imperiled, S3 = Vulnerable

4.5.3. Noxious Weeds and Invasive Species

There are 141 plant species that Alabama has listed as legally noxious (USDA NRCS, 2015 & 2003). The Alabama Invasive Plant Council (AIPC) lists 65 plant species that are considered invasive in Alabama, which includes 10 species of trees; 18 species of shrubs; 8 grasses, grass-like species and canes; 9 forbs; and 10 species of aquatic and wetland plants (AIPC, 2012). Of these species, 49 have been reported on EDDMapS (Center for Invasive Species and Ecosystem Health, 2020) in counties that are part of the Middle AL Basin (Table 10), including all 10 plant species on “Alabama’s 10 Worst Invasive Weeds" list (AIPC, 2012).

Table 10. Invasive Plant Species that Potentially Occur in the Middle AL Basin

Common Name	Species
Aquatic and Wetland Plants	
Alligatorweed	*Alternanthera philoxeroides*[1]
Common water hyacinth	*Eichhornia crassipes*

Table 10. Invasive Plant Species that Potentially Occur in the Middle AL Basin

Common Name	Species
Hydrilla	*Hydrilla verticillata*[1]
Parrotfeather	*Myriophyllum aquaticum*
Eurasian water milfoil	*Myriophyllum spicatum*[1]
Cuban bulrush	*Oxycaryum cubense*
Water lettuce	*Pistia stratiotes*
Giant salvinia	*Salvinia molesta*
Forbs	
Wild taro	*Colocasia esculenta*
Chinese lespedeza	*Lespedeza cuneata*
Purple loosestrife	*Lythrum salicaria*
Chamber bitter	*Phyllanthus urinaria*
Rattlebox	*Sesbania punicea*
Grasses, Grass-likes, and Canes	
Giant reed	*Arundo donax*
Cogongrass	*Imperata cylindrica*[1]
Japanese stiltgrass, Nepalese browntop	*Microstegium vimineum*
Torpedo grass	*Panicum repens*
Vaseygrass	*Paspalum urvillei*
Golden bamboo	*Phyllostachys aurea*
Johnsongrass	*Sorghum halepense*
Shrubs	
Thorny olive	*Elaeagnus pungens*
Autumn olive	*Elaeagnus umbellata*
Lantana	*Lantana camara*
Shrubby lespedeza	*Lespedeza bicolor*
Glossy privet	*Ligustrum lucidum*
Japanese privet	*Ligustrum japonicum*
Chinese privet	*Ligustrum sinense*[1]
Sweet breath of spring	*Lonicera fragrantissima*
Nandina, sacred bamboo	*Nandina domestica*
Macartney rose	*Rosa bracteata*
Cherokee rose	*Rosa laevigata*
Multiflora rose	*Rosa multiflora*[1]
Tropical soda apple	*Solanum viarum*[1]
Trees	
Tree-of-heaven	*Ailanthus altissima*
Silktree	*Albizia julibrissin*
Chinese parasoltree	*Firmiana simplex*
Chinaberrytree	*Melia azedarach*

Table 10. Invasive Plant Species that Potentially Occur in the Middle AL Basin

Common Name	Species
Trifoliate orange	*Poncirus trifoliata*
Callery pear "Bradford"	*Pyrus calleryana*
Tallowtree	*Triadica sebifera*[1]
Tungoil tree	*Vernicia fordii*
Vines	
Sweet autumn virginsbower	*Clematis terniflora*
Chinese yam	*Dioscorea polystachya*
English ivy	*Hedera helix*
Japanese honeysuckle	*Lonicera japonica*
Japanese climbing fern	*Lygodium japonicum*[1]
Kudzu	*Pueraria montana* var. *lobata*[1]
Bigleaf periwinkle	*Vinca major*
Chinese wisteria	*Wisteria sinensis*

4.6. Water Resources

There are approximately 29,080 acres of open water within the Middle AL Basin. The Alabama River originates north of Montgomery, and forms at the intersection of the Coosa River and the Tallapoosa River near the Fall Line. The Alabama River occupies the southeastern ridge of the Mobile River Basin, the sixth-largest river basin in the United States (Alabama Department of Environmental Management [ADEM], 2005).

4.6.1. Surface Water Quantity

The Middle AL Basin HUC comprises a drainage area of 21,140 mi2. A U.S. Geological Survey (USGS) stream gage is located just downstream of the HUC at Claiborne Lock and Dam near Monroeville, AL (USGS 02428400; USGS, 2012). This gage was established in 1975 and is still operational. The gage monitors a drainage area of 21,473 square miles which is 1.5 percent greater than the HUC area. Therefore, the gage observations were slightly adjusted to represent the discharge from the Middle AL Basin HUC. The long term mean monthly adjusted flow in cubic feet per second (cfs) is given in Table 11. It should be noted that Alabama does not currently regulate in-stream flow and has no law or regulations prescribing flow standards.

Table 11. Average Surface Water Flows for the Alabama River at Claiborne Lock and Dam

MONTH	Monthly Flow Statistics (CFS[1])
January	44,969
February	52,447
March	59,237
April	45,953
May	27,748
June	18,893
July	16,728
August	12,398
September	11,513

Table 11. Average Surface Water Flows for the Alabama River at Claiborne Lock and Dam

MONTH	Monthly Flow Statistics (CFS[1])
October	14,366
November	21,943
December	34,834

[1]Cubic feet per second.

The major tributary to the Alabama River in the Middle AL Basin HUC is the Cahaba River which joins the Alabama just below Marion Junction, AL. A USGS gaging station (USGS 02425000) has been in operation at Marion Junction since October 1938. This gage monitors a drainage area of 1766 square miles or about 8.3 percent of the total drainage area. This stream is also capable of supplying abundant water for irrigation. The long term mean monthly flow at Marion Junction is given in Table 12.

Table 12. Average Surface Water Flows for the Cahaba River at Marion Junction

Month	**Monthly Flow Statistics (CFS[1])**
January	4,420
February	5,250
March	5,920
April	4,730
May	2,450
June	1,670
July	1,420
August	1,210
September	1,070
October	893
November	1,420
December	2,800

[1]Cubic feet per second.

The water budget report (Harper et al., 2015) shown in Table 13 shows that surface water accounts for approximately 74 percent of withdrawals in the Basin (Middle Alabama). The budget includes all sector withdrawals with the returns shown separately.

Table 13. Alabama River – Demand Data

2015 Demands- Middle Alabama														
Withdrawals (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	**Percentage**
Irrigation-GW	0.23	0.29	0.39	0.50	0.82	1.24	1.30	1.12	0.76	0.65	0.38	0.29	0.67	18%
Irrigation-SW	0.25	1.10	1.61	2.42	4.10	5.98	6.17	5.80	4.02	3.28	1.77	1.12	3.15	82%
Irr-Total	0.48	1.39	2.00	2.92	4.92	7.22	7.47	6.92	4.78	3.93	2.15	1.41	3.82	100%
Total-GW	10.03	9.92	9.95	9.91	10.31	10.58	10.67	10.72	10.41	10.18	9.69	9.59	10.17	26%
Total-SW	26.06	26.96	25.08	27.88	29.71	30.81	30.69	30.86	28.47	29.21	28.15	27.17	28.43	74%
Total	36.09	36.88	35.03	37.79	40.02	41.39	41.36	41.58	38.88	39.39	37.84	36.76	38.60	100%
Irr GW%	2%	3%	4%	5%	8%	12%	12%	10%	7%	6%	4%	3%		
Irr SW%	1%	4%	6%	9%	14%	19%	20%	19%	14%	11%	6%	4%		
Returns (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	
Irrigation Returns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Returns	19.16	24.14	19.64	23.36	19.69	17.4	18	17.73	21	18.95	23.15	20.07	20.19	

The monthly groundwater withdrawals, surface water withdrawals, and total withdrawals for the Middle AL Basin (Hydrologic Code 03150203) are included in Table 14 (Harper et al., 2015).

Table 14. Monthly Withdrawals for 2015 in the Middle AL Basin (MGD)

Month	GW Withdrawals (MGD)	SW Withdrawals (MGD)	Total Withdrawals (MGD)
January	10.03	26.06	36.10
February	9.92	26.96	36.88
March	9.95	25.08	35.03
April	9.91	27.88	37.78
May	10.31	29.71	40.03
June	10.58	30.81	41.39
July	10.67	30.69	41.36
August	10.72	30.86	41.59
September	10.41	28.47	38.88
October	10.18	29.21	39.40
November	9.69	28.15	37.84
December	9.59	27.17	36.77

Aquaculture accounts for the most groundwater withdrawals, totaling 5.5 MGD, while industry accounts for the most surface water withdrawals, totaling 19.67 MGD (Table 15). Each of these sectors represent over half of the total demand for the respective water source. Currently, irrigation only accounts for 3.15 MGD of monthly surface water withdrawals and 0.67 MGD of monthly groundwater withdrawals. There are no thermoelectric withdrawals in this basin. Monthly residential withdrawals for groundwater and surface water combined are less than 1 MGD.

Table 15. Monthly Water Withdrawals by Sector in the Middle AL Basin (MGD)

Sector	GW Withdrawals (MGD)	SW Withdrawals (MGD)	Total Withdrawals (MGD)
Public	2.48	1.96	4.44
Residential	0.87	0	0.87
Irrigation	0.67	3.15	3.81
Livestock	0.27	0.41	0.68
Aquaculture	5.5	3.09	8.59
Industrial	0	19.67	19.67
Mining	0.37	0.015	0.53
Thermoelectric	0	0	0
Total	**10.17**	**28.43**	**38.6**

Stream order is also important to the overall hydrological makeup of the basin, and thus examining the stream network is important in determining potential project sites. Stream ordering is a method of classifying the hierarchy of natural channels within a watershed. The uppermost channels in a drainage network (such as headwater channels with no upstream tributaries) are designated as first-order streams. A second-order stream is formed below the confluence of two first-order channels, and third-order streams are created when two second-order channels join. This pattern continues on, until seventh-order is reached and is henceforth classified as a river (U.S. Environmental Protection Agency [USEPA], n.d.). Not only is stream order important to the hydrological makeup of the Basin, but it is also a key part of the River Continuum Concept. This concept helps identify connections between watersheds, floodplains, and stream systems, but also describes how biological communities develop and change in a stream system. As water proceeds downstream, channels widen, depth increases, and velocity of the waterways increase, all contributing to the types of aquatic organisms that inhabit a stream (USEPA, n.d.).

Based on the reaches included in the SPARROW water quality model, the surface water reaches within the Basin were mapped by stream order in Appendix C, Figure C-12.

4.6.2. Groundwater Quantity

4.6.2.1. Aquifers in the Middle Alabama Basin

Much of the material in this section relies primarily on groundwater and surface water assessments for Alabama completed by the GSA and the Alabama Office of Water Resources (OWR; Atkins et al., 2017; GSA, 2018). The physiography underlying the Middle AL Basin is contained within the East Gulf Coastal Plain groundwater province in Alabama. There are multiple groundwater sources in the Middle AL Basin study area including the Ripley aquifer, Eutaw aquifer, Gordo aquifer, and watercourse aquifer (Figure 13).

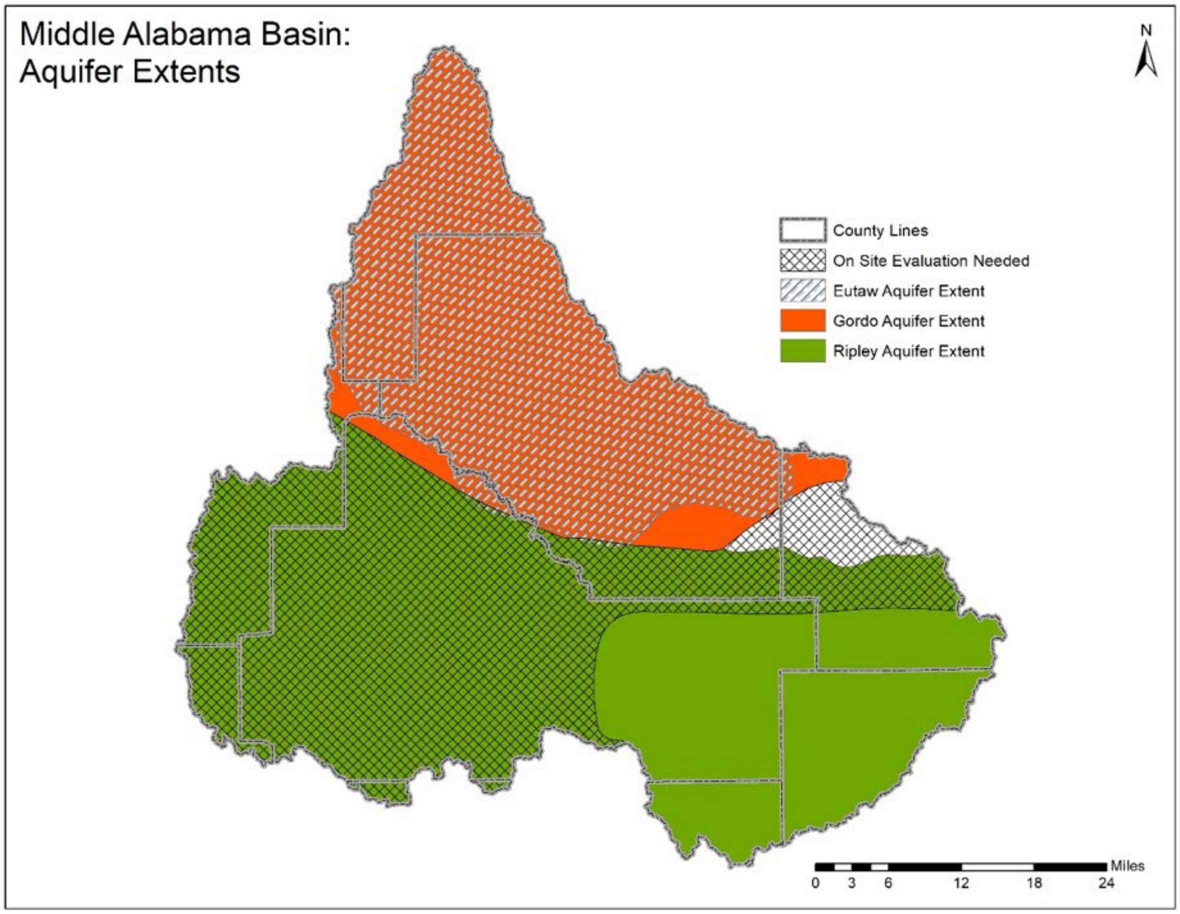

Figure 13. Aquifer Extents in the Middle AL Basin

Table 16 summarizes relevant data regarding the depth, pumping rate, and specific capacity of each aquifer.

Where available, well drawdown curves are given in the Alabama Geological Survey report and are used to determine if the aquifer has been declining, increasing, or stable over time. The report also notes whether there are any discernible drawdowns due to large pumping operations. Aquifer Net Primary Productivity maps can be seen in Appendix C Figures 36–38.

Table 16. Information on the Major Aquifers in the Middle AL Basin

Aquifer Name	Primary Production Area	Depth of Well/Depth to water	Pumping rates/specific capacity	Issues	Well Spacing
Watercourse	Located in the alluvial deposits along the banks of the Alabama River	Well depths generally range from 10 to 60 feet. Water depths are flowing to 30ft	No existing documented public supply or irrigation wells in the Watercourse Aquifer.	The aquifer needs to be at least 60-70 feet thick in order to utilize for irrigation.	N/A
Clayton	Butler County, Monroe County, and Northern Wilcox County	Well depths generally range from 100 to 340 ft in Butler County, 350 ft in Monroe County, and about 60 to 380 ft in Wilcox County. Water depths range from 13 to 150 ft bls in Butler County, about 140 ft bls in Monroe County, and about 10 to 130 ft bls in Wilcox County.	Pumping rates range from 5-10 gpm in Butler County and range from 10 to 60 gpm in Wilcox County. Specific capactiy rangess from 1.0 to 2.0 gpm/ft in Butler County and 0.30 to 0.69 gpm/ft in Wilcox County.	After examination of available hydrogeologic data, this aquifer is not suggested for irrigation in the Middle Alabama study area.	Suggested well spacing in the Clayton aquifer is 1.0 miles along the strike of the hydraulic gradient and 2.0 miles along the up or down gradient direction. It should be noted, however, that this aquifer is not suggested for irrigation use in this study area.
Ripley	Northwest Butler County, Southern Dallas County, Small Eastern portions of Marengo and Clarke County, southwestern portion of Lowndes County, and eastern Wilcox County, and northeastern Monroe County	Well depths generally range from 600 to 1,000 ft in Butler County, 130 ft in Dallas County, 120-190 ft in Lowndes County, 80 to 380 ft in Marengo County, and about 40 to 690 ft in Wilcox County. Water depths range from 190 to 280 ft bls in Butler County, about 75 ft bls in Dallas County, 30 to 60 ft bls in Lowndes County, 70 to 140 ft bls in Marengo County, and about 15 to 160 ft bls in Wilcox County.	Pumping rates are about about 530 gpm in Butler County, about 21 gpm in Dallas County, about 10 gpm in Marengo County, and range from 3 to 520 gpm in Wilcox County. Specific capacities range from 8.83 to 9.64 gpm/ft in Butler County, are about 0.72 gpm/ft in Dallas County, about 0.20 gpm/ft in Marengo County and range from 0.12 to 12.67 gpm/ft in Wilcox County.	N/A	Suggested spacing in the Ripley aquifer is 1.0 miles along the strike of the hydraulic gradient (east-west in this area) and 2.5 miles up or down the hydraulic gradient (north-south in this area).

Table 16. Information on the Major Aquifers in the Middle AL Basin

Aquifer Name	Primary Production Area	Depth of Well/Depth to water	Pumping rates/specific capacity	Issues	Well Spacing
Eutaw	Eastern Dallas County and Southern portion of Perry County	Well depths generally range from 200 to 1,120 ft in Dallas County, and about 200 to 950 ft in Perry County. Water depths range from 0 to 142 ft bls in Dallas County, and about 10 to 150 ft bls in Perry County.	Pumping rates range from 12 to 352 gpm in Dallas County and range from 50 to 1000 gpm in Perry County. Specific capacity ranges from 3.04 to 5.25 gpm/ft in Dallas County and 5.81 to 9.43 gpm/ft in Perry County.	Have to drill through 500-1,000 feet of chalk to access groundwater in portions of this aquifer. Also, chloride concentrations in the southern portion of this aquifer may exceed the agricultural guideline (106 mg/L).	Suggested spacing in the Eutaw aquifer is 1.5 miles along the strike of the hydraulic gradient (east-west in this area) and 2.0 miles up or down the hydraulic gradient (north-south in this area).
Gordo	Eastern Dallas County, Southern portion of Perry County, small portion of Western Lowndes	Well depths generally range from 445 to 850 ft in Dallas County, from about 200 to 1400 ft in Perry County and about 690 to 1,400 ft in Lowndes County. Water depths range from 17 to 186 ft bls in Dallas County, about 30 to 180 ft bls in Perry County, and about 65 to 265 ft bls in Lowndes County.	Pumping rates range from 325 to 1560 gpm in Dallas County, 10 to 1012 gpm in Perry County, and 100 to 402 gpm in Lowndes County. Specific capacities range from 5.18 to 12.76 gpm/ft in Dallas County, 13.19 to 36.14 gpm/ft in Perry County, and 0.89 to 20.10 gpm/ft in Lowndes County.	Have to drill through 500-1,000 feet of chalk to access groundwater in portions of this aquifer. Also, chloride concentrations in the southern portion of this aquifer may exceed the agricultural guideline (106 mg/L).	Suggested spacing in the Gordo aquifer is 1.5 miles along the strike of the hydraulic gradient (east-west in this area) and 2.0 miles up or down the hydraulic gradient (north-south in this area).

Table 16. Information on the Major Aquifers in the Middle AL Basin

Aquifer Name	Primary Production Area	Depth of Well/Depth to water	Pumping rates/specific capacity	Issues	Well Spacing
Coker	Perry County	Well depths generally range from 950 to 1500 ft in Perry County. Water depths range from 50 to 100 ft bls in Perry County.	Pumping rates range from 150 to 400 gpm in Perry County. Specific capacity ranges from 1.07 to 16.67 gpm/ft in Perry County.	To access would have to drill through the chalk layer, Gordo and Eutaw aquifer, so would likely be cost prohibitive to utilize for farming purposes. Also, the chloride concentrations are above the agricultural guideline in the southern portion of the aquifer. Due to these factors, this aquifer is not recommended for irrigation use in the study area.	This aquifer is not suggested for irrigation in Middle Alabama study area so well spacing has not been specifically determined.
Nanafalia	Butler County, Clarke County, Marengo County, Monroe County	Well depths generally range from 140 to 270 ft in Butler County, 240 to 450 ft in Clarke County, 160 to 250 ft in Marengo County, 270 to 800 ft in Monroe County. Water depths range from 25 to 150 ft bls in Butler County, 80 to 180 ft bls in Clarke County, 10 to 100 ft bls in Marengo County, about 40 to 250 ft bls in Monroe County.	Pumping rates in range from 6 to 10 gpm in Butler County, 10 to 50 gpm in Clarke County, and 12 to 301 gpm in Marengo County. Specific capacities range from 1.2 to 2.0 gpm/ft in Butler County, 0.25 to 1.79 gpm/ft in Clarke County, and are observed at 4.92 gpm/ft in Marengo County.	After examination of available hydrogeologic data, this aquifer is not suggested for irrigation in the Middle Alabama study area.	Suggested spacing in the Nanafalia aquifer is 1.0 miles along the strike of the hydraulic gradient direction (north-south in this area) and 2.0 miles up or down the hydraulic gradient direction (east-west). It should be noted, however, that this aquifer is not recommended for irrigation in the Middle Alabama study area.

4.6.2.1.1. *Watercourse Aquifer*

The shallowest source for groundwater withdrawals in the project basin is the watercourse aquifer. The watercourse aquifer was formed by alluvial deposits along the Alabama River. This may be a suitable source for irrigation and will be investigated in southern areas where other sources (Eutaw and Gordo) experience increased salinity levels. Utilizing the shallow watercourse aquifer would alleviate some costs associated with drilling deep wells to reach the Eutaw and Gordo aquifers. There are limitations associated with using the watercourse aquifer and may only be only suggested in areas where the aquifer thickness exceeds 60-70 feet.

4.6.2.1.2. *Eutaw Aquifer*

Approximately 300 feet below surface in the basin, a layer of around 500-1,000 feet of chalk/limestone exists between the overlying Ripley aquifer and underlying Eutaw aquifer. Wells completed below the chalk layer in the Eutaw aquifer may be used as a groundwater source in the basin. The recharge area for the Eutaw aquifer extends diagonally through the state, extending from east Alabama (Russell County), through western Alabama (Lamar County), and north to Lauderdale County (GSA Bulletin 186). In this aquifer, well depths may vary from 20 feet near the outcrop, to 2,240 feet bls downdip. Well depths are likely to fall between these two extremes due to the chalk/limestone layer found here. Increased salinity restricts the use of this aquifer to the northern portion of the basin.

4.6.2.1.3. *Gordo Aquifer*

Located below the Eutaw aquifer is the Gordo aquifer, an additional source of groundwater in the study area. Increased salinity levels are present in the southern portion of the study area, limiting the utilization of this aquifer to the northern portion of the basin. The Gordo aquifer is an abundant source of groundwater for northwest to east central Alabama and recharges from east Alabama in southern Lee County, and west through central to north Alabama (GSA Bulletin 186).

4.6.2.1.4. *Ripley Aquifer*

The Ripley aquifer serves as a major water source in southeast-central Alabama (GSA bulletin 186). The depth to water determined in the GSA bulletin for 86 wells in the Ripley aquifer varied from 1 to 390 ft bls. There is a down gradient limit of freshwater in the southern portion of the state. There is a portion of the aquifer in the southeastern area of the Middle AL Basin that is likely a suitable source for irrigation. This portion has been mapped on the Aquifer Net Primary Productivity Maps in Appendix C.

4.6.2.1.5. *Clayton Aquifer*

According to the GSA Bulletin 186, wells in the Clayton aquifer exist as shallow as 60 feet in Wilcox County. The Clayton aquifer thins west of Wilcox County and Eastern Marengo County (GSA Bulletin 186). After the examination of GSA geological cross-sections, it was determined that the Clayton aquifer was likely not a suitable source for irrigation in the Middle Alabama study area.

4.6.2.1.6. *Nanafalia Aquifer*

The Nanafalia aquifer extends the width of the state and is a major source of groundwater in southcentral and southeastern Alabama (GSA bulletin 186). It was also determined to be unsuitable as a source for large scale irrigation in this study area after the examination of GSA geological cross sections.

4.6.2.2. Certified Public Wells

A certified well has the capacity to withdraw 100,000 gallons of water per day and must be registered with OWR to obtain a certificate of use. There are 17 certified public wells in the Middle AL Basin and 6 certified wells used for irrigation purposes (Appendix C, Figure C-14). Most certified wells in the Basin are in Perry, Dallas, and Wilcox Counties.

4.6.3. Surface Water Quality

4.6.3.1. Impaired Streams and TMDLs

Section 303(d) of the Clean Water Act requires the USEPA and the States to identify and develop plans to restore impaired waters (Total Maximum Daily Loads, TMDL). According to ADEM (2022), there are a total of seven 303(d)-listed streams across eight HUC-12 sub-watersheds in the Middle AL Basin (Table 17). Only one of the streams (Bogue Chitto Creek) lists agriculture as an impairment source (ADEM, 2022a; Appendix C, Figure C-15).

Three water bodies on the 303(d) list are classified as S/F&W, meaning that they have dual classifications for "Swimming and Other Whole-Body Water-Contact Sports (S)" and "Fish and Wildlife (F&W)". Waterbodies assigned the S use, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places.

Table 17. 2020 303(d)-Listed Impaired Waters and Classifications in the Middle AL Basin

Assessment Unit ID	Waterbody	Class	Category	County	Cause(s)	Source(s)
AL03150203-0805-101	Alabama River (Claiborne Lake)	S/F&W	4, 5	Clarke, Monroe, Wilcox	Metals (Mercury)	Atmospheric deposition
AL03150203-0105-100	Alabama River (Claiborne Lake)	S/F&W	4, 5	Clarke, Monroe	Metals (Mercury)	Atmospheric deposition
AL03150203-0108-110	Bear Creek	F&W	5	Dallas, Perry	Pathogens (*E. coli*)	Aquaculture Pasture grazing
AL03150203-0110-100	Bogue Chitto Creek	F&W	5	Dallas, Perry	Siltation	Agriculture Pasture grazing
AL03150203-0103-200	Coffee Creek	F&W	5	Dallas, Perry	Nutrients, Siltation	Pasture grazing
AL03150203-0101-100	Washington Creek	F&W	5	Dallas, Perry	Pathogens (*E. coli*)	On-site wastewater systems, pasture grazing
AL03150203-0209-100	Cedar Creek	S/F& W	4, 5	Butler, Dallas, Wilcox	Pathogens (E. *coli)*	Pasture grazing

Each 303(d) listed waterbody within the Middle AL Basin is classified as a Category 4,5 or 5 waterbody. This assessment begins with the collection, compilation, and evaluation of water quality data and information for the purpose of determining if a water body is supporting all its designated uses (Table 18; ADEM, 2022b).

Table 18. Classification for Category 5 Waterbody (S)

The S Waterbody Can Be Placed in Category 5 if Any of the Following Are True	
Issue	**Condition**
Consumption Advisories	A fish consumption advisory has been issued by the Alabama Department of Public Health.

Table 18. Classification for Category 5 Waterbody (S)

The S Waterbody Can Be Placed in Category 5 if Any of the Following Are True	
Issue	**Condition**
Macroinvertebrate and Fish Assessments	Level IV WMB-I or fish IBI community assessment less than "fair".
Chlorophyll *a* data	Growing season mean chlorophyll *a* criterion has been exceeded in two years during the assessment cycle.
Toxic Pollutants	More than two exceedances of a particular toxic pollutant criterion in previous six years or more than one in a 3-year period.
Conventional Parameters	There is more than a 10 percent exceedance rate for any given parameter.
Bacteriological Data	Non-Coastal Waters: 1. The geometric mean *E. coli* density is greater than 126 colonies/100 ml, or; 2. More than 10 percent of single samples are greater than 235 colonies/100 ml.
	Coastal Waters: 1. The geometric mean enterococci density is greater than 35 colonies/100 ml, or; 2. More than 10 percent of single samples are greater than 104 colonies/100 ml.

The remaining four waterbodies on the 303(d) list are classified as only F&W. Waterbodies assigned with this classification are suitable for fish, aquatic life, and wildlife propagation. Requirements for Category 5 F&W waterbodies can be seen in Table 19.

Table 19. Fish and Wildlife Category 5 Requirements

The F&W Waterbody Can Be Placed in Category 5 if Any of the Following Are True	
Issue	**Condition**
Consumption Advisories	A fish consumption advisory has been issued by the Alabama Department of Public Health.
Macroinvertebrate and Fish Assessments	Level IV WMB-I or fish IBI community assessment less than "fair".
Chlorophyll *a* data	Growing season mean chlorophyll *a* criterion has been exceeded in two years during the assessment cycle.
Toxic Pollutants	More than two exceedances of a particular toxic pollutant criterion in previous six years or more than one in a 3-year period.
Conventional Parameters	There is more than a 10 percent exceedance rate for any given parameter.
Bacteriological Data	Non-Coastal Waters: 1. The geometric mean *E. coli* density is greater than 126 colonies/100 ml (May-October) or greater than 548 colonies/100 ml (November-April), or; More than 10 percent of single samples are greater than 298 colonies/100 ml (May-October) or greater than 2,507 colonies/100 ml (November-April).

Table 19. Fish and Wildlife Category 5 Requirements

The F&W Waterbody Can Be Placed in Category 5 if Any of the Following Are True	
	Coastal Waters: 1. The geometric mean enterococci density is greater than 35 colonies/100 ml, or; 2. More than 10 percent of single samples are greater than 158 colonies/100 ml (May-October) or greater than 275 colonies/100 ml (November-April).

According to the code of federal regulations (40 CFR 130.7(b)), each state must determine the total maximum daily load (TMDL) for each pollutant causing impairment as identified on the 303(d) list of impaired waters. The TMDL calculates the maximum amount of a pollutant that a waterbody can receive and still meet applicable water quality standards. According to the 2020 Integrated Water Monitoring and Assessment Report for Alabama (Report 305b), three TMDLs are listed for stream reaches within the Middle AL Basin (Table 20).

Table 20. Approved TMDLs in the Middle AL Basin

Assessment Unit ID	Waterbody	Date	County	Pollutants
AL03150203-0802-100	Pursley Creek	9/29/2011	Wilcox	Pathogens (*E coli)*
AL03150203-0802-400	UT to Pursley Creek (Town Branch)	9/29/2011	Wilcox	Pathogens (E *coli*)
AL03150203-0103-200	Coffee Creek	9/9/2019	Dallas, Perry	Pathogens (*E. coli*)

The 303(d) listed impaired streams and TMDLs within the project area are depicted in Appendix C, Figures C-16 and C-17, respectively.

4.6.3.2. Total Nitrogen

The main parameter considered during water quality evaluations was total nitrogen (TN) due to its correlation with agriculture. Total nitrogen is measured as the sum of organic and inorganic nitrogen, which includes nitrate (NO3), nitrite (NO2), and ammonia (NH3). Nitrogen levels are also used as an indicator of nutrient content for streams in the southeast, as high nutrient levels may result in eutrophication and harmful algal blooms that impair water quality.

Though the EPA does not have a regulation for TN loads (nor has the state of Alabama established a standard), EPA guidelines note an acceptable range of 2 to 6 mg/L (USEPA, 2013). Additionally, the maximum contaminant level goal (MCLG) for nitrate-nitrite is 10 mg/L (USEPA, 2009).

A modified USGS Spatially Referenced Regression on Watershed Attributes (SPARROW) nitrogen model predicted TN concentrations for 57 reaches within the study area. Of these, zero reaches had TN concentrations above 6 mg/L. Bear Creek had the highest TN baseline conditions at approximately 3.52 mg/L. None of the reaches exceeded the USEPA maximum guideline of 6 mg/L for TN. Additional reach basin size, mean flow, and TN baseline estimates are depicted in Table 21. Some reach names are duplicated where TN estimates were made in different portions of the reach, thus an reach based identifier is used based on the National Hydrography Dataset (USGS, 2016).

Table 21. Reach Basin Size, Mean Flow, and TN Baselines

Reach Name	NHD Reach Code	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)
Bear Creek	3150203041	91.91	25.65	3.52
Dry Cedar Creek	3150203028	334.59	42.48	3.16
Sturdevant Creek	3150203018	138.81	24.14	3.08

Table 21. Reach Basin Size, Mean Flow, and TN Baselines

Reach Name	NHD Reach Code	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)
Chilatchee Creek	3150203042	395.4	59.51	2.85
Big Swamp Creek	3150203032	130.39	34.43	2.11
Mush Creek	3150203029	155.52	37.96	2.08
Mud Creek	3150203040	234.85	130.46	2.04
Prairie Creek	3150203012	65.33	16.23	2.04
Pine Barron Creek	3150203017	112.06	67.67	1.85
Washington Creek	3150203039	88.98	49.3	1.82
Bear Creek	3150203014	197.41	36.31	1.76
Pine Barron Creek	3150203019	74.86	23.52	1.76
Pine Barron Creek	3150203015	30.42	98.82	1.51
Pine Barron Creek	3150203013	58.93	148.1	1.46
Pine Barron Creek	3150203013	12.47	148.1	1.41
Bogue Chitto Creek	3150203036	11.73	329.5	1.32
Bogue Chitto Creek	3150203034	85.11	475.06	1.29
Bogue Chitto Creek	3150203038	124.74	61.96	1.23
Cedar Creek	3150203027	280.36	86.5	1.21
Bogue Chitto Creek	3150203037	63.28	168.93	1.16
Pine Barron Creek	3150203011	180.45	201.07	1.16
Alabama River	3150203002	76.22	27,891.19	1.16
Bogue Chitto Creek	3150203033	105.22	529.02	1.15
Alabama River	3150203006	81.96	28,270.9	1.15
Alabama River	3150203010	251.92	29,402.2	1.13
Alabama River	3150203001	58.78	28,662.75	1.12
Alabama River	3150203030	1.1	28,831.12	1.11
Alabama River	3150203031	94.13	28,795.05	1.11
Chaney CR	3150203035	115.79	117.08	1.1
Alabama River	3150203020	4.45	29,813.12	1.1
Alabama River	3150203022	197.15	29,217	1.1
Alabama River	3150203021	7.24	29,750.12	1.1
Alabama River	3150203007	28.83	29,032.4	1.09
Alabama River	3150203008	4.85	29,224.11	1.09
Alabama River	3150203010	42.31	29,402.2	1.08

Table 21. Reach Basin Size, Mean Flow, and TN Baselines

Reach Name	NHD Reach Code	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)
Cedar Creek	3150203024	104.57	309.55	1.07
Cedar Creek	3150203023	27.79	359	1.07
Turkey Creek	3150203016	63.06	25.79	0.94
Cedar Creek	3150203025	197.97	246.34	0.86
Baptizing Creek	3150203051	110.48	52.6	0.81
Turkey Creek	3150203048	168.17	199.4	0.74
Beaver Creek	3150203046	16.33	305.8	0.65
Baptizing Creek	3150203050	2.56	110.7	0.64
Dry Creek	3150203052	83.78	48.9	0.63
Rockwet Creek	3150203009	67.88	63.6	0.61
Pursley Creek	3150203005	191.54	132.1	0.56
Beaver Creek	3150203044	11.37	396.9	0.56
Goose Creek	3150203047	155.08	95.4	0.55
Pursley Creek	3150203003	1.75	193.3	0.51
Gravel Creek	3150203004	77.69	55	0.47
Wolf Creek	3150203026	118.11	99.53	0.44
Dixon Creek	3150203043	108.19	97.8	0.43
Red Creek	3150203045	78.49	78.9	0.32
James Creek	3150203049	41.93	61.8	0.22
Bear Creek	3150203053	136.48	375.24	0.12
McCalls Creek	3150203054	112.96	556.53	0.12

All the HUC-12s in the Middle AL Basin are currently below the USEPA maximum guideline of 6 mg/L for TN. Thirty-five HUC-12s have TN concentrations of less than 2 mg/L and 11 HUC-12s have TN concentrations between 2 and 6 mg/L (Appendix C, Figure C-18).

4.6.3.3. Temperature, Dissolved Oxygen, pH, Total Suspended Solids, Total Dissolved Solids, and Turbidity

Additional water quality constituents used to characterize existing conditions in the Middle AL Basin are water temperature, dissolved oxygen (DO), pH, total dissolved solids, and turbidity. Data were acquired from USGS field samples from Pine Barren Creek near Snow Hill, Alabama (Appendix C, Figure C-19).

At this location, stream water temperature ranged from 10 to 29.5 degrees Celsius (C) with an average temperature of 19.6 degrees (C). Dissolved oxygen ranged from 7.6 mg/L to 11.7 mg/L with an average level of 9.3 mg/L, all of which exceed the 5.5mg/L minimum threshold associated with adverse effects on aquatic organisms. (Specific Water Quality Criteria, 2017). The pH ranged from 6.9 to 7.4 with an average of 7.2. The Pine Barren Creek location is within the secondary drinking water standard of 6.5 to 8.5 (EPA, 2009). Total Dissolved Solids ranged from 41 mg/L to 84 mg/L, which is within the EPA standard of 500 mg/L to ensure clean water and healthy aquatic environments (Minnesota Pollution Control Agency, 2008). Regarding water clarity, turbidity ranged from 55 NTU to 280 NTU which exceeds the guideline of 25 NTU for healthy fisheries and recreational waters (Minnesota Pollution Control Agency, 2008).

4.6.4. Ecosystem Services

Provisional service; water supply. As described in Sections 4.6.1 – 4.6.2, water in Alabama is used for several sectors including Agriculture, Residential, etc. This water provides for food production, feed production, and maintenance of agricultural land.

Regulating service; water quality. Crops with supplemental water application to prevent low soil moisture levels have higher nutrient use efficiency. Additionally, a crop that does not mature properly due to lack of water does not uptake the expected amount of nutrients, thus excess nutrients may contribute to water pollution. Supplemental water in times of inadequate rainfall will result in greater crop cover and nutrient use efficiency, thus reducing impacts to water quality.

4.7. Wildlife, Fish, and Aquatic Species

The project area provides diverse and extensive habitat for wildlife, fish, and aquatic species. The Middle AL Basin is located within the Alabama River Basin, which is a part of the greater Mobile River Basin. The greater Mobile Basin is well-noted for the presence of unique aquatic habitats, as well as various plant and animal species (ADEM, 2005).

The USFWS, Alabama Department of Conservation and Natural Resources (ADCNR), and the GSA have selected priority watersheds, referred to as Strategic Habitat Units (SHUs), and river corridors, referred to as Strategic River Reach Units (SRRUs), to focus activities for the management, recovery, and restoration of populations of rare fishes, mussels, snails, and crayfishes. The SHUs and SRRUs contain a substantial part of the area's remaining high-quality water courses and reflect the variety of aquatic habitats occupied by these species - both historically and presently (USGS, n.d.). Appendix C, Figure C-20 depicts the SHUs within the Middle AL Basin.

4.7.1. Federally Listed Species

The Endangered Species Act (ESA; 16 USC 1531 *et seq*), as amended in 1988, establishes a national program for the conservation of species listed as threatened and endangered (T&E), and the preservation of the habitats on which they depend. The USFWS Information for Planning and Consultation (IPaC) project planning tool powered by the Environmental Conservation Online System (ECOS) was used to identify federally listed animal and plant species that potentially occur within the Middle AL Basin. There are approximately 21 Threatened & Endangered (T&E) species within or bordering the basin including two species of plants, one species of fish, one reptile, one amphibian, two species of birds, one mammal, one snail, and twelve species of freshwater mussels (Table 22; USFWS, 2020).

Table 22. Federally Listed Species that Potentially Occur Within or Border the Middle AL Basin

Group	Species	Scientific Name	Status[1]
Amphibians	Red hills salamander	*Phaeognathus hubrichti*	LT
Birds	Red-cockaded woodpecker	*Picoides borealis*	LE
	Wood stork	*Mycteria americana*	LT
Fishes	Alabama sturgeon[2]	*Scaphirhynchus suttkusi*	LE
Flowering Plants	Georgia rockcress[2]	*Arabis georgiana*	LT
	Price's potato-bean	*Apios priceana*	LT
Mammals	Northern long-eared bat	*Myotis septentrionalis*	LT
Mussels	Alabama moccasinshell[2]	*Medionidus acutissimus*	LT

Table 22. Federally Listed Species that Potentially Occur Within or Border the Middle AL Basin

Group	Species	Scientific Name	Status[1]
	Alabama pearlshell	*Margaritifera marrianae*	LE
	Choctaw bean	*Villosa choctawensis*	LE
	Fuzzy pigtoe	*Pleurobema strodeanum*	LT
	Heavy pigtoe	*Pleurobema taitianum*	LE
	Narrow pigtoe	*Fusconaia escambia*	LT
	Orangeacre mucket[2]	*Lampsilis perovalis*	LT
	Ovate clubshell	*Pleurobema perovatum*	LE
	Round ebonyshell	*Fusconaia rotulata*	LE
	Southern clubshell[2]	*Pleurobema decisum*	LE
	Southern kidneyshell	*Ptychobranchus jonesi*	LE
	Southern sandshell	*Hamiota australis*	LT
Reptiles	Gopher tortoise	*Gopherus polyphemus*	C
Snails	Tulotoma snail	*Tulotoma magnifica*	LT

[1] Federal Status Abbreviations: LT = Threatened, LE = Endangered, C= Candidate, PE = Proposed Endangered, PT = Proposed Threatened, EXPN = Experimental Population, Non-essential
[2] Critical Habitat for the species overlaps the project area

The number of T&E species that potentially occur in each HUC-12 is depicted in Appendix C, Figure C-21 and with the corresponding agricultural land in Appendix C, Figure C-22 (USGS, n.d). The documented areas of the T&E species that potentially occur within the basin are depicted in Appendix C, Figures C-21 through C-28 (USGS, n.d).

Additionally, the basin overlaps designated Critical Habitat (CH) for five species: Alabama sturgeon (*Scaphirhynchus suttkusi*), Alabama moccasinshell (*Medionidus acutissimus*), orangeacre mucket (*Lampsilis perovalis*), southern clubshell (*Pleurobema decisum*), and Georgia rockcress (*Arabis georgiana*; Appendix C, Figure C-29; USGS, n.d). Per the ESA, organizations are required to consult with the USFWS if listed species or designated CH may be affected by a proposed project. There are defined procedures for listing species, designating CH for listed species, and preparing recovery plans, if necessary. The ESA requires federal agencies to evaluate the likely effects of the proposed project and ensure that it neither risks the continued existence of federally listed ESA species, nor results in the destruction or adverse modification of designated CH.

4.7.2. MBTA/BGEPA Species

The Migratory Bird Treaty Act (MBTA) prohibits the take of migratory birds, their nests, and eggs, except when specifically authorized by the Department of the Interior. Federal provisions as listed under the MBTA or Bald and Golden Eagle Protection Act (BGEPA). IPaC identified 13 bird species of particular concern that are protected under the Migratory Bird Treaty Act (MBTA) or the Bald and Golden Eagle Protection Act (BGEPA) and potentially occur within the Middle AL Basin (USFWS, 2020). The bird species listed in Table 23 may occur in the Basin and are Birds of Conservation Concern (BCC) species or an eagle species. This is not a complete list of MBTA species that may occur in the area.

Table 23. MBTA and BGEPA Species that Potentially Occur Within the Middle AL Basin

Common Name	Species
American kestrel	*Falco sparverius paulus*
Bald eagle	*Haliaeetus leucocephalus*
Cerulean warbler	*Dendroica cerulea*
Eastern whip-poor-will	*Antrostomus vociferus*

Table 23. MBTA and BGEPA Species that Potentially Occur Within the Middle AL Basin

Common Name	Species
Golden eagle	*Aquila chrysaetos*
Kentucky warbler	*Oporornis formosus*
Lesser yellowlegs	*Tringa flavipes*
Prairie warbler	*Dendroica discolor*
Prothonotary warbler	*Protonotaria citrea*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Rusty blackbird	*Euphagus carolinus*
Swallow-tailed kite	*Elanoides forficatus*
Wood thrush	*Hylocichla mustelina*

4.7.3. State Protected Species

In addition to Federally listed species, the project area may provide habitat to species protected by the State of Alabama. Table 24 lists wildlife species that occur in the Middle AL Basin that are designated State Rank S1 (Critically Imperiled) or S2 (Imperiled). State listed plant species are included in Section 4.5. There are 10 species of birds, 4 species of mammals, 1 amphibian, 2 reptiles, 5 insects, 9 fishes, 13 freshwater mussels, 3 snails, and 5 crayfishes that are State listed and have been documented in one or more counties that overlap the basin (Alabama Natural Heritage Program [ANHP], 2019).

Table 24. Species of Greatest Conservation Need that Potentially Occur in the Middle AL Basin

Common Name	Species	State Rank[a]	SGCN Rank[b]
Amphibians			
Red Hills salamander	*Phaeognathus hubrichti*	S2	P1
Birds[c]			
Wood stork	*Mycteria americana*	S2N, S4B	P2
Least bittern	*Ixobrychus exilis*	S2N, S4B	P2
Swallow-tailed kite	*Elanoides forficatus*	S2	P2
Short-eared owl	*Asio flammeus*	S2N	P2
Red-cockaded woodpecker	*Picoides borealis*	S2	P1
Bewick's wren	*Thryomanes bewickii*	S1N	P1
Crayfishes			
Speckled burrowing crayfish	*Creaserinus danielae*	S2	P2
Crisscross crayfish	*Procambarus marthae*	S2	P2
Fishes			
Alabama sturgeon	*Scaphirhynchus suttkusi*	S1	P1
Alabama shad	*Alosa alabamae*	S2	P1
Bluenose shiner	*Pteronotropis welaka*	S2	P2
Frecklebelly madtom	*Noturus munitus*	S2	P1
Mammals			
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	S2	P1
Southeastern myotis	*Myotis austroriparius*	S2	P1
Black bear	*Ursus americanus*	S2	P1

Table 24. Species of Greatest Conservation Need that Potentially Occur in the Middle AL Basin

Common Name	Species	State Rank[a]	SGCN Rank[b]
Eastern spotted skunk	*Spilogale putorius*	S2	P2
Mussels			
Alabama pearlshell	*Margaritifera marrianae* [d]	S1	P1
Alabama spike	*Elliptio arca*	S2	P1
Delicate spike	*Elliptio arctata*	S2	P2
Narrow pigtoe	*Fusconaia escambia*	S2	P2
Orangeacre mucket	*Hamiota perovalis*	S2	P2
Choctaw bean	*Obovaria choctawensis*	S2	P2
Alabama hickorynut	*Obovaria unicolor*	S2	P2
Southern clubshell	*Pleurobema decisum*	S2	P2
Fuzzy pigtoe	*Pleurobema strodeanum*	S2	P2
Heavy pigtoe	*Pleurobema taitianum*	S1	P1
Reptiles			
Gopher tortoise	*Gopherus polyphemus*	S3	P2
Snails			
Tulotoma snail	*Tulotoma magnifica*[d]	S2	P2
Salt Spring hydrobe	*Pseudotryonia grahamae* [d]	S1	P1
Spotted rocksnail	*Leptoxis picta* [d]	S1	P2

[a] State Rank abbreviations: S1 = Critically Imperiled, S2 = Imperiled, S3 = Vulnerable, S4 = Apparently Secure, S5 = Secure, SH = Historical (Possibly Extirpated), N = Non-breeding Population, B = Breeding Population
[b] Species of Greatest Conservation Need Rank abbreviations: P1 = Priority 1/Highest Conservation Concern, P2 = Priority 2/High Conservation Concern
[c] All nongame birds are protected in Alabama except crows, starlings, English sparrows, Eurasian collared doves, pigeons, and other non-native species per Alabama Regulations 2020-2021 Protected Nongame Species Regulation 220-2-.92(d).
[d] Alabama endemic species

4.8. Wetlands and Riparian Areas

Wetland communities are high in species diversity and provide essential habitat for many species. Species include ducks, geese, herons, egrets, shore birds, songbirds, birds of prey, raccoons, rabbits, beavers, muskrats, white-tailed deer, reptiles, and amphibians. The study area contains 269,789 acres of wetlands, which is approximately 19 percent of the total land cover in the project area (Appendix C, Figure C-30; USDA NASS, 2020b). Approximately 224,348 acres of mapped agricultural land within the project area are within a 0.5-kilometer (km) distance of a wetland. Wetland impacts will be avoided and/or minimized with on-site Environmental Evaluations (EE) performed by NRCS personnel using the CPA-52 review process.

4.9. Socioeconomic Resources

Social and economic demographic data such as income, education, and median age were obtained from the U.S. Census (2019) and USDA NASS. This information will be used to help identify areas within the Basin that may need more assistance and outreach in the planning and implementation process, and to estimate project costs to adjust for farmers that may receive socially disadvantaged, beginning, limited resource, and female farmers and ranchers (SDFR) cost-share rates for conservation practices. Socioeconomic data for Middle AL Basin counties from the U.S. Census Bureau (2019 Version) is included in Table 25.

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Table 25. Socioeconomic Values for Counties in the Middle AL Basin

	Butler	Clarke	Dallas	Lowndes	Marengo	Monroe	Perry	Wilcox	Alabama	USA
POPULATION AND RACE										
Total Population Estimate (2019)	19,448	23,622	37,196	9,726	18,863	20,733	8,923	10,373	4,903,185	328,239,523
Population Percent Change (2010-2019)	-7.1%	-8.6%	-15.1%	-13.9%	-10.4%	-10.1%	15.6%	-11.1%	2.6%	6.3%
White Alone	52.1%	53.0%	27.6%	26.0%	46.6%	55.4%	30.2%	27.6%	69.1%	76.3%
Minority Population	48.3%	47.3%	72.6%	75.1%	55.2%	44.5%	70.5%	72.9%	33.7%	39.3%
AGE										
Total Median Age (2018)	42.1	42.9	40.7	42.4	41.7	44.1	39.2	40.7	39.4	38.4
Population over 18 years of age	78.0%	78.7%	76.7%	78.0%	77.5%	78.9%	79.1%	76.7%	77.8%	77.7%
Population over 65 years of age	20.8%	20.5%	18.9%	19.8%	19.9%	21.2%	20.1%	20.3%	17.3%	16.5%
LANGUAGE SPOKEN AT HOME										
Total Households (2014-2018)	6,708	9,358	16,336	4,180	7,768	8,149	3,079	3,804	1,860,269	119,730,128
Language other than English spoken at home	1.4%	0.9%	1.6%	0.9%	0.7%	0.7%	1.4%	2.8%	5.2%	21.5%
EDUCATIONAL ATTAINMENT										
High School Graduate (2014-2018)	84.6%	81.2%	80.7%	77.5%	83.8%	83.7%	78.1%	76.9%	85.8%	87.7%
Advanced Education	16.1%	12.6%	15.1%	14.1%	15.4%	14.1%	15.7%	12.5%	24.9%	31.5%
EMPLOYMENT										
Total Employment (2018)	6,175	6,380	9,501	1,883	6,180	5,319	1,520	1,993	1,730,817	130,881,471
INCOME										

Table 25. Socioeconomic Values for Counties in the Middle AL Basin

	Butler	Clarke	Dallas	Lowndes	Marengo	Monroe	Perry	Wilcox	Alabama	USA
Median Household Income ($2018)	$39,109	$36,127	$31,602	$30,833	$32,809	$30,141	$23,561	$27,237	$48,486	$60,293
Per Capita Income (2019)	$37,523	$37,965	$38,362	$40,785	$41,567	$35,174	$33,529	$34,903	$44,145	$56,490
POVERTY										
Population below Poverty Level	24.5%	22.8%	31.4%	25.1%	24.0%	21.9%	35.3%	33.4%	15.5%	10.5%

4.9.1. General Population

Seven of the eight counties located within the basin experienced a decline in population from 2010 to 2018. Dallas County experienced the largest decline at 15.1 percent, while Butler County experienced the least at 7.1 percent. An average of 27 percent of the population within these counties is below the poverty level, and the median household income averages $31,427.

In this analysis, a minority is defined as any individual who is a citizen of the United States and who is Asian American, Native Hawaiian, Pacific Islander, African American, Hispanic, Puerto Rican, Native American, or an Alaska Native (42 USC §7141)

4.9.2. Farm Operator Demographics

Table 26 compares the farm operator demographics in the counties that overlap the project basin, the state, and the nation. According to the USDA, a farm producer (also known as operator) runs the farm and makes day-to-day management decisions. In the case of multiple producers, the respondent for the farm identifies the principal farm operator during data collection (USDA NASS, 2019a, p. B-20). Of the 4,343 principal producers in the counties that overlap the project basin, 38 percent are full-time operators, and 62 percent are part-time producers (USDA NASS, 2019a, pp. 558–587). These demographics are similar to the entire state and the nation. However, the counties that overlap the basin have a significantly higher proportion of socially disadvantaged producers. They make up 33 percent of the total operators in the counties that overlap the basin, while they make up just 7 percent of Alabama producers and 6 percent of producers nationwide. Socially disadvantaged farmers and ranchers (SDFR) are defined by the USDA as those belonging to groups that have been subject to racial or ethnic prejudice. SDFRs include farmers who are Black or African American, American Indian or Alaska Native, Hispanic or Latino, and Asian or Pacific Islander. For some but not all USDA programs, the SDFR category also includes women.

Table 26. Selected Producer Characteristics in the Counties That Overlap the Middle Alabama Basin and in Alabama

	Counties that overlap the Middle Alabama Basin	Alabama
Principal Producers (no.)	4,343	53,063
All Producers (no.)	5,268	64,742
Full-time Principal Producers (%)	38%	40%
Part-time Principal Producers (%)	62%	60%
Socially disadvantaged Producers (%)	33%	7%

Note: Data retrieved from USDA NASS, 2019a, pp. 558–587.

4.10. Environmental Justice

Environmental Justice (EJ) is defined by USDA as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies" (USDA, 2016, p. 26). Environmental Justice Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations" (Council on Environmental Quality [CEQ], 1997). Environmental Justice is achieved when all citizens enjoy the same degree of protections and equal access to NRCS programs and services to achieve a healthy environment in which to live, learn and work. Taking into consideration the EJ risks within the watershed will enable better project planning to ensure the rights and safety of all populations.

The counties in the Basin area have an average of 27.3% of the population below poverty level (U.S. Census Bureau, n.d.), and approximately 58.6% of the Basin's farm operators are from minority populations (USDA NASS, 2019a).

To better understand the EJ concerns within the watershed's boundaries, the EPA's Environmental Justice Screening and Mapping Tool (EJSCREEN Version 2019) can be used as a heuristic for analyzing concerns (EPA, 2019). The EJSCREEN is a free online tool that provides environmental justices indexes by county, as compared to the rest of the country. EJSCREEN does not provide data on every environmental impact and demographic indicator that may be relevant to a particular location, and data may be several years old. However, the tool is useful for providing an overarching view of potential environmental justice concerns. The EJSCREEN identifies 11 EJ indices that reflect the eleven environmental indicators that can be used for a broad assessment of potential EJ concerns within the watershed region. The 11 environmental indicators are based on information developed from direct measurements, proxy estimates of pollution exposure, and facility location information. Environmental and proximity indicators are screening-level proxies for exposure or risk – not actual exposure or risk.

The 11 EJ Index names are:

1) National Scale Air Toxics Assessment Air Toxics Cancer Risk
2) National Scale Air Toxics Assessment Respiratory Hazard Index
3) National Scale Air Toxics Assessment Diesel PM
4) Particulate Matter (PM2.5)
5) Ozone
6) Lead Paint Indicator
7) Traffic Proximity and Volume
8) Proximity to Risk Management Plan Sites
9) Proximity to Treatment Storage and Disposal Facilities
10) Proximity to National Priorities List Sites
11) Proximity to Major Direct Water Dischargers

Table 27 reports the EJSCREEN values for Butler, Clarke, Dallas, Lowndes, Marengo, Monroe, Perry, and Wilcox Counties.

The national percentile indicates the percentage of the US population that has an equal or lower value, meaning *less* potential for exposure/ risk/ proximity to certain facilities, or a lower percent minority.

Table 27. Environmental Justice Index Variables for the Middle AL Basin Counties

EJ Index Variable[a]	Description	Value	State Average	Percentile in State	Percentile in USA
Environmental					
Particulate Matter (PM 2.5 in ug/m3)	PM2.5 levels in air, µg/m3 annual avg.	8.83	9.75	17	66
NATA Diesel PM (ug/m3)	Diesel particulate matter level in air, µg/m3	0.182	0.346	19	<50
Ozone (ppb)	Ozone summer seasonal avg. of daily maximum 8-hour concentration in air in parts per billion	36.4	41.2	9	15
NATA Air Toxics Cancer Risk (risk per MM)	Lifetime cancer risk from inhalation of air toxics	44	43	54	90-95
NATA Respiratory Hazard Index	Air toxics respiratory hazard index (ratio of exposure concentration to health-based reference concentration)	0.71	0.65	69	95-100

Table 27. Environmental Justice Index Variables for the Middle AL Basin Counties

EJ Index Variable[a]	Description	Value	State Average	Percentile in State	Percentile in USA
Traffic Proximity and Volume (daily traffic count/distance to road)	Count of vehicles (average. annual daily traffic) at major roads within 500 meters, divided by distance in meters (not km)	55	220	45	26
Lead Paint Indicator (% pre1960s housing)	% of housing units built pre-1960, as an indicator of potential lead paint exposure	0.2	0.18	69	52
Superfund Proximity (site count/km distance)	Proximity to National Priorities List sites within 5 km (or nearest one beyond 5 km), each divided by distance in km	0.016	0.054	19	13
RMP Proximity (facility count/km distance)	Count of RMP (potential chemical accident management plan) facilities within 5 km (or nearest one beyond 5 km), each divided by distance in km	0.22	0.41	59	41
Hazardous Waste Proximity (Facility count/km distance)	Count of hazardous waste facilities (TSDFs and LQGs) within 5 km (or nearest beyond 5 km), each divided by distance in km	0.067	0.39	21	11
Wastewater Discharge Indicators (toxicity-weighted concentration/m distance)	RSEI modeled Toxic Concentrations at stream segments within 500 meters, divided by distance in km	0.0053	2.5	73	76
Demographic					
Demographic Index	The average of the count of minorities and count of low-income individuals	57%	36%	81	79
Minority Population	Minorities usually consist of four major racial and ethnic groups that often make up a substantial portion of, not the majority in each population: African Americans, American Indians and Alaska Natives, Asians and Pacific Islanders, and Hispanics	60%	34%	79	73
Low Income Population	Families earning less than twice the federal poverty rate	54%	39%	77	82

Table 27. Environmental Justice Index Variables for the Middle AL Basin Counties

EJ Index Variable[a]	Description	Value	State Average	Percentile in State	Percentile in USA
Linguistically Isolated Population	A linguistically isolated household is one in which no member 14 years old and over (1) speaks only English or (2) speaks a non-English language and speaks English "very well." In other words, all members 14 years old and over have at least some difficulties with English	0%	1%	72	45
Population with Less Than High School Education	% of population that has not completed a high school education	19%	15%	69	76
Population under Age 5	Population under the age of 5	6%	6%	53	51
Population over Age 64	Population over the age of 64	18%	16%	65	70

[a] Data includes Butler, Clarke, Dallas, Lowndes, Marengo, Monroe, Perry, and Wilcox Counties, EPA Region 4 (2019 Population: 157,955).

The EJSCREEN tool generates reports for "block groups", which is defined by the U.S. Census Bureau as an area that has a range of 600-3,000 people residing in it.

The demographic index is based on the average of two socioeconomic indicators; low-income and people of color. The supplemental demographic index is based on the average of five socioeconomic indicators; low-income, unemployment, limited English, less than high school education, and low life expectancy.

The primary indicators of environmental justice concern include Wastewater Discharge Indicators (76th national percentile), National Air Toxics Assessment (NATA) Air Toxics Cancer Risk (90-95th national percentile), and NATA Respiratory Hazard Index (95-100th national percentile). The wastewater discharge indicator index for the project area is depicted in Appendix C, Figure C-33 in relation to the project area (EPA, 2019).

The region also has a sizable number of older residents (70th percentile), low-income residents (77th percentile), and residents with less than a high school education (69th percentile) compared to the national average. Restricted mobility, financial instability, and/or a lack of employment opportunities could play a role in future environmental justice concerns relating to these indices.

4.10.1. National Scale Air Toxics Assessment

Air toxics are airborne substances that can cause serious health problems including cancer, reproductive problems, and birth defects, as well as having detrimental effects on the environment (EPA, 2020b). Examples of air toxics include benzene (found in gasoline), perchloroethylene (emitted from some dry-cleaning facilities), and methylene chloride (used as an industrial solvent and paint stripper). The EPA regularly reviews air toxics in the U.S. in what is called the National Air Toxics Assessment (NATA; EPA, 2021). According to EJSCREEN, the NATA Air Toxics Cancer Risk was in the 90-95th national percentile (EPA, 2019). The NATA Respiratory Hazard Index, which indicates that residents living in the region are at greater risk from air toxics than most of the country, was in the 95-100th national percentile.

4.10.2. Average Farmer Net Income by Operation per County

The net income of cash farm operations by county, as measured in dollars, was listed as follows in Table 28 (NASS, 2019a pp. 286-289). Farmer net income ranged from $-2,584 in Clarke County to $92,484 in Butler County.

Table 28. Net Income of Farms by Operation in 2017

County	Net Income[a]
Butler	$92,484
Clarke	$-2,584
Dallas	$35,071
Lowndes	$44,977
Marengo	$7,712
Monroe	$12,672
Perry	$38,525
Wilcox	$10,868

[a] USDA NASS, 2019a.

4.11. Cultural and Historic Resources

NRCS-AL recognizes that cultural and historic resources are an integral part of our national heritage and recognizes its responsibilities for historic preservation, particularly for properties listed on, or eligible for listing on, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior with the National Park Service (NPS, codified at PL 113-287, 54 U.S.C. 302101-302108, see 36 CFR Part 60.4). As defined in 36 CFR § 800.16(l)(1) of the regulations implementing "Section 106" of the of the National Historic Preservation Act (NHPA) of 1966, as amended (recodified at PL 89-665, 54 U.S.C. 306108), "historic properties" means any prehistoric or historic district, site (including archaeological), building, structure, earthwork, or object listed in or eligible for listing in the NRHP and properties of traditional religious and cultural importance to an Indian Tribe, Alaska Native, or Native Hawaiian Organization, and includes artifacts, records, and material remains that are related to and located within such properties. The term "cultural resources" encompasses all the tangible remains of past activities and accomplishments of people. These include historic properties and unevaluated resources that may be eligible for inclusion in the NRHP or a state or local equivalent and may also include cemeteries and less tangible resources such as karst features (e.g., caves, rock shelters, or sinks), landscapes (i.e., geographic areas that include both cultural and natural resources that exhibit cultural or aesthetic value), vistas, sacred sites, and cultural or religious practices.

Under 40 CFR Part 1508.8, the Council on Environmental Quality (CEQ) regulations for implementing NEPA (42 U.S.C. 4321-4347), and in compliance with "Section 106" of the NHPA and its implementing at 36 CFR Part 800, along with "Section 110" of the NHPA (recodified at PL 89-665, 54 U.S.C. 306101 et seq.), every federal agency is required to consider the impacts of their actions [or "undertakings" per 36 CFR 800.16(y)] on cultural resources and historic properties—including actions they may assist, fund, license, or permit—and take steps to avoid or minimize the potential for adverse effects to such resources. An "adverse effect" is when an undertaking may alter, directly or indirectly, the characteristics of a historic property that qualify it for inclusion in the NRHP in a manner that would diminish its integrity [36 CFR Part 800.5(a)(1); see also 36 CFR Part 60.4]. Fundamental to NRCS policy regarding responsibilities to cultural resources and historic resources under the NHPA is the protection and enhancement of these resources in their original location (i.e., *in situ*) to the fullest practical extent, and enacting treatment measures for mitigating adverse effects that cannot be avoided (NRCS Title 420, GM, Subpart C, see Parts 401.21-22). Whenever possible, NRCS policy is to avoid effects to cultural resources and historic properties by either moving the conservation practice (or "undertaking") to another area, changing the work limits, changing to an acceptable alternative practice or measure, or modifying the practice design [see NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.10(C)].

One way in which NRCS ensures compliance with the NHPA is through implementing conservation programs and practices (i.e., "undertakings") under a Prototype Programmatic Agreement (PPA) in accordance with 36 CFR Part 800.14(b)(4) of the regulations implementing "Section 106" of the NHPA and designated by the Advisory Council on Historic Preservation (ACHP) on November 21, 2014 (Donaldson, 2014; see NRCS Title 420, GM, Subpart C, see Part 401.21). The NRCS-PPA was developed with input from the ACHP, the National Conference of State

Historic Preservation Officers (NCSHPO), individual State Historic Preservation Officers (SHPOs), Tribal Historic Preservation Officers (THPOs), federally recognized Indian Tribes, Native Hawaiian organizations (NHOs), and historic preservation organizations (e.g., the National Trust for Historic Preservation, the Society for Historical Archaeology, the Society for American Archaeology), tribal membership organizations (e.g., the United South and Eastern Tribes), and other interested parties (Donaldson, 2014). As a program alternative for implementing "Section 106" pursuant to 36 CFR Parts 800.14(b) and 800.14(b)(4), a PPA may be used: when effects on historic properties are repetitive or are regional or national in scope [Part 800.14(b)(1)(i)]; when effects on historic properties cannot be fully determined prior to approval of an undertaking [Part 800.14(b)(1)(ii)]; when nonfederal parties are delegated decision-making responsibilities [Part 800.14(b)(1)(iii)]; where routine management activities are undertaken at federally managed properties Part 800.14(b)(1)(iv)]; and where other circumstances warrant a departure from the standard "Section 106" process [Part 800.14(b)(1)(v)]. The NRCS-PPA addresses NRCS' responsibilities under "Section 106" for its conservation practices and programs and enables streamlining of "Section 106" reviews by establishing review protocols, creating greater predictability in costs and time for consultation, and providing the flexibility to address specific situations and conditions to resolve adverse effects to historic properties (Donaldson, 2014; see NRCS Title 420, GM, Subpart C, Parts 401.21-22). NRCS-AL's compliance with "Section 106" is governed, in part, through implementing conservation programs and practices under a State-based Prototype Programmatic Agreement (SPPA, NRCS-AL, 2017). The SPPA was developed in consultation with the AHC pursuant to 36 CFR Part 800.14(b)(4) and conforms to the NRCS-PPA (Donaldson, 2014; see NRCS Title 420, GM, Subpart C, Parts 401.21-22). NRCS-AL's "Section 106" review procedures are outlined in Section V of the SPPA (NRCS-AL, 2017:5-7).

This Plan analysis addresses a broad land treatment area or watershed (the Middle AL Basin) and as such, is considered a "special case" under NRCS cultural resources policies and procedures [see NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.22(A)(2)(v)]. In this Plan, NRCS-AL is proposing the general number and type of conservation practices (or "undertakings") that may be required on existing agricultural land in the treatment area (Middle AL Basin) to meet the stated project objectives. NRCS-AL has determined that the following conservation practices proposed for this project are undertakings that have the potential to cause effects to cultural resources and historic properties as they are likely to exceed the existing depth of tillage or previous disturbance:

- NRCS Practice 430 Irrigation pipeline
- NRCS Practice 436 Irrigation reservoir
- NRCS Practice 441 Irrigation system, micro-irrigation (subsurface)
- NRCS Practice 533 Pumping plant
- NRCS Practice 642 Well development

Further planning, including the precise geographic locations for the proposed installation of conservation practices, will be initiated at the field office level with accelerated technical assistance and is dependent on the participation and cooperation of the landowner(s) and producer(s). With a "special case" project such as this, this planning and installation sequence does not allow NRCS-AL to tie the general conservation plan and practices (undertakings) proposed in this Plan to an exact Area of Potential Effects [APE, see 36 CFR 800.16(d)] until landowner and producer participants in the project are identified [NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.22(A)(2)(v)]. In accordance with NRCS cultural resources policies and procedures concerning "special cases," this analysis provides a general overview of previously identified cultural and historic resources in the Middle AL Basin treatment area to assist in the planning and decision-making process. Further identification and evaluation of cultural resources and historic properties in compliance with "Section 106" of NHPA and will be accomplished once landowner and producer participants are identified and NRCS-AL's site-specific Environmental Evaluation (EE) process is initiated (beginning with the Environmental Evaluation Worksheet [NRCS-CPA-52] and the NRCS-AL Cultural Resources Review form [Appendix E, Figure E-17]), and will follow review procedures outlined in the SPPA (NRCS-AL, 2017:5-7). NRCS-AL will then provide the proposed APE, identification of historic properties and/or scope of identification efforts, and assessment of effects to the AHC, Indian Tribes, and other consulting parties, as appropriate, in a format that meets the standards outlined in 36 CFR Part 800.4-5 and 800.11 and in accordance with the SPPA.

The NRHP, the Alabama Register of Landmarks and Heritage (ARLH), and the Alabama Historic Cemetery Register (AHCR) maintained by the AHC were used in conjunction with ArcGIS to provide an overview of previously recorded cultural resources and historic properties in the Middle AL Basin treatment area to inform planning decisions. The locations of identified NRHP, ARLH, and AHCR resources in the treatment area are depicted in Appendix C, Figure C-34 (Stutts, 2023, AHC, 2023). Thirty-six historic properties located in Clarke, Dallas, Perry, and Wilcox counties are listed in the NRHP and consist of twenty-one historic buildings, thirteen historic districts, and two sites (Table 29; Stutts, 2023). Seventy-nine resources listed in the ARLH were identified and include houses, schools, churches, and associated cemeteries among others (AHC, 2023, see Table 31). Five of these ALRH resources are no longer extant (Table 30). A total of 201 named cemeteries have been identified thus far within the treatment area, twenty-two of which are listed on the AHCR (AHC, 2023). Named cemeteries in the Middle AL Basin treatment area are depicted in Appendix C, Figures C-35 (AHC, 2023, Sipes, 2017). Additionally, a review of the Alabama Cultural Resources Online Database (ACROD), which is the state archaeological site file maintained by the University of Alabama (UA) Office of Archaeological Research (OAR), indicates approximately thousands of previously identified prehistoric and historic archaeological sites within the Middle AL Basin treatment area, representing thousands of years of human occupation (UA, 2023). A map of previously identified archaeological resources in the treatment area is not provided in this Plan as information on cultural resources obtained through ACROD is not public information per NRCS privacy and Freedom of Information Act (FOIA) policy and pursuant to Section 800.11(c) of 36 CFR Part 800 [see NRCS Title 190 NCRPH, Part 601, Subpart E, see Section 601.46]. NRCS-AL's disclosure of such information to Indian Tribes, the AHC, and other appropriate consulting parties to meet our "Section 106" compliance will follow the policies and procedures outlined in the SPAA and in accordance with NRCS policies and procedures (NRCS Title 190 NCRPH, Part 601).

Table 29. NRHP Properties Identified Within the Middle AL Basin Treatment Area

Property Name	County	Listing Date	Category of Property
Airmount Grave Shelter	Clarke	2/24/2000	Structure
Thomasville Historic District	Clarke	2/12/1999	District
Adams Grove Presbyterian Church	Dallas	6/5/1986	Building
Cahaba	Dallas	5/8/1973	Site
Carlowville Historic District	Dallas	1/18/1978	District
Pleasant Hill Presbyterian Church	Dallas	4/22/1999	Building
St. Luke's Episcopal Church	Dallas	3/25/1982	Building
Street Manual Training School	Dallas	7/28/1999	Building
Brand, Bryand, House	Perry	8/6/2010	Building
Chapel and Lovelace Hall, Marion Military Institute	Perry	9/13/1978	Building
First Congregational Church of Marion	Perry	12/17/1982	Building
Green Street Historic District	Perry	5/30/1979	District
Henry House	Perry	9/25/1986	Building
Kenworthy Hall	Perry	8/23/1990	Building
Moore-Webb-Holmes Plantation	Perry	8/24/2011	District
Phillips Memorial Auditorium	Perry	2/13/1990	Building
Pitts' Folly	Perry	8/9/1984	Building
Uniontown Historic District	Perry	2/24/2000	District
West Marion Historic District	Perry	4/22/1993	District
Westwood	Perry	11/21/1974	Building
Westwood (Boundary Increase)	Perry	3/15/1984	Building
Westwood Plantation(Boundary Increase)	Perry	12/10/1984	District
Ackerville Baptist Church of Christ	Wilcox	4/18/2003	Building
Beck, William King, House	Wilcox	5/21/1993	District

Table 29. NRHP Properties Identified Within the Middle AL Basin Treatment Area

Property Name	County	Listing Date	Category of Property
Bethea, Tristram, House	Wilcox	7/11/1985	Building
Dry Forks Plantation	Wilcox	2/26/1999	Building
Furman Historic District	Wilcox	5/13/1999	District
Hawthorn House	Wilcox	3/7/1985	Building
Liberty Hall	Wilcox	1/5/1984	Building
Liddell Archeological Site	Wilcox	11/17/1978	Site
Oak Hill Historic District	Wilcox	6/26/1998	District
Pine Apple Historic District	Wilcox	2/26/1999	District
Prairie Mission	Wilcox	10/29/2001	Building
Snow Hill Normal and Industrial Institute	Wilcox	2/24/1995	District
Tait-Ervin House	Wilcox	2/24/1995	Building
Wilcox County Courthouse Historic District	Wilcox	1/18/1979	District
Wilcox Female Institute	Wilcox	4/3/1975	Building

Table 30. ARLH Resources within the Middle AL Basin Treatment Area

Property Name	ARLH Listed Date	City
Butler		
Coleman-Crenshaw House	3/24/2005	Greenville
Hawkins' Quarters	3/13/1996	Forest Home (vicinity)
Major Edward Price Preston House	1/24/2008	Forest Home
Pine Flat United Methodist Church	7/6/1978	Forest Home
William Carter Home (Pine Flat Plantation)	3/8/1994	Forest Home
Clarke		
Pleasant Hill Methodist Church	3/29/2012	Thomasville
Thomasville High School	8/25/1994	Thomasville
Dallas		
Anthony Stoutenborough Hall	7/18/1989	Elm Bluff (location unconfirmed)
Bailey-Mayo Store (Demolished)	11/2/1990	Pleasant Hill
Beloit Industrial Institute (Dallas County Training School)	8/6/1993	Beloit (Orrville vicinity)
Belvoir (Saffold Plantation)	11/2/1990	Pleasant Hill (vicinity)
Belvoir Superintendent's House	11/2/1990	Pleasant Hill (vicinity)
Boguechitto Institute	3/29/2012	Bogue Chitto
Butler-Rives House	11/2/1990	Pleasant Hill
Cedar Acres (Maxwell-Carter House)	11/2/1990	Pleasant Hill (vicinity)
Cedar Creek Bridge	11/2/1990	Pleasant Hill (vicinity)
Craig-Wilson Home (Mooreland)	2/12/2015	Orrville
Dunaway-Meyer House	4/14/1978	Orrville
Eden (Boykin Plantation)	7/21/1978	Tilden

Table 30. ARLH Resources within the Middle AL Basin Treatment Area

Property Name	ARLH Listed Date	City
Frank Lewis House	11/2/1990	Pleasant Hill (location unconfirmed)
Good Hope Baptist Church (Demolished)	2/6/1998	Browns (vicinity)
Green-Underwood House	11/2/1990	Pleasant Hill
Hurricane Creek Bridge	11/2/1990	Pleasant Hill (vicinity)
Magnolias (Crumpton House)	11/2/1990	Pleasant Hill (vicinity)
Maxwell-Fail House, ca. 1840/1906	11/2/1990	Pleasant Hill
McMillan-Oxford Home	1/29/1980	Pinebelt
Pleasant Hill Baptist Church	11/2/1990	Pleasant Hill
Pleasant Hill Presbyterian Church	11/2/1990	Pleasant Hill
Pope-Givhan House	8/27/1990	Safford
Prosperity CME Church	9/27/2007	Orrville
Providence School	4/1/2010	Orrville (vicinity)
Safford Community House	6/14/18	Safford
Street Manual Training School (NRHP listed)	3/12/1997	Richmond-Minter
Ulmer House	11/2/1990	Pleasant Hill (vicinity)
Vasser-Ellis House (Demolished)	11/2/1990	Pleasant Hill (vicinity)
Watson House	5/28/2009	Orrville
W.C. Harrell Store (Demolished)	11/2/1990	Pleasant Hill
Lowndes		
Hopewell Baptist Church	11/19/2015	Mount Willing
Mt Willing Christian Church	11/19/2015	Mount Willing
Snow Cemetery	9/12/1988	Dutchbend Community
Marengo		
Bethel Baptist Church	4/11/1984	McKinley
Perry		
Brand-Moore-Holmes House (NRHP listed)	9/20/2006	Marion
Carlisle Hall (NRHP listed)	12/15/1989	Marion
Fairhope Plantation (NRHP listed)	12/19/1991	Uniontown
Fiquet-Perkins-Sturdivant-Moore House	2/6/1978	Marion
Lincoln High School Gymnasium and Classroom Addition	9/29/2005	Marion
Lockett-Martin House (Napoleon Lockett House)	7/7/1980	Marion
Uniontown Post Office	11/23/1976	Uniontown
Phillips Memorial Auditorium (NRHP listed)	2/19/1988	Marion
Wilcox		
Ackerville Baptist Church	7/22/1991	Ackerville
Antioch Baptist Church	11/13/1996	Camden
Beck-Crewswell House	11/13/1996	Camden
Beck-Darwin House	10/19/1979	Camden

Table 30. ARLH Resources within the Middle AL Basin Treatment Area

Property Name	ARLH Listed Date	City
Bessie Munden Park	8/25/2011	Camden
Camden Academy	6/27/2019	Camden
Camden African American Historic District	6/14/2018	Camden
Cathcart House	3/23/1990	Alberta
Cedarcrest	4/21/1981	Oak Hill
Cook Hill (Dan Cook Home Place)	10/19/1979	Camden
Creagh-Glover Family Cemetery	3/22/1991	Catherine
Dulaney AME Church and Cemetery	4/18/2007	Camden
First Baptist Church	12/19/2019	Pine Apple
G.W. Watts High School	12/19/2019	Pine Apple
Gee's Bend Farms Community School	3/30/1989	Boykin
Griffin House	7/21/1978	Arlington
Hawthorne House	11/9/1982	Pine Apple
Hope Well Church	5/19/1999	Furman
Kaster House (Demolished)	11/6/1980	Camden
Moore Academy School	6/30/1995	Pine Apple
New Virgin Baptist Church and Cemetery	12/19/2019	Pine Apple
Prairie Mission School (NRHP listed)	7/22/1991	Prairie
Primm-Rouse-Dunnam House	10/17/1980	Camden
Reeves Chapel Methodist Church and Cemetery	7/7/1980	Camden
Snow Hill Normal and Industrial Institute (NRHP listed)	7/14/1981	Snow Hill
Stanford House	9/28/2004	Pine Apple
Sterret House	4/14/1992	Camden
White Columns (Starr/Felix Tait Plantation, NRHP listed)	3/25/1976	Possum Bend
William S. Irby, Sr. House	12/4/1992	Lower Peach Tree

4.12 Air Quality

The Clean Air Act as amended (CAA) is the underlying Federal environmental law for air quality in the U.S. Regulatory agencies, such as the EPA and other state and local regulatory agencies must promulgate specific regulations to implement the CAA. The CAA requires the EPA to establish National Ambient Air Quality Standards (NAAQS) for specific pollutants. The Middle AL Basin is not located in a nonattainment area.

5. Alternatives

5.1. Formulation Process

Numerous structural and non-structural measures were considered and evaluated in the formulation of alternative plans. Measures which had been determined either not feasible, unacceptable, or did not meet the needs of the area during feasibility studies were not considered in the general reevaluation. These measures included groundwater artificial recharge, intensified drilling of deeper aquifers, moving water across properties, and reallocation of storage in reservoirs and construction of large reservoirs. Engineering, environmental, economic, sociological, institutional, acceptability, and other factors were key in the formulation of alternatives to ensure that resources were not wasted in the development of unreasonable plans.

Non-structural alternatives such as soil conservation practices can mitigate crop stress in times of drought or flash drought. Auburn University has soil health and conservation farm system research and Extension programs to assist producers. This project coordinates with and complements those existing programs.

The process used to formulate alternatives was based on the primary objective of the SLO with respect to the Federal Objective and Guiding Principles" (DM9500 pg. 6). The objective of this project is to minimize damage to plant health and vigor associated with untimely and unpredictable rainfall that impairs rainfed agricultural crop resilience in Alabama. Without the ability to apply supplemental water in times of inadequate soil moisture due to inadequate precipitation, producers carry a real risk of production loss. Over time, production loss becomes unsustainable from both a resource and economic standpoint. By developing diffuse or decentralized on-farm irrigation systems suitable for the farming practices in the Middle AL Basin, the risk of production loss can be greatly reduced. The objective should be attained while avoiding or minimizing adverse impacts to ecosystems and ecosystem services. Additionally, alternatives were devised to meet the project's purpose of Agricultural Water Management and further the conservation, development, utilization, and disposal of water in cropping systems. The federally assisted alternative will represent works or practices needed to address the purpose and need for action while providing the flexibility required for appropriately assessing specific practices at the site level. Given the potential diversity of application and need, the SLO does not wish to limit the flexibility in which this project will support agricultural land use in the form of sustainable adoption of diffused irrigation systems.

5.2. Alternatives Eliminated from Detailed Study

Alternative formulation was first evaluated on whether the alternative met the project purpose and need (Section 2). Then, alternatives were evaluated based on the criteria listed in the NEPA and the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water Resource Investments (PR&G, DM 9500-13). This includes evaluating alternatives while considering the following: completeness, effectiveness, efficiency, and acceptability. Alternatives that did not meet the purpose and need of the project or were deemed unsuitable because of cost, logistics, or social and environmental reasons were removed from subsequent detailed evaluations.

5.2.1. Current/Conventional Adoption: Adoption of irrigation that supports 18 acre-inches per year

The project would support storing the standard volume of water considered a season's worth of irrigation in a reservoir via withdrawals during high winter flows. This alternative was studied in detail with respect to water availability by Srivastava et al. (2010). Although different crops have varying water needs, the maximum storage required for the season to irrigate crops in Alabama is about 1.5 acre-feet (Srivastava et al., 2010). While the actual crop water demand might be less, this number accounts for evaporation, seepage, and other losses that occur when storing water. Assuming each pond is generally 10 feet deep for optimal economic return (Limaye et al., 2004), it would take approximately 1 acre of pond for every 6.6 acres of irrigated land.

This alternative would require a total cost of $11,260,000 for reservoir development ($130,000 reservoir for every 7.6 acres of 3,052 total project acreage; Appendix E, Figure E-14.). This cost is not inclusive of additional equipment needed to supply irrigation water to crops such as pipelines, pumping plants, and irrigation systems. The costs required to implement this alternative would detract from the primary purpose and need for this program. This alternative was not considered further as the cost would be unreasonable and it would provide water excessive to that required for the identified outputs.

5.2.2. 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 would 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. However, Alabama abides by the 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. Controversy and unacceptable environmental impacts are anticipated with this alternative. This alternative was not considered in further detail due to the estimated potential for unacceptable environmental impacts, anticipated controversy, and unfavorable likelihood of success.

5.3. Alternatives Description

The alternatives carried forward for further examination include the No-Action Alternative (Future Without Project) and the Sustainable Irrigation Adoption (SIA) Alternative.

5.3.1. Alternative 1 - Future Without Project (FWOP)

The Future Without Project Alternative (FWOP) would not provide federal support for the adoption of irrigation in the Middle AL Basin, and no action will be taken.

The FWOP Alternative would not meet the project purpose of minimizing damage to plant health and vigor. This alternative would not satisfy PR&G Guiding Principles, nor would it achieve the Federal Objective. Under current conditions (FWOP), the climate and variability of rainfall will continue to reduce plant health and vigor.

5.3.2. Alternative 2 - Sustainable Irrigation Adoption (SIA) Above Current Adoption

The project would support the goal of minimizing damage to plant health and vigor associated with untimely and unpredictable rainfall that impairs rainfed agricultural crop resilience in Alabama. The project would also provide a plan that will identify and prioritize areas that are most suitable for irrigation and that can provide sustainable water supply to crops. In contrast to the FWOP alternative, the preferred alternative will increase irrigation infrastructure under a management plan to minimize impacts on water quantity and quality. Properly planned and implemented, irrigation can improve crop nutrient use efficiency by decreasing the amount of nutrients available for runoff (Ellenburg, 2022). Studies have also shown that the inclusion of conservation practices can reverse any small increases in sediment export due to irrigation (Estes et al., 2022). Healthier crops and their canopies keep soils in place and minimize raindrop energy, thus reducing sedimentation from fields.

Alternative 2 allocates funding to assist farmers with the installation of water delivery/supply infrastructure and/or irrigation application equipment at the farm level on previously rainfed crop production land. The following NRCS Conservation Practice Standards (CPSs) found in the Alabama NRCS Field Office Technical Guide would be eligible for cost-share assistance:

- Irrigation Pipeline (Code 430)
    - Definition: A pipeline and appurtenances installed to convey water for storage or application as part of an irrigation water system.
- Irrigation System, Microirrigation (Code 441)

    - Definition: An irrigation system for frequent application of small quantities of water on or below the soil surface: as drops, tiny streams or miniature spray through emitters or applicators placed along a water delivery line.
- Sprinkler system (Code 442)
    - Definition: A distribution system that applies water by means of nozzles operated under pressure.
- Pumping plant (Code 533)
    - Definition: A facility that delivers water at a designed pressure and flow rate. Includes the required pump(s), associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy source(s), and protective structures.
- Water Well (Code 642)
    - Definition: A hole drilled, dug, driven, bored, jetted, or otherwise constructed into an aquifer for agricultural water supply.

Associated costs for necessary power supply would also be eligible.

In unique situations where additional capacity is needed for short term storage, Irrigation Reservoir (Code 436), may be eligible as part of the water development for the irrigation system. Irrigation Reservoir is defined as an irrigation water storage structure made by constructing a dam, embankment, pit, or tank. This practice is not anticipated to be used widely or ranked as a high priority. An example where reservoirs might be needed is where ground water or surface waters may be limited; these situations will be evaluated on a case-by-case basis for feasibility and would only be considered where environmental impact is low.

Under Alternative 2, producers who would like to receive NRCS assistance to convert rainfed cropland to irrigated cropland would apply for assistance with the SLO. The SLO would rank applicants based on criteria found in Table E-2 of Appendix E, and potential site locations would be selected based on applicant rankings. An onsite Environmental Evaluation (EE) would be performed at each potential site using NRCS Form CPA-52. Sites for which Alternative 2 (SIA) is decided to be the best alternative after the EE process would be selected for project implementation.

The NRCS CPSs that best meet the project plan purpose and objectives and the producer's needs will be selected for each project site. The water source for each site will be determined based on criteria found in this Plan. The water source must be able to provide sufficient water for crops when needed. Water requirements depend on the climate, crop, and the amount of available soil moisture (Lamont et al., 2012). Irrigation water will be sourced from perennial streams or aquifers. If a perennial stream is accessible, a novel flow duration methodology named the Irrigation Potential Assessment at 90% of the time (IPA90) will be used to estimate the volume of potential surface water available for irrigation that ensures natural stream low flows required to protect ecosystem viability are maintained in the months when irrigation is likely to occur. If the volume of water needed for irrigation exceeds IPA90, a more sustainable option would be considered. A more detailed explanation of this alternative's impacts on surface water can be found in Section 6.6.2.1. An analysis of groundwater in the basin found all of the aquifers in the basin could support substantial increases in withdrawals for irrigation use without reducing the amount of water recharged to the aquifers by more than 10%. An in-depth analysis of aquifers in the basin and the estimated impacts of their use to supply irrigation water is found in Section 6.6.2.4.

The SLO will offer a three-year irrigation management plan to all successful applicants which includes conservation agricultural equipment and a user-friendly interface for the farmer. This will be fully covered by the ASWCC. The equipment that will be offered for promoting sustainable agricultural and conservative irrigation practices includes the following:

- Flow meters
- Soil moisture sensors
- Variable rate irrigation (VRI) components
- Telemetry
- Scheduling assistance
- Weather station

The SIA Alternative contributes to the sponsors' objectives as follows:

- Minimize damage to resources of concern (plant health and vigor)
- Improve water conservation and irrigation efficiency on farms
- Improve water availability and reliability for agricultural production
- Improve water quality and soil health through uptake of in-field nutrients
- Increase organic matter to improve soil health and water-holding capacity
- Benefit rural agricultural communities
- Support existing agricultural production and land use

The estimated project installation cost for the *SIA* Alternative is $10,040,202. The Operation, Maintenance, and Replacement (OM&R) costs to be borne by the producer are to be included in the crop enterprise budgets.

5.4. Summary and Comparison of Alternatives

Table 31 contrasts Alternative 1 (FWOP) and Alternative 2 (SIA) on their impacts to resources and ecosystem services.

Environmental consequences and associated compliance and BMPs for each Alternative and the three Scenarios for the SIA Alternative are summarized in Section 6.

Table 31. Comparison of Alternatives

Watershed Plan Element	Item or Concern	Alt. 1: FWOP (No-Action)	Alt. 2: SIA
Alternative Plans	Locally Preferred		x
	National Economic Efficiency	x	
	Regional Economic Benefits		x
	Socially Preferred		x
	Environmentally Preferred		x
Guiding Principals	Healthy and Resilient Ecosystems		x
	Sustainable Economic Development		x
	Floodplains		x
	Public Safety		x
	Environmental Justice		x
	Watershed Approach		x
Measures to Address	Reliability of Water Availability and Delivery	Water delivery reliability for agriculture would not be improved as infrastructure and operations would not change. ALSWCC would continue to be unable to meet patron demands.	Water delivery reliability for agriculture would improve for approved irrigators/farmers within the basin.

Table 31. Comparison of Alternatives

	Regional and National Economic Benefit	There would not be a change in the current economic status within the region or nation from agricultural production alone.	The region would benefit economically through reduced indemnities through crop insurance
	Damage to resource (plant health and vigor)	Resource damage occurs. Less cropland would be converted from rainfed to irrigated, and plant health and vigor would be at risk in times of drought as the availability of water would remain unpredictable.	Resource damage reduced. Resilience of plant health and vigor would be enhanced through the implementation of irrigation practices.
	Soil Health	There would be no improvements in soil health as management practices would not change.	Soil health would be sustained through increased water-holding capacity, increased organic matter, and uptake of in-field nutrients (improved nutrient use efficiency), thus leading to sustained or potentially improved water quality.
	Water Quality	There would be no improvements in water quality as management practices would not change.	Sustained or potentially improved water quality would occur because of increased water holding capacity in soil, and improved nutrient use efficiency.
Installation Costs	NRCS Contribution	$0	$6,614,000
	Farmer Contribution	$2,214,000	$3,426,000
	Total	$2,214,000	$10,040,000
NEE Benefit-Cost Analysis	Annualized Installation Costs	$99,000	$433,000
	Annualized O&M Costs	$79,000	$343,000
	Annualized Technical Assistance Cost	$0	$17,500
	Total Annualized Monetized Costs	$178,000	$794,000
	Total Annualized Monetized Benefits	$166,000	$725,000
	Annual Monetized Net Benefits	($12,000)	($69,000)
	Benefit-Cost Ratio	0.93	0.91
	Annual Remaining Flood Damage	N/A	N/A

Notes:

a. Operation, maintenance, and replacement responsibilities of the AWM Elements will be assumed by the producer. The approved producers will sign an O&M agreement for the AWM Elements concurrently with the Cost-Share agreement

	Beneficial Effects Annualized

Table 31. Comparison of Alternatives

Regional Economic Impacts	Local jobs due to increased production	No effect	100 jobs
		$1,757,517	$7,663,000

Resources Identified			
SOILS	Upland Erosion	Under rainfed farming, erosion from fields may occur during drought periods; eventual rainfall creates excessive runoff and erosion.	Potential for increased soil loss due to irrigation runoff. Runoff increases are minor, and effects would be short term and localized. However, erosion is minimized where conservation tillage and cover crops are implemented.
	Stream Bank Erosion	No effect	Potential for stream bank erosion during installation of surface water intake.
	Sedimentation	No effect	Potential for additional runoff by increasing irrigation, which might lead to more sediment transport.
	Prime and Unique Farmland	No effect	Potential for protection and enhancement by increasing irrigation.
WATER	Surface Water Quantity	No effect	Impacts to local water resources are negligible to minor in intensity.
	Surface Water Quality	No effect	Water quality parameters such as turbidity and water clarity could be temporarily impacted due to land disturbing activities associated with the construction of irrigation delivery systems. However, supplemental irrigation can improve water quality through improved nutrient use efficiency and subsequent runoff reductions.
	Groundwater Quantity	No effect	Impacts range from negligible to minor.
	Groundwater Quality	No effect	Irrigation may increase groundwater leaching in the case of over-irrigation or excess fertilization. However, irrigation applied in accordance with BMPs reduces the risk of groundwater leaching.
	Clean Water Act	No effect	CWA Section 404 responsibilities will be fulfilled, and landowners are responsible for obtaining permits prior to project implementation.

Table 31. Comparison of Alternatives

	Wetlands	No effect	Identification and evaluation of wetlands will be accomplished for each potential project site following procedures outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52). If wetlands would be adversely impacted by a proposed action, NRCS will advise clients of alternative actions. Where there is a practicable alternative to avoid adverse impacts and no available exemption exists, then mitigation would be required. If clients decline mitigation measures, NRCS shall terminate all assistance for the project.
	Water Bodies	No effect	Minor effects on both the surface and groundwater supply.
AIR	Air Quality	No effect	Given the relatively small areas and slight increase in application rates, models show impacts would be negligible and temporary
PLANTS	Endangered and Threatened Species	No effect	Identification and evaluation of T&E species will be accomplished for each potential project site following procedures outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52). If T&E species would be adversely impacted by a proposed action, mitigation measures formed in informal consultation, biological opinion, or 4(d) special rule will be followed. If the action cannot be modified to avoid the effect, NRCS will consult with FWS/NMFS. The action can only be implemented according to the terms of the consultation.
	Riparian Areas	No effect	There may be slight increases of runoff and nutrient loads at some sites near riparian areas. Sites will undergo evaluations to identify any potential risk to riparian zones.
ANIMALS	Fish and Wildlife Habitat	No effect	The extent of potential impacts on fish and aquatic resources is difficult to evaluate until specific project sites have been identified by the NRCS and the SLO. Any adverse effects can be effectively mitigated.

Table 31. Comparison of Alternatives

	Endangered and Threatened Species	No effect	Identification and evaluation of T&E species will be accomplished for each potential project site following procedures outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52) and the Alabama USFWS-NRCS Informal ESA Consultation. If T&E species would be adversely impacted by a proposed action, mitigation measures formed in informal consultation, biological opinion, or 4(d) special rule will be followed. If the action cannot be modified to avoid the effect, NRCS will consult with FWS/NMFS. The action can only be implemented according to the terms of the consultation.
HUMANS	Cost, Economic Efficiency	No effect	The Federally assisted plan will create quantified and non-quantified economic benefits, both regionally and nationally.
	Cultural and Historic Resources	Assuming land use in the Middle AL Basin remains constant, effects to any archaeological resources located in rainfed fields are expected to be negligible to major; whereas effects to non-archaeological historic resources are expected to be negligible	Potential effects to subsurface (archaeological) cultural resources and historic properties. Identification and evaluation of cultural resources and historic properties in compliance with "Section 106" of NHPA will be accomplished once landowner and producer participants are identified and NRCS-AL's site-specific review process initiated. This approach minimizes the potential for adverse effects to known or heretofore unknown cultural resources and historic properties. NRCS policy is to avoid effects to cultural resources and historic properties whenever possible by either moving the conservation practice, changing the work limits, changing to an acceptable alternative practice or measure, or modifying the practice design. Technical assistance funding is available for mitigation measures if necessary.
	Local and Regional Economy	No effect	Positive impacts are expected due to the economic impact spurred by increased production of agricultural products at the local level.

Table 31. Comparison of Alternatives

	Potable Water Supply	No effect	Once specific sites have been identified, an Environmental Evaluation (NRCS-CPA-52) will be done to identify any potential localized risk to water supply.
ECOSYSTEM SERVICES – Trade Offs			
Provisional	Crops for food, fuel, & fiber	Farmers in the Middle AL basin face high risk of reduced plant health and vigor as rainfall amounts throughout the growing season remain unpredictable. While marginal increases in crop production may be gained through better genetics and improved management practices, those increases are likely to be small and are still dependent on adequate rainfall.	Risk of reduced plant health and vigor due to inadequate rainfall is substantially reduced. Crop outputs can be considerably increased when rainfed cropland is converted to irrigated cropland, especially in years with prolonged or flash droughts.
	Water Supply	Due to lack of resources, little rainfed cropland will be converted to irrigated cropland. However, any farmers installing new irrigation infrastructure may not consider surface water withdrawals during low flow conditions which could lead to water supply issues in isolated areas for users downstream or impact fish and wildlife populations.	Groundwater and surface water withdrawal for irrigation will lead to reduced water availability. However, the approach developed for assessing surface water flows at the HUC 12 level during times of the year when irrigation is most likely to occur will allow irrigation to be targeted to areas where streamflow will not be adversely affected. A groundwater evaluation will inform the recommended well depth and spacing to minimize risk of aquifer depletion.
Regulating	Water quality (Nutrient pollution)	Excess nutrients unused by rainfed crops in times of inadequate soil moisture will continue to pollute groundwater and surface waters, especially in times of drought.	Crops with supplemental irrigation to prevent low soil moisture levels have healthier crops and higher nutrient use efficiency. Additionally, a crop that does not mature properly due to lack of moisture does not uptake the expected amount of nutrients, thus excess nutrients contribute to water pollution. Additionally, the irrigation management plan provided by the SLO will help train producers on best irrigation management practices to prevent over irrigation that can contribute to nutrient pollution.

Table 31. Comparison of Alternatives

	Water quality (sediment pollution)	In times of inadequate rainfall, rainfed crops will not fully develop. Decreased crop cover leads to increased soil erosion. Hard pan dried soils can decrease infiltration and increase surface runoff and sediment transport.	Though Supplemental irrigation will increase soil moisture and thus increase overall surface runoff, irrigation will result in greater crop cover which can decrease the available sediments in the surface runoff, potentially resulting in less soil erosion overall.
Cultural	Farming Heritage	Farmers in the Middle AL Basin face challenges including heir property. Farmers who work on such properties are limited in the benefits of cultural services from farming.	Farmers in the Middle AL Basin will have increased profitability from crop production. The local economies within the Basin will improve with increased agricultural-related economic activities.

6. Environmental Consequences

This section presents the intensity threshold table used to quantify estimated effects to resources of concern because of the proposed alternative. See Table 32 for reasoning of each threshold as used for impact estimations.

The results of an action are estimated. These impacts are quantified using the following reasoning:

- Direct Effect are caused by the action and occur at the same time and place.
- Indirect Effects are caused by the action and occur later in time or farther removed in distance but are still reasonably foreseeable.
- Cumulative Effects results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such actions.

Table 32. Intensity Threshold Table

Beneficial	Changes in the resource or resource-related values are favorable or advantageous with respect to the resource. The effects on the resource or environment may range from slight to regional.
Negligible	Changes in the resource or resource-related values would be below or at the level of detection. If detected, the effects on the resource or environment would be considered slight with no perceptible impacts.
Minor	Changes in resource or resource-related values would be measurable but small. The effects on the resource or the environment would be localized.
Moderate	Changes in the resource or resource-related values would be measurable and apparent. The effects on the resource or the environment would be relatively local.
Major	Changes in resource or resource-related values would be measurable and substantial. The effects on the resource or the environment would be regional.
Impact Duration Definitions	
Temporary	Transitory effects which only occur over a period of days or months.
Short-Term Effect	Resource or resource-related values recover in fewer than 5 years.
Long-Term Effect	Resource or resource-related values take more than 5 years to recover.

6.1. Climate

6.1.1. Alternative 1 - Future without Project

Increases in air temperature over the last few decades in the Southeast have been small compared to the rest of the United States, although increases in minimum temperature have been larger and more widespread (Carter et al., 2018, Christy, 2021; Fall et al., 2021). In the coming decades, Alabama is expected to become warmer and experience a 2 to 3 °F increase in average temperature (EPA, 2016; Carter et al., 2018). With summers projected to get hotter, Alabama is likely to experience a reduction of corn yields. However, the fertilizing effects of increased carbon dioxide concentrations will result in yield increase for other crops such as cotton, wheat, and peanuts if water is available (EPA, 2016). In summary, no action will likely result in decreased yields due to climate change.

6.1.2. Alternative 2 - SIA

Irrigation will result in a decrease of surface temperatures because part of the solar energy will be spent on evaporation. Irrigated agriculture can decrease maximum temperatures and increase minimum temperatures thus shrinking the diurnal temperature range (DTR) considerably (Mahmood et al., 2006; Lobell and Bonfils, 2008;

Nocco et al., 2019). Irrigation can also cause increased atmospheric moisture and local rainfall (Guimberteau et al., 2012; Thiery et al., 2017; Nocco et al., 2019).

In the case of Alabama, the DTR impact could be even higher than that in the Midwest. Additionally, irrigated agriculture seems to have reduced the vapor pressure deficit (VPD) by an average of 0.10 kPa in the same region and significantly decreased evaporative demand for 25% and 66% of study days compared to rainfed agriculture and forest, respectively in that region (Nocco et al., 2019). Implementation of irrigation systems as an adaptation option will help increase or sustain current crop yield levels and minimize runoff, erosion, nutrient losses, and pesticide losses, and effects are likely to be minor-moderate.

6.2. Agriculture

6.2.1. Alternative 1 - Future Without Project

6.2.1.1. Irrigated Cropland under Alternative 1

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 33; Ellenburg et al., 2022). It is predicted that the irrigation adoption rate in the basin under the FWOP alternative will continue at 175 acres per year.

Table 33. Comparisons of irrigation adoption rates by year range.

Years	2006–2021	2006–2011	2011–2015	2015–2021
Average irrigation adoption rate	175 acres/year	14 acres/year	545 acres/year	64 acres/year

Source: Ellenburg et al., 2022.

According to the 2017 Census of Agriculture, the eight counties that overlap the project area experienced an average 3.4 percent increase in farmland from 2012 to 2017. Although much of the basin is considered prime agricultural land, external evidence suggests current land use and ownership patterns may change to favor developed land over agricultural land. Considering the disparities presented by other factors such as land conversion, it cannot be assumed that irrigation adoption trends will remain constant over time.

Particular barriers encountered by producers in this section of the Black Belt region are the lack of electrical grid infrastructure, the depth of groundwater and the associated cost to access it, and limited access to capital investment.

Additionally, impacts of climate change may adversely impact agricultural yields within the state.

There is one 303(d) stream (Bogue Chitto Creek) that lists agriculture as an impairment source (ADEM, 2020a; Appendix C, Figure C-15). Existing water quality concerns associated with agriculture will continue and possibly increase in the FWOP Alternative. Additionally, there are no current programs that identify sustainable water sources for irrigation. Without proper planning and/or programmatic funding, any additional irrigation could be installed without regard to the locations most suitable for sustainable irrigation adoption.

6.2.1.2. Ecosystem Services under Alternative 1

Provisional service; crops for food, fuel, and fiber. Farmers in the Middle AL Basin will continue to face high risk of reduced plant health and vigor as rainfall amounts throughout the growing season remain unpredictable, resulting in variable streamflow. While marginal increases in crop production may be gained through better genetics and improved management practices, those increases are likely to be small and depend on adequate rainfall.

Cultural service; farming heritage, sense of place and connection. Farmers in the Basin reported that aesthetic value, farming heritage, spiritual and religious connection to land, sense of place, and recreation were important cultural services. This program helps farmers maintain economically sustainable operations.

6.2.2. Alternative 2 – SIA

6.2.2.1. Irrigated Cropland under Alternative 2

Historical irrigation adoption rates have been highly variable in the basin (Table 33; Ellenburg et al., 2022). Such variation in past irrigation adoption rates and the many obstacles faced by producers in the basin make it difficult to predict increases in irrigated farmland due to this project. Some of the barriers faced by producers in this section of the Black Belt region are the lack of electrical grid infrastructure, the depth of groundwater and the associated cost to access it, and limited access to capital investment. While irrigated farmland acreage increased by 175 acres per year from 2006 to 2021, increases in irrigated farmland jumped to 545 acres per year from 2011 to 2015 due to drought in the Midwest that increased demand for commodity crops from other regions of the country. The implementation of center-pivot irrigation systems by only two producers in a single year could match or pass the 15-year average increase of 175 acres per year. It is assumed that the financial incentives provided by this project would provide a major incentive to invest in irrigation infrastructure just as the higher commodity demand provided an incentive to invest from 2011 to 2015. It is estimated that this project will meet and exceed by 40 percent the average increase in irrigated acres seen from 2011 to 2015. Therefore, a predicted increase of 763 irrigated acres per year for four years (3,052 acres) will occur through the implementation of this alternative. The rate of adoption may be higher or lower depending on farmer preferences, access to water, and economic conditions. However, an evaluation of environmental impact and water supply reveals that the basin has the potential to sustain a much greater increase in irrigated acres than is estimated to increase because of this project. Uncertainty in the rate of irrigation adoption influences the costs and benefits of this alternative. Actual costs of irrigation may vary from farm to farm depending on the type of equipment installed, creating uncertainty in the costs of the preferred alternative.

6.2.2.2. Agriculture Economic Effects under Alternative 2

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 (Figures D-8 through D-15 of Appendix D) and the 5-year average commodity prices in Alabama to calculate revenue per acre (Table D-8 of Appendix D). Irrigation infrastructure construction costs were not included. The use of irrigation increases yield and net profit per acre for each of the four major commodity crops found in the Mid AL Basin (Table 34).

Table 34. 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 basin from the 2019 CropScape Data Layer to calculate an average damage reduction benefit per acre in the basin. An average damage reduction benefit from irrigation is calculated to be $162 per irrigated acre (Table 35). 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 35. Proportional Average Damage Reduction Benefit per Acre in the Middle AL Basin

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**

6.2.2.3. Agriculture Ecosystem Services under Alternative 2

Provisional service; crops for food, fuel, and fiber. The risk of reduced plant health and vigor due to inadequate rainfall is substantially reduced. Crop outputs could be considerably increased when rainfed cropland is converted to irrigated cropland, especially in years with prolonged or flash droughts. Irrigation may also contribute to increased crop diversity.

Cultural service; farming heritage, sense of place and connection. Farmers in the Middle AL Basin will have increased profitability from crop production. The local economies within the Basin will improve with increased agricultural-related economic activities. In cases where heirs' property is uncertain, the USDA Heirs' Property Relending Program will be utilized to help interested producers resolve land ownership and succession issues on agricultural land.

6.3. Land Use and Cover

6.3.1. Alternative 1 - Future without Project

The No Action Alternative would have no direct effect on land use within the project area. Land use changes are expected to remain consistent with existing ownership, easements, or right-a-way in the foreseeable future. However, as previously stated, a review of the agricultural land use trends from 2012-2017 showed an average of 3.7 percent increase in the number of farms and an approximate 7.4 percent average decrease in farmland acreage within the eight counties overlapping the basin area (USDA NASS, 2017). Although much of the basin is considered as Alabama's prime agricultural land, it may be likely that the current land use and ownership patterns may change to favor developed land over agricultural land.

6.3.2. Alternative 2 - SIA

Under this alternative there would be no effect on land use adjacent to the project area, as property ownership and existing use of land would not change. As mentioned earlier, it cannot be guaranteed that this project will influence land use changes. However, Federal support of the existing agricultural production in this basin may incentivize farmers to continue providing a reliable food source needed for the future. Overall, installation of irrigation on existing fields will not result in land use changes, resulting in negligible impact with this Alternative.

6.3.3. Compliance and Best Management Practices

To minimize the conversion of agricultural land to developed land, there is a clause within the agreement between the SLO and the applicant requiring the applicant to own or control the land that will be benefiting from this cost-share for at least five years.

6.4. Geology and Soils

6.4.1. Alternative 1 - Future without Project

6.4.1.1. Geology

Assuming land use in the Middle AL Basin remains constant; the No Action alternative would have no effect on geology.

6.4.1.2. Soils

Under rainfed farming, erosion from fields can result during drought periods. This is because crops do not develop root structure to stabilize soils during these drought periods, leaving the land potentially fallow with no cover. Eventual rainfall creates excessive runoff and erosion. The effect of the No Action Alternative on soils would be small but measurable, and therefore, would be minor.

6.4.2. Alternative 2 - SIA

6.4.2.1. Geology

This alternative would result in minor soil disturbance during the installation period. Soil disturbances would be minor, as these effects would be temporary and localized to the irrigation installation site. Effects would be further minimized, if necessary, through implementation of soil stabilization measures during installation. This alternative may result in increased runoff that could also carry sediment. Effects will be mitigated through NRCS conservation practices as part of the site selection process. Sites identified for implementation will also undergo onsite evaluations as outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52) to identify and resolve additional mitigation measures required to reduce erosion. Anticipated effects are expected to be minor.

6.4.2.2. Soils

Irrigation may cause soil erosion and an alteration of soil properties. Erosion from irrigated fields can result from numerous reasons. The increase in natural runoff that can accompany irrigation could also carry sediment from the field. In this case, the amount of erosion, or sediment flushing, would be highly dependent on several conditions including irrigation technology used, the amount and intensity of rainfall and runoff, the erodibility of the soil, and the slope of the field. For example, tow irrigation systems can have instantaneous application rates that exceed soil infiltration rates resulting in erosion. Indirect effects may include waterlogging (excessive water levels). Other possible impacts of irrigation on soils include (i) an increase in soil salinity: evapotranspiration from irrigated areas causes an accumulation of salt near soil surface and results in sodic soils; and (ii) a decrease in soil structural stability that can make soils more vulnerable to damages (Marshall et al., 1996; Murray and Grant, 2007).

The purpose of irrigation is to maintain the soil moisture of agricultural fields at an optimum level for plant growth during dry periods. The stabilization of soil moisture from irrigation may increase runoff during rainstorms and smaller rain events that typically would not have runoff. Runoff increases are of minor intensity, and the irrigated area is small compared to the watershed area as a whole. The small increases in runoff are not expected to degrade downstream habitats or increase flood levels. Temporary impacts may occur when trenching for irrigation delivery systems.

6.4.3. Compliance and Best Management Practices

USDA Conservation Practice Standard Irrigation Water Management (Code 449) will be implemented. BMPs attempt to address these issues through responsible management of irrigation systems. This may include the following steps: understanding the soil properties of the field, knowing the water requirements of the particular crop being irrigated, designing and operating the proper irrigation system for the situation (soils, crops, and topography), scheduling the irrigation cycles with proper knowledge, monitoring the irrigation system regularly, and taking into account the water quality of the irrigation water, particularly the nitrogen content. If these steps are followed properly,undesirable consequences can be avoided.

6.5. Vegetation

6.5.1. Alternative 1 - Future without Project

6.5.1.1. Federally Listed Plant Species

Assuming land use in the Middle AL Basin remains constant, conditions affecting Federally Listed T&E Species are estimated to remain the same (no impact).

6.5.2. Alternative 2 - SIA

6.5.2.1. Federally Listed Plant Species

Irrigation implementation would be done on already established agricultural land. Development and disturbance in watersheds can directly or indirectly impact habitats used by T&E species. Changes in habitat conditions can have a range of impacts on T&E species, from short-term threats to long-term alterations to the watershed's ability to support them. Threatened and endangered species may be especially sensitive to changes in watershed conditions. The extent of potential impacts on T&E species is difficult to evaluate until specific project sites have been identified by the NRCS and the SLO. Measures have been and will continue to be taken to prevent negative impact on T&E populations. The SHU data will help inform NRCS personnel during specific project site evaluations of possible conflict or intersection. Any effects can be minimized through mitigation efforts. Each of the project-approved practices results in a “no effect”, “mitigating action”, and/or specific “on-farm consult”. Based on this tiered approach, the anticipated effects are expected to be of no impact to minor in intensity.

The NRCS follows obligations under Section 7(a)(1) of the ESA to protect and conserve plant species listed or proposed for listing as endangered or threatened. ESA Section 7(a)(2) requires NRCS, in consultation with and with the assistance of the Secretary of the Interior, to ensure that its agency actions and activities do not jeopardize the continued existence of T&E species or result in the destruction or adverse modification of the species’ critical habitat.

6.5.3. Compliance and Best Management Practices

Potential presence of T&E species is illustrated by 12-digit HUC in Appendix C, Figure C -11. Per the ESA, organizations are required to consult with the USFWS if listed species or designated Critical Habitat may be affected by a proposed project. The ESA requires federal agencies to evaluate the likely effects of the proposed project and ensure that it neither risk the continued existence of federally listed ESA species, nor results in the destruction or adverse modification of designated Critical Habitat.

All requirements of the Alabama USFWS-NRCS Informal ESA Consultation for federally listed species will be followed (excerpts are included in Table E-1 and Figure E-15 of Appendix E). The decision diagram and practice matrix help the field office and the NRCS Biologist determine if a practice will result in a finding of “no effect” or “may affect – not likely to adversely affect”. A habitat assessment will be performed by the State Biologist, who will initiate informal consultation according to that assessment and the programmatic procedures. The informal consultation involves an evaluation of streamflow, species presence, sensitive habitats, water withdrawal volumes and timing, disturbance activities, stream geomorphology, etc. NRCS and the USFWS will consider cumulative effects where surface water withdrawals might impact streamflow volumes in a watershed to a degree that T&E species might be affected. Each project assessment will consider the overall effects of the program on the reaches with T&E species. Formal Endangered Species Act Section 7(a) consultation will occur, if necessary, to develop or negotiate reasonable and prudent measures to mitigate potential negative impacts, including cumulative effects. Mitigation strategies may include not altering hydrology of ephemeral drains, increasing buffer distance as needed to maintain the ecological and structural integrity of the riparian buffer and stream bank, and not crossing streams when using an irrigation water conveyance practice.

6.6. Water Resources

6.6.1. Alternative 1 - Future without Project

6.6.1.1. Surface Water Hydrology

Currently, Alabama has little water policy regarding irrigation water use and thus any irrigation implemented under the No Action alternative may not consider low flow considerations. Therefore, any increased irrigation could lead to negative surface water impacts. While the rate of irrigation adoption in the Middle AL Basin is currently relatively slow (approx. 165 acres per year), considerations for withdrawals during drought or low flow conditions are unlikely to be considered during the planning and installation of new irrigation systems.

6.6.1.2. Surface Water Quality

6.6.1.2.1. Total Nitrogen Loads in Streams

Overall, rainfed fields receive less fertilizer compared to irrigated fields. However, during a drought, plants are unable to fully develop root systems that are needed to take up the applied fertilizer. When the rainfall returns, the residual nitrogen may be carried off the fields by surface runoff or leached into the groundwater during fallow periods. While results vary, studies have shown that increases in plant uptake of nitrogen allow for fewer nitrates to be available in surface runoff or leaching.

Assuming no change in agricultural practices, existing agricultural lands, rainfed and irrigated, would continue to discharge current nutrient and sediment loads into the hydrologic system. As more irrigation is added to existing agricultural lands with no change in agricultural practices, the nutrient loads are likely to increase. While the nutrient loads on the fields will increase, irrigated fields will result in more efficient use by plants of the fertilizer applied. Thus, the delivery of nutrients into the hydrologic system and subsequent effects on water quality should be minimal. Due to the addition of irrigated flow to natural precipitation, sediment runoff into the hydrologic system would be expected to increase. The sediment increases can be managed with sustainable agriculture efforts to increase cover management and conservation practices that will result in minimal effects on water quality. Low flow conditions from droughts would exacerbate further the effects of nutrient and sediment loads on water quality, this is especially true in small/ephemeral streams (i.e. low stream orders).

6.6.1.2.2. Dissolved Oxygen

Excess nutrients and sediment load that may run from farmlands may contribute to eutrophication resulting in removal of DO through algal respiration, the decomposition of dead algae, and sediment oxygen demand. Low DO levels are harmful to aquatic life.

6.6.1.2.3. Water Turbidity

Sediment transported in runoff from barren fields (caused by drought) could increase the turbidity of the receiving waters. Increased sediment turbidity impacts primary productivity, degrades stream habitat, and negatively affects some fish and macroinvertebrates

6.6.1.3. Groundwater Quantity and Quality

Assuming land use trends in the Middle AL Basin continue, the No Action Alternative is unlikely to have effects on groundwater quality and quantity.

6.6.1.4. Ecosystem Services

Provisional service; water supply. Due to lack of resources, little rainfed cropland will be converted to irrigated cropland. However, without planning, any farmers installing new irrigation infrastructure may not consider surface water withdrawals during low flow conditions which could lead to water supply issues in isolated areas for users downstream or impact fish and wildlife populations.

Regulating service; water quality. Excess nutrients unused by rainfed crops in times of inadequate soil moisture will continue to pollute groundwater and surface waters, especially in times of drought.

6.6.2. Alternative 2 - SIA

6.6.2.1. Surface Water Hydrology

With the Alabama River flowing at an annual mean of 30,000 ft3/s from the Middle AL Basin and six productive aquifers residing below, the Middle AL Basin is host to an abundant amount of water resources. Thus, there is confidence that any impact on the overall annual water availability and downstream conditions will be minimal (See WASSI runs, etc. in APPENDIX). However, in terms of surface water, the timing of water availability is not evenly distributed across the year, and more importantly, not all agricultural areas are adjacent to the Alabama River. To fully assess the impact of irrigation and a sustainable increase in irrigation, smaller streams with low flows, especially during the growing season, must be considered.

A novel flow duration methodology named the Irrigation Potential Assessment (IPA) was created and employed to provide an initial assessment of the impact of irrigation on in-season low flows. The approach implements common low flow metrics and estimates the amount of surface water available for irrigation during the time when irrigation is most likely to occur (May, June, July). A flow duration curve is used to determine the streamflow volume that is exceeded above a potential threshold (e.g., 90%) of the time, then the minimum 7-day, 10-year average flow (7Q10) is subtracted from the 90% duration flow to ensure the natural low flows are maintained. The result provides an estimate of the potential surface water available for irrigation (Irrigation Potential Assessment at 90% of the time, or IPA90) at each HUC-12 while ensuring ecosystem viability.

The IPA90 can be applied spatially across the Middle AL Basin to provide an initial assessment of where surface water is available for irrigation. Streams near the watershed boundaries and streams that are less than fourth-order (when third-order stream branches join to form a fourth-order stream) are generally not suitable for direct in-season surface water withdrawal due to insufficient flows. The IPA90 identifies areas where a more sustainable water source should be considered (i.e., groundwater or surface storage).

Knowing the flow rate needed for an irrigation system allows for the IPA90 to be translated into an area that can be irrigated within each HUC-12 without adversely affecting streamflow and minimizing the risk to farmers. This analysis is meant to be an initial assessment that can inform the planning process of low flow considerations early in the decision and ranking process. A separate evaluation of available groundwater is conducted on site with groundwater hydrologists to ensure the withdrawals will not significantly affect the aquifer’s recharge.

To perform the IPA90 analysis at the HUC-12, a drainage area-flow duration relationship was calculated with all available USGS gauge data in the Middle AL Basin. The full methodology and statistics can be found in Appendix D. Figure 15 below shows the IPA at the HUC-12 level across the Middle AL Basin in (a) volumetric flow rate (ft3/s) and (b) total seasonal volume (ac-ft).

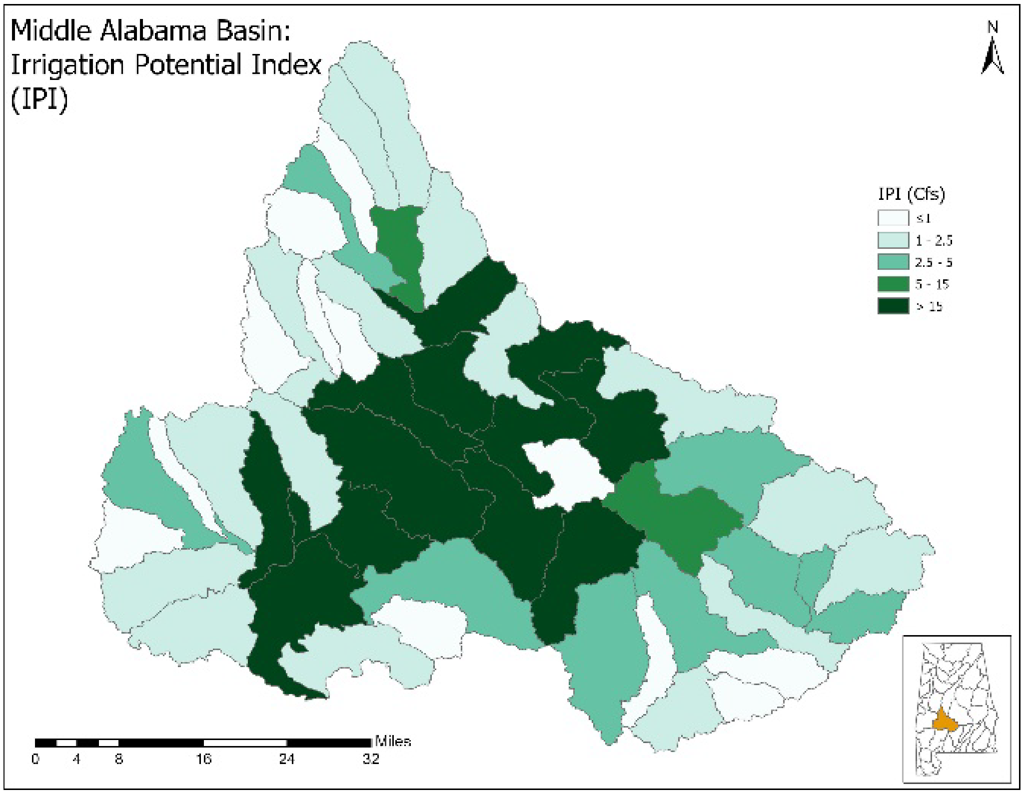

Figure 15. Irrigation Potential Assessment by HUC12

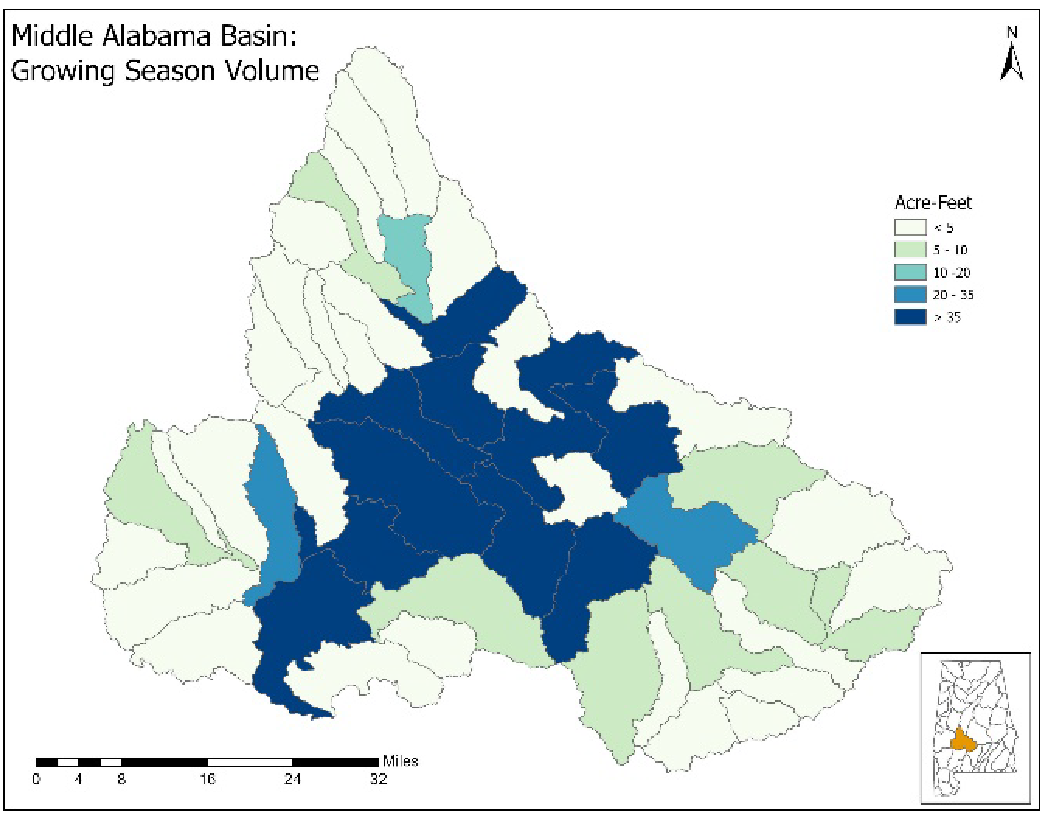

Figure 16. Growing Season Volume of Water Available by HUC12

The gauges used to create the drainage area relationship ranged from 36 to 261 square miles in the Middle AL Basin. Therefore, HUC-12s with a contributing area greater than or less than that range are beyond the model assumptions. Those areas that are less than the modeled range (light blue/green) are likely to have limited surface water resources available for widespread increases in irrigation. Those areas that are above the drainage assumptions (dark blue/green) can be assumed to have ample water resources for increased irrigation.

Figure 16 presents a spatial delineation of areas of available surface water for irrigation. Small scale increases (small acreage, drip systems) could be sustainable in the upper reaches, whereas near the Alabama River, the available surface water could irrigate most of the agricultural area in the HUC. This analysis allows for the surface water resource to indicate areas of sustainable increase. To get a complete picture of the water resources, groundwater must be assessed alongside the surface water.

Any surface water withdrawals will be constrained to areas that are deemed sustainable using the IPA. Streams near the watershed boundaries and stream orders that are less than 4 generally need more evaluation for direct in-season surface water withdrawal. The IPA90 identifies areas where a more sustainable water source should be considered (i.e., groundwater or surface storage). By definition, if instream irrigation withdrawals are limited to the volume of the IPA, then the maximum increase in the occurrence of 7Q10 will be no more than 10 percent. This is a maximum case scenario and would be considered a minor impact. However, the increase in acreage of surface withdrawals will be limited to the IPA (in most cases much less). Thus, as part of the preferred plan implementation, impacts and risk to the overall surface water availability and environmental low flows will be negligible to minor.

Interaction between surface and groundwater is evident especially in the shallow aquifers. Any significant drawdown in groundwater could lead to reduced streamflow. However, the potential for extreme drawdown is mitigated as part of this plan using the IPA methodology above. If surface water withdrawals are constrained by the IPA, impacts on groundwater recharge will be minor at most, and overall risk will be minimal.

6.6.2.2. Surface Water Quality

Implementing the project with sustainable agricultural practices for the expanded irrigation of existing agricultural land will promote more efficient use of fertilizer by plants, sustainable practices such as crop rotation, no till agriculture, and others. Overall, this is expected to decrease nutrients and sediment discharged into the hydrologic system resulting in enhanced water clarity and less risk for unhealthy eutrophic conditions to occur. The reduced nutrient and sediment loads would benefit water quality during low flow conditions as well, however, drought conditions would have a significant impact on nutrient levels and seasonal variations around mean conditions.

6.6.2.2.1. Increased Total Nitrogen Loads in Streams

More fertilizer is applied to irrigated fields when compared to rainfed cases because the stable soil moisture in irrigated fields allows for increased uptake of nutrients by the plants. Minor increases in surface water runoff are expected during irrigation of agricultural lands. The potential exists for some of this increased nitrogen to be carried off the fields directly by surface runoff or leached into the groundwater during fallow periods. While results are varied, some studies show that increases in plant uptake of nitrogen allow fewer nitrates to be available for surface runoff or leaching (see Ellenburg, 2011 for a review).

An increase in irrigated agricultural lands has the potential to increase fertilizer loads. Based on crop studies in Alabama and other representative regions estimated fertilizer rates of 125 lbs/acre (140 kg/ha) for rainfed agricultural fields and 250 lbs/acre (280 kg/ha) for irrigated fields (AAES, 2020).

6.6.2.2.2. Water Turbidity

Sediment transported in runoff from barren fields (caused by drought) could increase the turbidity of receiving waters. Increased sediment turbidity impacts primary productivity, degrades stream habitat, and negatively affects some fish and macroinvertebrates. water turbidity is unlikely to be impaired in the future.

6.6.2.2.3. Temporary Impacts

Water quality parameters such as turbidity and water clarity could be temporarily impacted due to land disturbing activities associated with the construction of irrigation delivery systems. Impacts would be temporary and of low magnitude. Projects should be evaluated per NRCS-CPA-52 on-farm evaluation to determine if the short-term construction to implement irrigation systems requires mitigation measures.

6.6.2.3. Groundwater Quality

Results vary concerning the effects of leaching on groundwater quality, but most studies indicate that leaching is increased under irrigation. Leaching is influenced by field irrigation application methods. Application of irrigation water that exceeds field capacity allows for vertical movement of moisture and nutrients out of the soil column. Soil texture and subsurface conditions, such as depth to the water table, also contribute to groundwater leaching. Irrigation applied in accordance with BMPs reduces the risk of groundwater leaching. In fact, studies have shown (see Ellenburg, 2011 for a review) that when irrigation and fertilization are applied responsibly, plant uptake of nitrogen is increased, and fewer residual nutrients are left in the soil to be leached. This is especially true in the case of corn. Only in the case of over irrigation or excess fertilization is leaching increased. In the present situation, it will be stressed to the recipients that BMPs be followed under irrigation so that leaching will be negligible or minor compared to current conditions.

6.6.2.4. Groundwater Quantity

The Middle AL Basin has several aquifers that can support considerable amounts of irrigation for agricultural purposes. To assess and quantify groundwater availability in an area, it is important to understand the process of recharge to the aquifers. Groundwater recharge is the primary means of water entering an aquifer and occurs by rainwater infiltrating the subsurface at the unconfined aquifer recharge areas. This infiltration continues to flow down gradient and some eventually exists as confined flow under artesian conditions.

The recharge estimates for the water bearing aquifers used in this study came from the GSA Bulletin 186 (Assessment of Groundwater Resources in Alabama, 2010-16, Bulletin 186, 2018) and a study on Eutaw Aquifer in Alabama done by the Geological Survey of Alabama (Cook, 1993).

Shallow recharge is often estimated by the separation of surface water hydrographs into the baseflow and runoff portions. After this separation, the baseflow can be related to the groundwater recharge in the aquifer contributing to the streamflow. Four hydrograph separation methods were used by the Alabama Geological Survey to obtain the recharge estimates reported in the Groundwater Resources Bulletin. These methods had varying degrees of complexity. For example, one method used only days when base flow was known to be unaffected by rainfall and runoff and another method used long term base flow-to-total runoff ratios.

Deep recharge to the deeper, confined aquifers occurs through infiltration at the aquifer recharge area that flows down gradient to the lower portions of the aquifers. Additionally, deep recharge can occur to confined units in the subsurface through flow from overlying or underlying units. Generally, deep recharge is smaller in quantity than shallow recharge and is also harder to estimate. Deep recharge is not a direct component of the base flow of the streams in the recharge area. Because of this, the hydrograph separation technique of recharge estimation described previously is not applicable.

In the Middle AL Basin, the Eutaw aquifer is recharged by deep recharge and the recharge values used in the groundwater analyses came from the report done on the aquifer by the Geological Survey of Alabama (Cook, 1993). The value used for recharge in the Eutaw aquifer was the average of 5 values from multiple estimation techniques. These techniques evaluated sources of discharge of water from the subsurface portions of the Eutaw aquifer. These sources include upward discharge from the Eutaw aquifer into the Demopolis Chalk and Mooreville Chalk and into streams as well as discharge from wells constructed in the Eutaw Aquifer.

As discussed in section 4.8.2 of this report, the major water-bearing aquifers that exist in this basin are the Watercourse, Clayton, Gordo, Eutaw, Ripley, Coker, and Nanafalia aquifers. By examining existing well and cross-section data it has been determined that the Watercourse, Eutaw, Ripley and Gordo aquifers would be able to sustain withdrawals in support of irrigation. The Watercourse aquifer is unconfined and was formed by alluvial deposits along the Alabama River. As discussed previously, withdrawals from this aquifer would alleviate costs associated with deep well drilling that would be required for withdrawals from the confined aquifers. The limitations to using this aquifer include ensuring that it is at least 60 to 70 feet thick in areas withdrawals would be taking place. Alternatively, the Eutaw, Ripley, and Gordo are all confined and have the potential to provide large amounts of groundwater when managed appropriately and well spacing recommendations are followed.

The impact of groundwater withdrawals on recharge is used as a tool to determine the effects of irrigation on the groundwater resources, and specifically for this study the three aquifers mentioned above. The effect of irrigation on groundwater recharge was estimated by determining the percentage of recharge that would no longer be recharging the aquifer due to irrigation usage. Values for baseline irrigation demand were obtained for the agricultural areas within the optimal aquifer extents and are used in these calculations.

$$Baseline\ irrigation\ demand\ (in) = \frac{baseline\ irrigation\ (acre\ ft)}{Optimal\ aquifer\ extent\ in\ ba\sin\ (acres)} \times 12$$

$$Average\ \%\ Rech = \frac{baseline\ irrigation\ demand\ (in)}{Aquifer\ Rech\ value\ (in)}$$

Using these relationships, it was estimated that under baseline irrigation usage approximately 1.8% of recharge in the Eutaw aquifer would be used for irrigation. In the Ripley aquifer, 0.36% of recharge would be used for irrigation. Similarly, in the Gordo Aquifer, only 1.2% of groundwater recharge would be used for irrigation. None of these values indicate a significant impact on the groundwater resources of the basin.

A recharge threshold was also established to quantify the impacts on groundwater resources. The impact of groundwater withdrawals on recharge is used as a tool to determine the effects of irrigation on the groundwater resources, specifically for the water bearing aquifers in the study area. The effect of irrigation on groundwater recharge was estimated by determining the percentage of annual recharge that would no longer be recharging the aquifer due to irrigation usage. The threshold is based on the concept of sustainable yield (Ponce 2007, 2008; Miles and Chambet, 1995; Hahn et al. 1997). Here we assume that a conservative estimate of sustainable yield would be up to 10% of the dynamic annual recharge, thus this would constitute a negligible impact. If the withdrawals as part of this project exceeds 10% of recharge, but less than 10% of the time on average, this would constitute a minor impact. The impact would be moderate if the withdrawals reached 40% of recharge and major if withdrawals reached 70% (Ponce, 2007; 2008; Miles and Chambet, 1995; Hahn et al., 1997).

The goal of the threshold was to determine how much irrigation could be supported in Alabama using groundwater from the aquifers analyzed in this basin without reducing the amount of water recharged to the aquifers by more than 10% annually. By setting the maximum effect on recharge to 10%, it was possible to estimate the number of acres that could then be irrigated using groundwater from the Eutaw and Ripley aquifer areas contained in Alabama. Factors used in these calculations were baseline irrigation demands, annual recharge rate of each aquifer, and recharge area extent. This analysis was not done for the Gordo aquifer because there is no recharge area extent for the Gordo aquifer in the Middle Alabama study area.

The statewide extent of the Eutaw aquifer recharge area is 1,077,349 acres. Data from 2021 indicates that approximately 1,093 acres of this recharge area are currently being irrigated. By increasing the irrigation to reach the 10% recharge threshold, roughly 88,318 acres in the recharge area extent could potentially be irrigated using groundwater from the Eutaw aquifer. The Eutaw aquifer can support a large increase in irrigation without significant stress, as long as appropriate well spacing guidelines are followed.

Similar calculations were done for the Ripley aquifer. The statewide extent of the Ripley aquifer recharge area is 1,370,445 acres. In 2021, approximately 2,396 acres of this recharge area were currently irrigated. Using the same calculation methods used for the Eutaw aquifer, it was concluded that roughly 128,229 acres of the recharge area extent could be irrigated using groundwater from the Ripley aquifer without reducing the aquifer's annual recharge by more than 10%.

While none of these examples indicate that a single aquifer alone should support the irrigation of all of the agriculture contained in the Middle AL Basin, the amount of irrigation could be substantially increased from current levels without significant stress to the groundwater resources. In the basin, there are multiple aquifers that can support increased withdrawals to support irrigation, especially when an onsite assessment is performed to determine most viable aquifer given the farm location and well placing guidelines for the given aquifer are followed.

It is also important to consider that these values do not take into the account the distribution of water demand between surface water and groundwater. According to the OWR data from 2015 (Estimated 2015 Water Use and Surface Water Availability in Alabama, 2015), in the Middle AL Basin only 17.6% of the water used for irrigation came from groundwater sources. The remainder was withdrawn from surface water in the basin. In the examples discussed above, all the water used for irrigation is being pulled from groundwater. This indicates that the values calculated for the number of acres that can be irrigated before exceeding the recharge threshold are very conservative and would increase substantially when surface water contributions are also considered.

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 alternative. This would result in an additional 3,052 irrigated acres in the Middle Alabama. The actual rate of irrigation adoption may vary depending on farmer preferences, access to water, and economic conditions. This estimated increase in irrigated acreage based on the rate of adoption is substantially lower than the amount of acres that can be irrigated before reducing any of the aquifer's annual recharge by more than 10%. Additionally, since a large amount of the water being used for irrigation will likely come from surface water, it is extremely unlikely that the groundwater resources in Middle Alabama will be significantly impacted by the estimated rate of irrigation adoption.

6.6.2.5. Ecosystem Services

Provisional service; water supply. Groundwater and surface water withdrawal for irrigation will lead to reduced water availability. However, the approach developed for assessing surface water flows at the HUC-12 level during times of the year when irrigation is most likely to occur will allow irrigation to be targeted to areas where streamflow will not be adversely affected. A separate evaluation of available groundwater will ensure withdrawals do not significantly affect the aquifer's recharge.

Regulating service; water quality. Crops with supplemental irrigation to prevent low soil moisture levels have higher nutrient use efficiency. Additionally, a crop that does not mature properly due to lack of moisture does not uptake the expected amount of nutrients, thus excess nutrients contribute to water pollution. An underdeveloped crops also reduced the amount of organic matter available for incorporation into the soil. Organic matter is linked to improved soil nutrient holding capacity. Additionally, the irrigation management plan provided by the SLO will help train producers on best irrigation management practices to prevent over irrigation that can contribute to nutrient pollution

6.7. Wildlife, Fish, and Aquatic Species

6.7.1. Alternative 1 - Future without Project

Without the project, the short-term effects on wildlife, fish, and aquatic species doesn't change. However, the long-term impact of "no action" might be negative due to the temperature variation, which has been noted by many studies. For instance, irrigated agriculture has shown decrease in maximum temperatures, increase in minimum temperatures, thus shrinking the diurnal temperature range by an average of 3°C in Midwest region of the U.S. Additionally, irrigated agriculture decreased evaporative demand for 25% and 66% of study days compared to rainfed agriculture and forest, respectively (Nocco et al., 2019). This type of regional climate change impact could be even higher in the case of Middle Alabama River basin compared to the Midwest region.

6.7.1.1. Federally Listed Species

Assuming land use in the Middle AL Basin remains constant, conditions affecting the Federally Listed T&E Species are estimated to remain the same (no impact).

6.7.1.2. MBTA/BGEPA Species

Assuming land use in the Middle AL Basin remains constant, conditions affecting MBTA/BGEPA Species are estimated to remain the same (no impact).

6.7.2. Alternative 2 - SIA

6.7.2.1. Federally Listed Species

Development and disturbance in watersheds can directly or indirectly impact habitats used by T&E species. Changes in habitat conditions can have a range of impacts on T&E species, from short-term threats to long-term alterations to the watershed's ability to support them. Threatened and endangered species may be especially sensitive to changes in watershed conditions. The extent of potential impacts on T&E species is difficult to evaluate until specific project sites have been identified by the NRCS and the SLO. Measures have been and will continue to be taken to prevent negative impact on T&E populations. The SHU data will help inform NRCS personnel during specific project site evaluations of possible conflict or intersection. Any effects can be minimized through mitigation efforts. Each of the project-approved practices results in a “no effect”, “mitigating action”, and/or specific “on-farm consult”. Based on this tiered approach, the anticipated effects are expected to be negligible to minor.

Using the Irrigation Potential Assessment (IPA) coupled with the groundwater analysis (Appendix XX), cumulative impacts of surface and ground water withdrawals are assessed to determine where sustainable irrigation can occur. Specifically, the IPA and ground water analysis determines the amount of water that can be withdrawn without significantly changing the low flow statistics or the recharge rates. Thus Alternative 2 will have negligible to minor impacts to federally listed species.

Irrigated cropland can have positive impacts on wildlife and aquatic species. First, irrigation acts as a drought mitigating strategy. It helps to improve soil quality, minimize soil erosion, and increase crop nutrient use efficiency. Overall, it helps to minimize the nutrient runoff into water sources ultimately reducing the negative impact on wildlife and aquatic species. The nutrient and sediment analysis (Appendix XX) show that there are positive ecosystem services as a result of the preferred alternative in the Alabama River Basin. Industrial expansion, construction, and urbanization likely cause more significant negative impacts to wildlife and aquatic species relative to the agricultural sector.

Lastly, an increase in irrigation adoption has the potential to reduce the diurnal temperature range (regional climate change). As a result, it has been widely accepted that irrigated cropping is an effective agricultural adaptation measure in response to climate change. This regional climate changes will not affect wildlife and aquatic species negatively. The changes to groundwater quality and surface water degradation due to increases in irrigated cropland are predicted to be negligible. Current evaluations of groundwater-sourced irrigation water in the region are informative and could be updated in the future to minimize the potential impacts. Sustainable use of surface water and groundwater will have little effect on wildlife, fish, and aquatic species.

6.7.2.2. MBTA/BGEPA Species

Construction and operation of project components are not likely to affect migratory birds or eagles. Wintering or migrating birds would experience negligible impacts from construction disturbance because they have the flexibility to move away from disturbances to other suitable areas.

6.7.3. Compliance and Best Management Practices

6.7.3.1. Federally Listed Species

The project area overlaps with the designated Critical Habitat for one fish, one reptile, one amphibian, two bird species, one mammal, one snail, and twelve types of freshwater mussel. Potential presence of T&E Species is illustrated by the 12-Digit HUC in Appendix C, Figures C-21 through C-29. Per the ESA, organizations are required to consult with the USFWS if listed species or designated Critical Habitat may be affected by a proposed project and ensure that it neither risk the continued existence of federally listed ESA species, nor results in the destruction or adverse modification of designated Critical Habitat.

All requirements of the Alabama USFWS-NRCS Informal ESA Consultation for federally listed species will be followed (excerpts are included in Table E-1 and Figure E-15 of Appendix E). The decision diagram and practice matrix help the field office and the NRCS Biologist determine if a practice will result in a finding of “no effect” or “may affect – not likely to adversely affect”. A habitat assessment will be performed by the State Biologist, who will initiate informal consultation according to that assessment and the programmatic procedures. The informal consultation involves an evaluation of streamflow, species presence, sensitive habitats, water withdrawal volumes and timing, disturbance activities, stream geomorphology, etc. NRCS and the USFWS will consider cumulative effects where surface water withdrawals might impact streamflow volumes in a watershed to a degree that T&E species might be affected. Each project assessment will consider the overall effects of the program on the reaches with T&E species. Formal Endangered Species Act Section 7(a) consultation will occur, if necessary, to develop or negotiate reasonable and prudent measures to mitigate potential negative impacts, including cumulative effects. Mitigation strategies may include not altering hydrology of ephemeral drains, increasing buffer distance as needed to maintain the ecological and structural integrity of the riparian buffer and stream bank, and not crossing streams when using an irrigation water conveyance practice.

6.7.3.2. MBTA/BGEPA Species

MBTA, BGEPA, and E.O. 13186 require NRCS-AL to consider the impacts of planned actions on migratory bird and eagle populations and habitats for all planning activities. This may require cooperation with the USFWS if the action will result in a measurable negative effect on migratory bird populations. The SLO and NRCS will be working with USFWS to ensure minimal disturbance to any bald or golden eagles nesting near the project area. A site visit with a USFWS biologist will be conducted if deemed necessary to assess potential habitat disturbance. The NRCS would continue to work with USFWS to ensure that appropriate buffers are maintained between project construction activities and active nests or that construction in areas with known nests is avoided during the critical nesting period. The critical nesting period for bald and golden eagles is January 1 through August 31.

6.8. Wetlands and Riparian Areas

6.8.1. Alternative 1 - Future without Project

6.8.1.1. Wetlands

The relationship between wetlands and irrigated cropland is complex and requires careful evaluation based on the water availability, precipitation, landscape, and cropping practices. The average annual precipitation in the region is above 50 inches, an adequate amount for crop requirements. However, most of the precipitation occurs during off-growing season (early spring and post-harvest). The study area does contain wetlands. While it is possible that landowners would, on their own, develop irrigation reservoirs in a wetland or a stream segment, this is not likely to happen on a large scale. The no action alternative is predicted to have negligible effects to wetlands.

6.8.1.2. Riparian Areas

This alternative should have no impact to the current depth or spatial extent of existing riparian areas over the planning horizon.

6.8.2. Alternative 2 - SIA

6.8.2.1. Wetlands

The alternative is anticipated to have minimal impacts on wetlands. NRCS Wetland Policy as found in the General Manual 190, Part 410 must be followed. The National Environmental Policy Act (NEPA) specifically identifies wetlands as a required consideration in determining the significance of impacts. In addition, NRCS is required to consider impacts to wetlands through other Federal laws including, but not limited to, the Clean Water Act and the Wetland Conservation provisions of the Food Security Act of 1985. Executive Order No. 11990 requires that each agency take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the beneficial functions of wetlands when "providing federally undertaken, financed or assisted construction and improvements." All of these laws, Executive orders and NRCS Policy will be addressed during the site-specific CPA-52 Environmental Evaluation. The groundwater analyses previously described show that the water table in the region will not be adversely impacted so that the depth and extent of wetlands should remain unchanged. The planned spray and drip irrigation (DI) systems will not cause erosion and associated sediment transfer that could fill wetlands and reduce water quality. Expanded irrigation may result in slight increases of runoff and nutrient loads at some sites near existing wetlands. Installation of irrigation systems and related items may temporarily impact wetlands by increasing erosion and runoff from short-term construction activities to access water resources for irrigation. Pipelines and center pivot tracts may need to cross small wetlands and would be evaluated for minimal effect exemptions. An on-farm evaluation (EE) per NRCS-CPA-52 will be required on a case-by-case basis to determine impacts and any required mitigation measures. This alternative, which promotes ecologically sound and sustainable irrigation minimizes adverse impacts to wetlands through avoidance, minimal effect exemptions, and mitigation.

6.8.2.2. Riparian Areas

Based on the minor changes to water quantity, existing riparian areas are likely to experience negligible to minor impacts from this alternative. Sites identified for implementation will also undergo onsite evaluations as outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52) to identify any potential localized risk to riparian zones and water supplies.

6.8.3. Compliance and Best Management Practices

The CPA-52 EE will determine if compliance or BMPs should be included. Conservation planning in riparian areas requires special considerations. A resource problem within the riparian area may be the manifestation of upland management decisions. If there are sites selected near riparian areas, the NRCS-AL consultation will consider soils, the present plant community, the site potential, geomorphology of both stream and the watershed, hydrologic regime, fish and wildlife needs, the management of the upland areas of the watershed, and the producer's objectives. Potential mitigation strategies include increasing buffer distance as needed to maintain the ecological and structural integrity of the riparian buffer and stream bank, and not crossing streams when using an irrigation water conveyance practice.

6.9. Socioeconomic Resources

6.9.1. Alternative 1 - Future without Project

Current conditions are expected to remain relatively constant in the future without the project. The study area consists of a part of the Blackland Prairie region known as the "Alabama Black Belt," a region of Alabama with fertile soils. The Black Belt region is characterized sociologically as experiencing severe social and economic hardships, and the communities in these areas are among the 100 poorest counties in the nation according to the 2000 U.S Census (ACWP, 2005). Several limited resource farmers produce crops in this economically depressed area of the state.

6.9.2. Alternative 2 - SIA

An increase rate of irrigation adoption in this region is expected to result in higher crop productivity without adverse effects to ecosystem services. Some government entities are focused on improving the wellbeing of the Black Belt region, however water resource management in the Black Belt is generally not well understood. An increase in irrigated cropland in this region will likely have minor effects on socioeconomic condition of residents in the region.

6.9.2.1. National Economic Efficiency Analysis under Alternative 2

A benefit-cost analysis has been performed to evaluate the costs and benefits of the No-Action Alternative and Alternative 2. The analysis was performed in accordance with the NRCS Guidelines outlined in the NRCS Natural Resources Economics Handbook and the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Resource Investments. The NEE net benefit is estimated with a benefit-to-cost ratio of 0.91. See Appendix D for the full NEE analysis.

6.10. Environmental Justice

6.10.1. Alternative 1 - Future without Project

This alternative would not result in any beneficial effect on the current conditions of Environmental Justice.

6.10.2. Alternative 2 – SIA

Increasing irrigation adoption is not expected to cause disproportionately high and adverse environmental or human health effects for minority or low-income populations. NRCS has existing mechanisms to ensure the environmental and public-health concerns of historically underserved communities are considered in its decision-making process to ensure the fair implementation of policies, programs, and activities nationwide. Once a potential site has been identified for project implementation, the NRCS CPA-52 form will be completed by authorized personnel, who will further evaluate the specific environmental justice conditions. As part of the planning process, agencies must identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations, low-income populations, and Indian Tribes. The NRCS EJ principles that are integrated into conservation program policies and the Field Office Technical Guide will be followed to meet Executive Order 12898.

6.11. Cultural and Historic Resources

6.11.1. Alternative 1 - Future without Project

6.11.1.1. Archaeological Resources

Under rainfed farming, erosion from fields can result due to drought periods. This is because crops do not develop root structure to stabilize soils during these drought periods, leaving the land potentially fallow with no cover. Eventual rainfall creates excessive runoff and erosion, which can affect surface soils that protect underlying archaeological deposits. Assuming land use in the Middle AL Basin treatment area remains constant, effects to any previously identified and heretofore unidentified archaeological (i.e., subsurface) resources located in rainfed fields are expected to be negligible to major under this alternative based on current inventories.

6.11.1.2. Non-Archaeological Cultural and Historic Resources

Previously identified NRHP-listed historic properties in the Middle AL Basin treatment area include twenty-one historic buildings and thirteen historic districts (Stutts, 2023; Table 29). Seventy-nine resources listed in the ARLH were identified and include houses, schools, churches, and associated cemeteries among others (AHC, 2023; Table 30). Assuming land use in the Middle AL Basin treatment area remains constant, effects to any known or heretofore unidentified, non-archaeological cultural and historic resources beyond existing conditions are expected to be negligible under this alternative based on current inventories.

6.11.2. Alternative 2 – SIA

This Plan analysis addresses a broad land treatment area or watershed (the Middle AL Basin) and as such, is considered a "special case" under NRCS cultural resources policies and procedures [NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.22(A)(2)(v)]. The general number and type of conservation practices (or "undertakings") that may be required on existing agricultural land in the treatment area (Middle AL Basin) to meet the stated project objectives are proposed in the Plan. NRCS-AL has determined that the following conservation practices proposed for the sustainable irrigation adoption project are undertakings that have the potential to cause effects to cultural resources and historic properties as they are likely to exceed the existing depth of tillage or previous disturbance:

- NRCS Practice 430 Irrigation pipeline
- NRCS Practice 436 Irrigation reservoir
- NRCS Practice 441 Irrigation system, micro-irrigation (subsurface)
- NRCS Practice 533 Pumping plant
- NRCS Practice 642 Well development

6.11.2.1. Archaeological Resources

Because these undertakings largely involve subsurface impacts that may exceed the existing depth of tillage or previous disturbance on agricultural lands, NRCS-AL has determined that they have potential to affect archaeological resources. With a "special case" project such as this, the planning and installation sequence does not allow NRCS-AL to tie the general conservation plan and practices (undertakings) proposed in this Plan to an exact APE [see 36 CFR 800.16(d)] until landowner and producer participants in the project are identified [NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.22(A)(2)(v)]. Additional planning, including the precise geographic locations for the proposed installation of conservation practices, will be initiated at the field office level with accelerated technical assistance and is dependent on the participation and cooperation of the landowner(s) and producer(s). Further identification and evaluation of cultural resources and historic properties in compliance with "Section 106" of NHPA and will be accomplished once landowner and producer participants are identified and NRCS-AL's site-specific Environmental Evaluation (EE) process is initiated (beginning with the Environmental Evaluation Worksheet [NRCS-CPA-52] and the NRCS-AL Cultural Resources Review form [Appendix E, Figure E-17]), and will follow review procedures outlined in the SPPA (NRCS-AL, 2017:5-7). NRCS-AL will then provide the proposed APE, identification of historic properties and/or scope of identification efforts, and assessment of effects to the AHC, Indian Tribes, and other consulting parties, as appropriate, in a format that meets the standards outlined in 36 CFR Part 800.4-5 and 800.11 and in accordance with the SPPA. NRCS-AL will avoid adverse effects to historic properties whenever possible. Such avoidance efforts may include moving the undertaking (i.e., irrigation practice) to another area, changing the work limits, changing to an acceptable alternative practice or measure, or modifying the practice design [see NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.10(C)]. The site-specific evaluation and review process, and continued consultation with the AHC and Indian Tribes should ensure there are no known or heretofore unknown archaeological resources that are adversely affected by implementing this project. Based on this approach, the anticipated impacts are expected to be negligible to minor.

6.11.2.2. Non-Archaeological Cultural and Historic Resources

Because these undertakings largely involve subsurface impacts that may exceed the existing depth of tillage or previous disturbance on existing agricultural lands, effects to non-archaeological cultural and historic resources are not expected. The site-specific evaluation and review process, and continued consultation with the AHC and Indian Tribes should also ensure there are no known or heretofore unknown non-archaeological cultural and historic resources that are adversely affected by implementing this project. Additionally, fundamental to NRCS policy regarding responsibilities to cultural and historic resources under the NHPA is the protection and enhancement of these resources in their original location (i.e., in situ) to the fullest practical extent, and mitigation of adverse effects that cannot be avoided through treatment of the historic or cultural properties (NRCS Title 420, GM, Subpart C, see Parts 401.21-22). Whenever possible, NRCS policy is to avoid effects to cultural and historic resources by either moving the undertaking (i.e., conservation practice) to another area, changing the work limits, changing to an acceptable alternative practice or measure, or modifying the practice design [NRCS Title 190 NCRPH, Part 601, Subpart C, see Section 601.10(C)]. Based on this approach, the anticipated impacts are expected to be negligible to minor.

6.11.3. Compliance and Best Management Practices

NRCS-AL's compliance with "Section 106" is governed, in part, through implementing conservation programs and practices under the SPPA, which was developed in consultation with the AHC pursuant to 36 CFR Part 800.14(b)(4) and conforms to the NRCS-PPA (Donaldson, 2014; see NRCS Title 420, GM, Subpart C, Parts 401.21-22). Upon initiation of NRCS-AL's site-specific Environmental Evaluation (EE) process (beginning with the Environmental Evaluation Worksheet [NRCS-CPA-52] and the NRCS-AL Cultural Resources Review form (Appendix E, Figure E-17), and as outlined in Section V(c)-(d) of the SPPA (see NRCS 2017): NRCS-AL will provide its proposed APE, identification of historic properties and/or scope of identification efforts, and assessment of effects to the AHC, Indian Tribes, and other consulting parties, as appropriate, in a format that meets the standards outlined in 36 CFR Part 800.4-5 and 800.11; NRCS-AL shall also attempt to avoid adverse effects to historic properties whenever possible. Continued consultation under "Section 106" with Indian Tribes and the AHC will ensure cultural resources and historic properties are properly identified, and potential adverse effects avoided. Where historic properties are in the APE, NRCS-AL shall describe how it proposes to modify, buffer, or move the undertaking to avoid adverse effects. Per Section V(h) of the SPPA (see NRCS 2017): where a proposed undertaking may adversely affect historic properties, NRCS-AL shall describe proposed measures to minimize or mitigate the adverse effects, and follow the process outlined in 36 CFR Part 800.6, including continuing consultation with consulting parties and notification to the ACHP, to develop a Memorandum of Agreement to resolve the adverse effects. Procedures for post-review discoveries, unanticipated effects to historic properties, and dispute resolution are also outlined in Sections VI – VII of the SPPA.

NRCS-AL will ensure all NRCS staff or individuals carrying out "Section 106" historic preservation compliance work on its behalf, including the NRCS-AL historic preservation professional staff member (the Cultural Resources Specialist or CRS), are appropriately qualified to coordinate the reviews of resources and historic properties as applicable to the resources and historic properties being addressed (e.g., site, building, structure, landscape, resources of significance to Indian Tribes, and other concerned communities). NRCS-AL currently has a CRS on staff who meets the Secretary of Interior's Professional Qualifications Standards and is qualified to coordinate reviews of cultural resources and historic properties in the state of Alabama.

6.12. Air Quality

6.12.1. Alternative 1 - Future without Project

No adverse effects are expected to occur under the No Action alternative.

6.12.2. Alternative 2 - SIA

Increase of N_2O emissions resulting from the enhanced fertilizer applications which are usually done in conjunction with crop irrigation. Calculations have been done for the average farm size in the Middle AL Basin for rainfed and irrigated scenarios. 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 creates an increase of 16.1 CO_2 metric tons equivalent per year. Models show impacts would be negligible to temporary. In addition, small increases in NO_2 emissions would occur if engines (diesel, natural gas) were used to drive generators (see Appendix D Section 5).

6.12.3. Compliance and Best Management Practices

If needed, wetting of soil or construction of wind barriers can be implemented as mitigation measures to prevent dust generation from construction activities.

6.13. Cumulative Effects

6.13.1. Cumulative Effects by Resource

Cumulative impacts are defined by CEQ Regulations in 40 CFR 1508.7 (1978) as the "impact on the environment which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions."

6.13.2. Past Actions

Past actions include land and water use for agriculture. The nature and extent of those past actions and how they have influenced the existing environment are described for each resource in Section 4 of the Plan.

6.13.3. Current and Reasonably Foreseeable Future Actions

Current actions are those projects currently underway. Reasonably foreseeable future actions generally include those proposed or planned or those that are highly likely to occur based on present information.

Table 36 summarizes the impact thresholds, duration of effects, and rationale for past actions, current and reasonably foreseeable future actions, the FWOP (No-Action) Alternative and Alternative 2 (SIA).

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
Climate	Past Actions	Negligible - Major	Long-Term; Seasonal	During the past decades, Alabama has experienced a 5-10% increase in precipitation, and this trend is projected to continue along with more intense rainfall events.
	Current/ Reasonably Foreseeable Future	Negligible - Major	Long-Term; Seasonal	Increasing rainfall is likely to be offset by stronger evaporation and likely longer drought episodes. Climate change is expected to result in the decrease of source water (surface and ground) provisioning as well as increases in soil erosion and nutrient losses within the Middle AL Basin. Crop yields are expected to decrease between 0 to over 40% for most geographic areas globally including the Midwest and the US Southeast.
	FWOP (No-Action)	Negligible - Major	Long-Term; Seasonal	In the coming decades, Alabama is expected to become warmer and experience a 2 to 3 °F increase in average temperature (EPA, 2016; Carter et al., 2018). No action will likely result in decreased yields due to climate change.
	Alternative 2 - SIA	Minor-Moderate		Implementation of irrigation systems as an adaptation option will help increase or sustain current crop yield levels and minimize runoff, erosion, nutrient losses, and pesticide losses, and effects are likely to be minor-moderate.
Agriculture	Past Actions	Minor-Moderate	Long-Term; Seasonal	Agricultural production in Alabama decreased by 3.6 percent between 2012-2017.
	Current/ Reasonably Foreseeable Future	Minor-Moderate	N/A	Impacts of climate change will continue to adversely impact agricultural yields within the state.
	FWOP (No-Action)	Minor-Moderate	Long-Term; Seasonal	Impacts of climate change will continue to adversely impact agricultural yields within the state.
	Alternative 2 - SIA	Minor-Moderate	Long-Term; Seasonal	Implementation of irrigation systems as an adaptation option will help increase or sustain current crop yield levels and effects are likely to be minor-moderate.
Land Use and Cover	Past Actions	Negligible-Major	Long-Term; Seasonal	Land use has been altered over the past due to a variety of activities including agriculture, urban and suburban development, and road construction.

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
	Current/ Reasonably Foreseeable Future	Negligible-Moderate	Short-term; Long-term	Depending on current agricultural locations, the following may occur: existing land uses or ownership would continue as before; short-term change or interruption to land use or access to existing land uses; or land use changes that are inconsistent with existing ownership, easements, or right-of-way.
	FWOP (No-Action)	Negligible	N/A	Land use changes are expected to remain consistent with existing ownership, easements, or right-a-way in the foreseeable future. However, current land use and ownership patterns may change to favor developed land over agricultural land.
	Alternative 2 - SIA	Negligible	N/A	There would be no effect on land use adjacent to the project area, as property ownership and existing use of land would not change. However, Federal support of the existing agricultural production in this basin may incentivize farmers to continue providing a reliable food source needed for the future.
Geology and Soils	Past Actions	Negligible – Major	N/A	Past actions including agriculture or other land development may have affected soils.
	Current/ Reasonably Foreseeable Future	Minor	Temporary	Under rainfed farming, erosion from fields may occur during drought periods; eventual rainfall creates excessive runoff and erosion.
	FWOP (No-Action)	Minor	Temporary	Under rainfed farming, erosion from fields may occur during drought periods; eventual rainfall creates excessive runoff and erosion.
	Alternative 2 - SIA	Minor	Temporary	May result in increased runoff that could also carry sediment, but the effects would be short-term and localized.
Vegetation	Past Actions	Negligible-Major	Long-term; Seasonal	Past activities including grazing, urban and suburban development, and road construction may have affected vegetation.
	Current/ Reasonably Foreseeable Future	Negligible-Minor	Long-term; Seasonal	There are approximately 2 T&E plant species within the project area. Long-term changes may not be measurable. Any adverse effects can be effectively mitigated.
	FWOP (No-Action)	Negligible-Minor	N/A	Assuming land use remains constant, conditions affecting T&E plant species are estimated to remain the same.

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
	Alternative 2 - SIA	Negligible-Minor	Long-term; Seasonal	Identification and evaluation of T&E species will be accomplished for each potential project site following procedures outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52). If T&E species would be adversely impacted by a proposed action, mitigation measures formed in informal consultation, biological opinion, or 4(d) special rule will be followed. If the action cannot be modified to avoid the effect, NRCS will consult with FWS/NMFS. The action can only be implemented according to the terms of the consultation
Water Resources – Surface Water Quality	Past Actions	Negligible-Major	Long-term	Urban, suburban, and agricultural development may have affected surface water quality in the past. Past actions have resulted in 6 streams in the study to be designated 303d.
	Current/ Reasonably Foreseeable Future	Negligible-Moderate	Long-term: Seasonal	Nutrient and sediment loading to the hydrologic system will continue at historical or accelerating rates due to urban, suburban and agricultural development. Some increased irrigation is ongoing that may affect water quality depending on whether sustainable agricultural practices are being followed. Irrigation will continue expanding with no controls or incentives for sustainable agriculture practices that may further adversely affect water quality, especially under low flow conditions as defined in table 40.
	FWOP (No-Action)	Negligible-Moderate	Long-term: Seasonal	Nutrient and sediment loading to the hydrologic system will continue at historical or accelerating rates due to urban, suburban and agricultural development. Irrigation will continue expanding with no controls or incentives for sustainable agriculture practices that may further adversely affect water quality, especially under low flow conditions as defined in table 40.

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
	Alternative 2 - SIA	Negligible-Minor	Short-term: Seasonal	Nutrient and sediment loading to the hydrologic system may continue at due to urban, suburban development, however, sustainably expanding irrigation on existing farmland will increase the efficiency of plant uptake of fertilizers and potentially reduce nutrient loads from agriculture. The additional irrigation will increase runoff, however, through cover management and farming practices the sediment loads reaching waterways can be maintained at current or improved levels. General water quality conditions, including 303d streams, are expected to persist at current levels for the foreseeable future with minimal impact. Urbanization and other land cover land use changes will continue to affect nutrient and sediment loads in runoff to the hydrologic system, however, a more profitable agricultural system may decrease urban, suburban sprawl, thus potentially reducing overall loads
Water Resources – Surface Water Quantity	Past Actions	Negligible: Moderate	Short-term: Seasonal	Land use development has affected surface water quantity in the past, especially during drought conditions.
	Current/ Reasonably Foreseeable Future	Negligible: Moderate	N/A	Land use development has affected surface water quantity in the past, especially during drought conditions.
	FWOP (No-Action)	Negligible: Moderate	Short-term: Seasonal	Urban development and irrigation systems will continue to use surface water and affect water quantity. This could increase the impact on low flows if irrigation is not properly planned
	Alternative 2 - SIA	Negligible: Minor	Short-term: Seasonal	Water withdrawals for expanded irrigation will be managed to avoid withdrawals from smaller streams and rivers during low flow conditions to mitigate any adverse effects on aquatic or riparian zone ecology. No adverse impacts are anticipated for larger streams supporting irrigation Well withdrawals to support irrigation will have minor to no effects on surface water quantity. Retention ponds to support expanded irrigation would increase the amount of surface water.
Water Resources – Ground Water Quality	Past Actions	No Impact- Minor	N/A	Urban, suburban, and agricultural development may have affected groundwater quality in the past.
	Current/ Reasonably Foreseeable Future	No Impact- Minor	N/A	Urban, suburban, and agricultural development may have affected groundwater quality in the past.

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
	FWOP (No-Action)	No Impact - Negligible	N/A	Assuming land use in the Middle AL Basin remains constant; the No Action alternative is unlikely to have considerable effects on groundwater.
	Alternative 2 - SIA	Negligible - Minor	Temporary; Seasonal	Irrigation may increase groundwater leaching in the case of over-irrigation or excess fertilization. However, irrigation applied in accordance with BMPs reduces the risk of groundwater leaching.
Water Resources – Ground Water Quantity	Past Actions	No Impact- Minor	N/A	Urban, suburban, and agricultural development may have affected groundwater quantity in the past.
	Current/ Reasonably Foreseeable Future	No Impact - Negligible	N/A	Any aquifer stress in this region is generally located near population centers where municipalities use high-capacity wells within close proximity; however, while these areas have relatively higher demand, no identifiable levels of unacceptable stress exist.
	FWOP (No-Action)	No Impact - Negligible	N/A	Assuming land use in the Middle AL Basin remains constant; the No Action alternative is unlikely to have considerable effects on groundwater.
	Alternative 2 - SIA	Negligible - Minor	Temporary; Seasonal	Due to the limited expansion of agriculture proposed, quality of the soils in existing agricultural areas and emphasis on using best management practices to prevent over irrigation, the potential for extreme drawdown is mitigated as part of this plan and the risk should be negligible.
Wildlife, Fish, and Aquatic Species	Past Actions	No Impact- Negligible	N/A	Urban, suburban, and agricultural development may have affected wildlife presence in the past.
	Current/ Reasonably Foreseeable Future	No Impact- Negligible	Long-term; Seasonal	There are approximately 21 T&E species within the project area including one species of fish, one reptile, one amphibian, two species of birds, one mammal, one snail, and twelve species of freshwater mussels. Long-term changes in wildlife populations or habitats would not be measurable. Any adverse effects can be effectively mitigated.
	FWOP (No-Action)	No Impact- Negligible	Long-term; Seasonal	Assuming land use remains constant, conditions affecting T&E and MBTA/BGEPA species are estimated to remain the same.

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
	Alternative 2 - SIA	No Impact–Minor	Long-term; Seasonal	Identification and evaluation of T&E species will be accomplished for each potential project site following procedures outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52). If T&E species would be adversely impacted by a proposed action, mitigation measures formed in informal consultation, biological opinion, or 4(d) special rule will be followed. If the action cannot be modified to avoid the effect, NRCS will consult with FWS/NMFS. The action can only be implemented according to the terms of the consultation
Wetlands and Riparian Areas	Past Actions	No Impact–Minor	N/A	Urban, suburban, and agricultural development may have affected wetlands and riparian areas in the past.
	Current/ Reasonably Foreseeable Future	Negligible–Minor	N/A	The current altered hydraulic function or hydraulic capacity of wetlands and riparian areas are expected to increase with increased development.
	FWOP (No-Action)	Negligible–Minor	N/A	This alternative should not result in significant change to the current depth or spatial extent of existing wetlands or riparian areas.
	Alternative 2 - SIA	Negligible–Minor	Short-term; Temporary	There may be slight increases of runoff and nutrient loads at some sites near existing wetlands or riparian areas. Locations will be evaluated to determine impacts and any required mitigation measures will be implemented. Identification and evaluation of wetlands will be accomplished for each potential project site following procedures outlined in the Environmental Evaluation Worksheet (NRCS-CPA-52). If wetlands would be adversely impacted by a proposed action, NRCS will advise clients of alternative actions. If clients decline mitigation measures, NRCS shall terminate all assistance for the project. to mitigate any adverse impacts to wetlands if present
Socioeconomics	Past Actions	Negligible–Major	Long-term; Seasonal	Past actions in the basin may have supported economic development and the agricultural industry.
	Current/ Reasonably Foreseeable Future	Negligible–Minor	Short-term; Temporary	No effect, or in times of drought, little effect on the yield of agricultural products due to lack of water availability. Temporary changes to income and/or local employment levels.
	FWOP (No-Action)	Negligible	N/A	Current conditions are expected to remain relatively constant in the future without the project.

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
	Alternative 2 - SIA	Moderate	Long-term	Moderate, positive impacts are expected due to the change in yield of agricultural products at the local level.
Environmental Justice	Past Actions	No Impact- Minor	N/A	Past actions in the basin may have impacted conditions of Environmental Justice communities.
	Current/ Reasonably Foreseeable Future	No Impact- Minor	N/A	Current conditions basin may impact conditions of Environmental Justice communities.
	FWOP (No-Action)	No Impact- Minor	N/A	This alternative would not result in any beneficial effect on the current conditions of Environmental Justice communities.
	Alternative 2 - SIA	No Impact- Minor	N/A	Increasing irrigation adoption is not expected to cause disproportionately high and adverse environmental or human health effects for minority or low-income populations.
Cultural and Historic Resources	Past Actions	Negligible – Major	Long-term; Seasonal	The treatment area has undergone changes in the past. Overall, the counties within the basin experienced an increase of 40,654 acres of agriculture between 2012 and 2017.
	Current/ Reasonably Foreseeable Future	Negligible – Major	Long-term; Seasonal	The treatment area overlaps with hundreds of known cultural and historic resources and thousands of archaeological sites. Watershed conditions that cause measurable change, whether short- or long-term, to cultural resources, may currently exist. The true current effects are unknown at this scale
	FWOP (No-Action)	Negligible – Major	Long-term; Seasonal	Assuming land use in the Middle AL Basin remains constant, effects on any archaeological (subsurface) resources located in rainfed fields are expected to be negligible to major; whereas effects on non-archaeological historic and cultural resources are expected to be negligible.

Table 36. Potential Impacts on the Resources of Concern Estimated for Each of the Alternatives

RESOURCE CONCERN	SCENARIO	ESTIMATED IMPACT THRESHOLD	ESTIMATED DURATION OF EFFECTS	RATIONALE
	Alternative 2 - SIA	Negligible – Minor	Long-term	Identification and evaluation of cultural resources and historic properties in compliance with "Section 106" of NHPA will be accomplished once landowner and producer participants are identified and NRCS-AL's site-specific review process initiated, which includes continued consultation with the AHC, Indian Tribes, and other consulting parties, as appropriate. This approach minimizes the potential for adverse effects to known or heretofore unknown cultural resources and historic properties. NRCS policy is to avoid effects to cultural resources and historic properties whenever possible by either moving the conservation practice, changing the work limits, changing to an acceptable alternative practice or measure, or modifying the practice design. Where a proposed undertaking may adversely affect historic properties, NRCS-AL shall describe proposed measures to minimize or mitigate the adverse effects, and follow the process outlined in 36 CFR Part 800.6, including continuing consultation with consulting parties and notification to the ACHP, to develop a Memorandum of Agreement to resolve the adverse effects.
Air Quality	Past Actions	Negligible-Major	Long-term; Seasonal	Air quality in the Basin may have been affected by developmental activities in the past.
	Current/ Reasonably Foreseeable Future	Negligible-Major	Long-term; Seasonal	The project area is in the 90-95th percentile for the NATA Air Toxics Cancer Risk, and 95-100th for the NATA Respiratory Hazard Index.
	FWOP (No-Action)	Negligible	N/A	No adverse effects are expected to occur.
	Alternative 2 - SIA	Negligible	Temporary	Dust could be generated during construction. Increased fertilizer application results in increased CO_2, but models show impacts would be minimal given the relatively small areas and slight increase in application rates

7. Consultation, Coordination, and Public Participation

NEPA requires NRCS, where NRCS has control or responsibility over the action, to analyze the environmental impacts of such actions and make the analysis available to the public before decisions are made and actions are taken unless the action is categorically excluded. The analysis and finding begins by conducting an environmental evaluation to determine whether an EA and finding of no significant impact (FONSI), an EIS and record of decision (ROD), or a categorical exclusion is the appropriate form of documentation. NRCS regulations for complying with NEPA may be found in 7 CFR Section 650.

7.1. Consultation

Table 37 lists the resource concerns or regulation and the appropriate consulting entity that may require consultation.

Table 37. Consulting Entities per Resource Concern

Resource Concern / Regulation	Consulting Entity
Air Quality	EPA Office of Air and Radiation
Water Quality	ADEM/EPA Office of Water
Cultural Resources (Historic Properties)	SHPO/THPO/Federally recognized Indian Tribe
Coastal Zones	State Coastal Zone Program Office
Endangered and Threatened Species	USFWS/National Marine Fisheries Service (NMFS)
Essential Fish Habitat	NMFS
Tribal Interests	Affected Tribal Government
Waters of the United States, Including Wetlands	U.S. Army Corps of Engineers (USACE)

Consultations are tied to the Federal action and are the responsibility of the lead Federal agency (NRCS-AL) regardless of partners, cooperating entities, or the sponsors involved. NRCS may delegate consultations to third-party contractors or other entities (except for historic property consultation), but NRCS remains the responsible party for conducting the consultation.

7.2. List of Persons and Agencies Consulted

Table 38 lists agencies and tribal communities that will be contacted and invited to be cooperating agencies for the EA reviewal process and determine if there were new circumstances or information relevant to the environmental concerns and bearing on the proposed actions or its impacts. In accordance with the NRCS guidelines, each group will be formally invited to participate.

Table 38. List of Consulting Entities for the Middle AL Basin

Type of Entity	Consulting Entities
Tribal Authorities	Absentee-Shawnee Tribe of Oklahoma
	Alabama-Coushatta Tribe of Texas
	Alabama-Quassarte Tribal Town
	Cherokee Nation
	Chickasaw Nation
	Choctaw Nation of Oklahoma
	Coushatta Tribe of Louisiana
	Eastern Band of Cherokee Indians
	Eastern Shawnee Tribe of Oklahoma
	Jena Band of Choctaw Indians

Table 38. List of Consulting Entities for the Middle AL Basin

Type of Entity	Consulting Entities
	Kialegee Tribal Town
	Miccosukee Tribe of Indians of Florida
	Mississippi Band of Choctaw Indians
	Muscogee (Creek) Nation of Oklahoma
	Poarch Band of Creek Indians
	Seminole Nation of Oklahoma
	Seminole Nation of Florida
	Shawnee Tribe
	Thlopthlocco Tribal Town
	United Keetoowah Band of Cherokee Indians
Governmental Agencies	U.S. Fish and Wildlife Service
	Geological Survey of Alabama
	Alabama Department of Economic and Community Affairs
	U.S. Geological Survey
	Alabama Department of Environmental Management
	Alabama Department of Conservation and Natural Resources
	Alabama Historical Commission
	Alabama Department of Agriculture & Industries
	Alabama Soil and Water Conservation Committee: Conservation Districts
	U.S. Army Corps of Engineers
Non-Governmental Organizations	Alabama Rivers Alliance
	The Nature Conservancy
	Alfa Farmers Federation
	Manufacture Alabama
	Alabama Rural Water Association

7.3. Review of the Draft Plan

A preliminary draft of the Plan was sent to all Tribal authorities in the project area in March 2024.

8. Preferred Alternative

8.1. Selection of the Preferred Alternative

The project sponsors selected Alternative 2 (Sustainable Irrigation Adoption) as the Preferred Alternative based on its ability to meet the purpose and need of the project and provide the most beneficial effects on ecosystem services. The Preferred Alternative is the only alternative that meets the SLO purpose and need and meets the PR&G.

8.2. Rationale for the Preferred Alternative

This alternative would support major ecosystem services, minimize damage to crop health and vigor, and enhance farmers' resilience against future climate change.

Several methods were considered to achieve the goal of minimizing damage to crop health and vigor while supporting ecosystem services. Many NRCS conservation practice standards address such goals. However, the preferred alternative includes a farmer application ranking process as described in sections 8.4.6. and 8.7.3. The ranking process prioritizes farmers that have already implemented such conservation practice standards. This project focuses on a pressure point (water availability) that cannot be alleviated by other practices.

While the benefit-cost ratio of this project is 0.91, this project provides both regional economic benefits that are not part of the NEE and ecosystem services benefits that cannot be quantified with high confidence by the SLO due to limited resources and data.

8.2.1. Farmland Value

Non-monetized benefits of this project include increased net returns to operations, resulting in increased likelihood of farmland being used in its current purpose. A significant branch of land economics literature has evaluated the value of preserving cropland or pasture in its current form on residential housing values (Duke and Aull-Hyde, 2002; Irwin, 2002; Roe et al. 2004). For example, Roe et al. (2004) use a conjoint analysis to identify willingness to pay for preserving 10% of farmland within one mile of a residential area, finding that agricultural land preservation increases residential house prices by 3-6% in Ohio. Similarly, Irwin (2002) estimates that preserving a neighboring parcel of land as agricultural land increases willingness to pay for residential lots by 3%. Accounting for inflation, these values amount to between $7,649 to $13,213 per residential lot in 2023-dollars.

Additionally, in a Southeastern US farmland preservation experiment, Dorfman et al. (2009) find that the equilibrium price of preserving farmland through a voluntary program would be $4,100 per acre, or $5,795 in 2023-dollars after adjusting for inflation. The value of preserving just 10% of the acreage irrigated in this project (305 acres) would thus amount to an estimated $1,768,600 in 2023-dollars. However, while this project increases the probability that land will remain as farmland due to irrigation, we do not have evidence to estimate at what level that would be. Therefore we do not include these benefits in the NEE analysis.

8.2.2. Job Creation

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, irrigation adoption is 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 ten jobs to the economy (Fields et al., 2013). As a result of increased sales, the preferred alternative would add 100 jobs to the Alabama labor force.

8.2.3. Economic Impact of Increased Crop Production

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, the preferred alternative 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. While these regional net benefits ($258,000) cannot be compared 1:1 to the annual NEE net benefits (-$69,000), their inclusion would likely show that the benefits of this project well exceed the costs.

8.2.4. Ecosystem Services Tradeoff Analysis

While it may be assumed that certain provisional and regulating services such as water supply and water quality in streams and rivers would be negatively impacted by converting rainfed cropland to irrigated cropland in exchange for the positive impacts on crop yields and farming resilience against climate change, analysis indicates that negative impacts can be mitigated or eliminated with proper conservation measures applied.

As described in Section 6.6, a new model called the IPA90 can be applied spatially across the Middle AL Basin to provide an initial assessment of where surface water is available for irrigation within each HUC-12 without adversely affecting streamflow. Furthermore, it is demonstrated in Section 6.6.2.4 that the amount of irrigation could be substantially increased from current levels without substantial stress to groundwater resources. In the basin, there are multiple aquifers that can support increased withdrawals to support irrigation, especially when an onsite assessment is performed to determine most viable aquifer given the farm location and well placing guidelines for the given aquifer are followed.

In a simulated model of sediment runoff from irrigated versus rainfed fields, irrigated fields exported slightly less sediment than rainfed fields (see Section 2.1 in Appendices). As stated earlier, crops in the Middle Alabama would not need constant irrigation. Rather, irrigation would only be supplemental to rain and applied when needed to reduce crop damage in dry periods. As a result, crop yield as well as organic mass returned to the soil are maximized.

A nutrient export simulation model predicts that irrigated cropland exports less nitrogen than rainfed cropland in dry years while the reverse is true in wetter years (see Section 2.2 in Appendices). That is because there is not enough moisture available in dry years for plants to uptake all the nutrients they need. As a result, the excess nutrients in the soil are transported offsite when rain events eventually occur. Maintaining adequate soil moisture in drier years allow higher nutrient uptake efficiency. The correlation between ecosystem service values and nitrogen export values demonstrates that there are positive ecosystem service benefits in dry years when irrigation is more likely to be required to sustain crops. The benefits or costs of ecosystem services vary little between the dry and wet years, nevertheless.

It can also be argued that better water quality can offer benefits in terms of cultural and provisioning ecosystem services. However, determining these benefits by specific ecosystem service type is a challenge and would necessitate the development of new techniques, as well as the inclusion of additional variables and assumptions.

In general, the SIA alternative is expected to result in higher crop productivity and thus improve the socioeconomic condition of residents in the region without adverse effects to ecosystem services (Estes et al. 2022). For this reason, the SIA alternative has been selected as the preferred alternative.

A conceptual model indicating how the preferred alternative (SIA) will affect identified ecosystem services is illustrated in Figure 14.

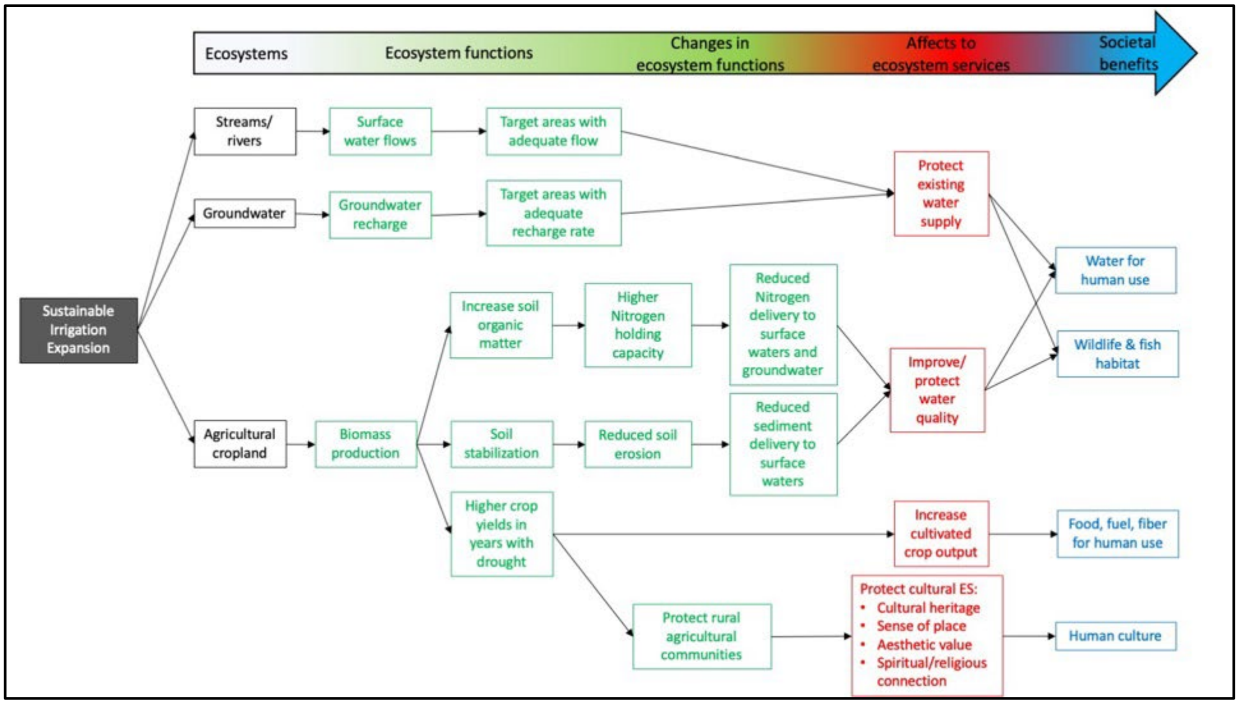

Figure 14. Conceptual model illustrating how the preferred alternative (Sustainable Irrigation Adoption) will impact ecosystem services.

8.3. Measures to be Installed

The infrastructure that would be made available for cost-share include the following:

- NRCS Practice 436 Reservoir
- NRCS Practice 430 Irrigation pipeline
- NRCS Practice 436 Irrigation reservoir
- NRCS Practice 441 Irrigation system, micro-irrigation (with both surface and subsurface scenarios)
- NRCS Practice 442 Sprinkler system
- NRCS Practice 533 Pumping plant (including necessary power sources)
- NRCS Practice 642 Well development
- Associated costs for necessary power supply

8.4. Minimization, Avoidance, and Compensatory Mitigation Measures

The SLO will offer a three-year irrigation management plan to all successful applicants which includes conservation agricultural equipment and a user-friendly interface for the farmer. This will be fully covered by ASWCC. The equipment that will be offered for the purpose of promoting sustainable agricultural and conservative irrigation practices include the following:

- Flow meters
- Soil moisture sensors
- Variable rate irrigation (VRI) components
- Telemetry
- Scheduling assistance
- Weather station

This irrigation management plan will help train farmers on best irrigation management practices that can mitigate issues from over irrigation such as increased sediment erosion, increased nutrient runoff, and inefficient use of water resources.

Mitigation measures will be identified and developed through on-farm consultation with the local NRCS-AL district conservationists and will be completed in the same manner required for a typical Environmental Quality Incentives Program (EQIP) practice.

For example, irrigation systems are to be designed and approved by certified irrigation designers or professional engineers; requirements exist for systems to be installed and maintained properly. Soil disturbing practices will be minimized by limiting disturbance and providing temporary erosion control. All local, state and Federal rules concerning worker safety will be observed; measures may include signage, lighting, and access control during and after construction.

The NRCS-AL may find specific mitigation features to be necessary once the onsite EE has been conducted, and recommended conservation measures will be incorporated into site-specific project designs to prevent negatively impacting cultural resources, wetlands, streams, T&E species, etc. Mitigation for impacts associated with on-farm construction will also be provided as needed. These measures may include the BMPs described below.

- Appropriate erosion control measures would be used; ground disturbances would be limited to those areas necessary to safely implement the preferred alternative.
- Adjacent landowners would be provided a construction schedule before construction begins.
- Stormwater and erosion BMPs would be implemented as appropriate.
- Construction would occur outside of the nesting period and outside of the USFWS approved buffer distances for any known bald and golden eagle nests. Should an active bald or golden eagle nest be found during construction, construction would be paused and consultation with a local USFWS biologist would occur to determine subsequent steps.
- Appropriate emission control devices would be required for all construction equipment.
- When needed, water or other dust suppressants would be used on unpaved roads and areas of ground disturbance to minimize dust and any effects on air quality.
- An Inadvertent Discovery Plan would be followed if cultural materials including human remains were encountered during construction. Construction would stop accordingly, SHPO and NRCS-AL cultural resources staff would be consulted, and appropriate tribes would be notified. Continuation of construction would occur in accordance with applicable guidance and law.

Table 39 and subsequent sections outline estimated potential concerns due to an increase in irrigation adoption and strategies to mitigate those concerns.

Table 39. Potential Mitigation Measures

Resource Concerns		FWOP (No-Action) Alternative	SIA (Preferred) Alternative
Soil	**Erosion**	N/A	Appropriate erosion control measures would be used to minimize soil erosion, create positive SOC and N budgets, enhance activity and species diversity of soil biota (micro, meso, and macro), and improve structural stability.
	Soil Quality Degradation	N/A	Site-specific techniques of restoring soil quality could include conservation agriculture, integrated nutrient management, continuous vegetative cover such as residue mulch and cover cropping.
Water	**Water Quantity**	N/A	Irrigation water losses include air losses, canopy losses, soil and water surface evaporation, runoff, and deep percolation. The magnitude of each loss is dependent on the design and operation of each type of irrigation system.
	Water Quality Degradation	N/A	To prevent degradation to surface and groundwater resources through erosion and chemical runoff, BMPs can be implemented to reduce erosion. Proper soil testing can prevent overuse of fertilizers.
Air	**Air Quality Impacts**	N/A	Appropriate emission control devices would be required for all construction equipment. When needed, water or other dust suppressants would be used on unpaved roads and areas of ground disturbance to minimize dust and any effects on air quality.
Plants	**Degraded Plant Conditions**	N/A	Altering the irrigation strategy on site can impact excessive soil salinity (sometimes caused by irrigation and fertilization).
Fish and Wildlife	**Inadequate Habitat**	N/A	The potential direct negative environmental impacts of the use of groundwater for irrigation arise from over-extraction, waterlogging (excessive water levels) and salinization of soils which all have mitigating strategies. Individual site visits will be conducted by a certified hydrogeologist to assess well spacing, depth, and aquifer recharge rates of the potential project site and avoid any potential for excessive withdrawals that would harm Fish and Wildlife Habitat. Impacts to aquatic habitat can be minimized and/or mitigated by considering timing and extent of stream withdrawals, including conservation measures such as riparian forest buffers, conservation tillage, irrigation water management, cover crops, and precision application of pesticides and nutrients.
	Livestock Production Limitation	N/A	N/A
Energy	**Inefficient Energy Use**	N/A	Inefficient energy use in irrigation can be mitigated with good maintenance techniques, careful initial planning of water application, and proper irrigation scheduling.

Table 39. Potential Mitigation Measures

Human	**Economic and Social Considerations**	N/A	Adjacent landowners would be provided a construction schedule before construction begins. All local, state and Federal rules concerning worker safety should be observed. Measures may include signage, lighting, and access control during and after construction.
Special Environment		**FWOP (No Action) Alternative**	**Sustainable Irrigation Adoption**
Clean Air Act		N/A	Reducing agricultural emissions that contribute to increased concentrations of particulate matter and NOx in the air, especially from sources near a Class I area, will help mitigate agriculture's contribution to regional haze issues. These emissions include directly emitted particulate matter (dust and smoke are examples) and NOx. Additionally, emissions of ammonia and volatile organic compounds (VOCs), as well as NOx, can contribute to fine particulate matter formation in the atmosphere. Many common NRCS practices can be used to address agriculture's contribution to regional visibility degradation by reducing emissions of these pollutants.
Clean Water Act/ Waters of the U.S.		N/A	To effectively fulfill our CWA Section 404 responsibilities and to prevent project delays, coordination with the Corps, EPA and/or appropriate State agencies is essential. The landowner is responsible for obtaining appropriate permits prior to project implementation, though NRCS often assists to expedite the coordination process. Along with ensuring that the landowner obtains appropriate permits, NRCS should also consider impacts of proposed actions on streams included on States' 303(d) lists and plan accordingly.
Coastal Zone Impacts		N/A	N/A
Coral Reefs		N/A	N/A
Cultural Resources/Historic Properties		N/A	Per Section V(h) of the SPAA, where a proposed undertaking may adversely affect historic properties, NRCS-AL shall describe proposed measures to minimize or mitigate the adverse effects, and follow the process outlined in 36 CFR Part 800.6, including continuing consultation with consulting parties and notification to the ACHP, to develop a Memorandum of Agreement to resolve the adverse effects. Procedures for post-review discoveries, unanticipated effects to historic properties, and dispute resolution are also outlined in Sections VI – VII of the SPAA. Technical assistance funding is available for mitigation measures if necessary.
Threatened and Endangered Species			If the practice will be placed in a habitat where a threatened or endangered species may reside, further investigation is required. Mitigation strategies include: not altering hydrology of ephemeral drains (avoiding logging during wet weather) within the FWS habitat; increasing buffer distance as needed to maintain the ecological and structural integrity of the riparian buffer and stream bank, and not crossing streams when using an irrigation water conveyance practice.

Table 39. Potential Mitigation Measures

Environmental Justice	N/A	In addition to adjusted cost-share rates for socially disadvantaged producers, the USDA Heirs' Property Relending Program is available and will be utilized to help interested producers
Essential Fish Habitat	N/A	N/A
Floodplain Management	N/A	During the on-site EE, the NRCS will determine if mitigation efforts are needed for pre-existing floodplain of floodway areas. The local floodplain administrator and/or State should work closely with the property owner to discuss any floodplain management requirements or other factors that might impact the selection of a mitigation measure, such as local and state mitigation priorities that should be considered in the selection of a mitigation solution. The goal is to encourage the property owner to select an option that is in the best interest of both the individual and community as a whole. Furthermore, the state may offer information or assistance concerning NFIP program requirements and the coordination of local and statewide mitigation planning. The FEMA Regional Office can assist with mitigation activities, including floodplain management, mitigation project guidance, identification of mitigation funding, cost-benefit project analysis, and environmental issues and requirements.
Invasive Species	N/A	Recognizing and addressing the presence of invasive species is an integral part of the conservation planning process, as well as implementing NRCS policy and any existing county, State, or Federal regulations concerning noxious and/or invasive species. At a minimum, the conservation plan includes: 1) an inventory of invasive species; 2) a map outlining the affected areas; 3) identification of control/restoration strategies, and 4) analysis of their impacts. Further mitigation efforts and consultations will be considered if determined necessary.
Migratory Birds/ Bald and Gold Eagle Protection Act	N/A	MBTA, BGEPA, and E.O. 13186 require NRCS to consider the impacts of planned actions on migratory bird populations and habitats for all planning activities. This may require cooperation with the USFWS if the action will result in a measurable negative effect on migratory bird populations. For example, if a proposed action can potentially kill or injure a migratory bird resulting in an intentional or unintentional "take" to the birds, nests, or eggs, conservation measures must be considered to mitigate adverse impacts. There are currently no anticipated impacts, but the NRCS will consult with the USFWS in the case where mitigation measures may be needed.
Natural Areas	N/A	N/A
Prime and Unique Farmlands	N/A	N/A

Table 39. Potential Mitigation Measures

Riparian Area	N/A	Conservation planning in riparian areas requires special considerations. A resource problem within the riparian area may be the manifestation of upland management decisions. If there are sites selected near riparian areas, the NRCS consultation will consider soils, the present plant community, the site potential, geomorphology of both stream and the watershed, hydrologic regime, fish and wildlife needs, the management of the upland areas of the watershed, and the producer's objectives.
Scenic Beauty	N/A	The analysis, conservation and enhancement of scenic beauty is an important part of providing planning assistance. Emphasis will be given to conservation practices that protect and enhance the attractiveness of the landscape while increasing agricultural efficiency and productivity. Through proper planning, the visual characteristics of a scenic landscape can be protected, maintained, and improved.
Wetlands	N/A	If wetlands will be impacted by a proposed activity, NRCS will identify whether practicable alternatives exist that either enhance wetland functions and values or avoid or minimize harm to wetlands. If such alternatives exist, the client will be given the opportunity to select one of those alternatives. If the client selects a practicable alternative, the NRCS may continue technical assistance for the conversion activity as well as the development of the mitigation plan. If a practicable alternative is not selected, NRCS may assist with the development of an acceptable mitigation plan, but no further financial or technical assistance for the wetland conversion activity may be provided.
Wild and Scenic Rivers	N/A	N/A

8.4.1. Soil quality degradation

The state of existing soils can have a large impact on how irrigation and potential erosion can affect both crop productivity and water quality. Soil degradation trends can be reversed by conversion to a restorative land use and adoption of recommended management practices. Mitigating soil degradation includes minimizing soil erosion, creating positive SOC and N budgets, enhancing activity and species diversity of soil biota (micro, meso, and macro), and improving structural stability and pore geometry (Gruver, 2013).

Mitigation Strategies:

- Site-specific techniques of restoring soil quality include conservation agriculture, integrated nutrient management, continuous vegetative cover such as residue mulch and cover cropping, and controlled grazing at appropriate stocking rates. The strategy is to produce “more from less” by reducing losses and increasing soil, water, and nutrient use efficiency.
- Elevated organic matter levels in the top several centimeters of an eroded soil can dramatically increase water infiltration, nutrient cycling, and resistance to detachment (Franzluebbers, 2002).
- Continuous no-till cropping systems with cover crops have been found to be particularly effective because of their ability to quickly enhance levels of organic matter near the surface. Practices that increase infiltration such as cover cropping, conservation tillage, and tile drainage can reduce run-off.
- Terraces and buffer strips can also promote deposition of suspended sediment before it leaves the field.

8.4.2. Water quantity loss based on irrigation method

The five Irrigation Practices available for cost-share include Low Pressure Center Pivots, Micro-Irrigation, Linear/Lateral Irrigation, Tow/Traveler Irrigation, and Plasticulture. Potential water quantity losses may occur due to air loss, drift, droplet evaporation, canopy evaporation, foliage interception, surface loss, surface water evaporation, and surface runoff. Recommended mitigation strategies for reducing loss of water quantity include using water-efficient technologies in combination with soil enhancing conservation methods and appropriate regulations that limit water allocation and use.

8.4.2.1. Sprinkler Irrigation Losses

Sprinkler packages (especially center pivots), even if properly designed, do not have perfect distribution uniformity. Each nozzle outlet progressively must cover a larger land area (concentric circles) with increasing distance from the center pivot point. Each outlet has a unique and specific discharge rate requirement. However, nozzle outlets are not manufactured in an infinite number of sizes.

Mitigation Strategies:

- **Proper nozzle outlet design:** For a specific nozzle outlet, the designer will select the nozzle outlet size that most closely matches the design specification. Sprinkler spacing must also be consistent with the manufacturer’s recommendations to avoid distribution problems.
- **Reducing runoff:** Slope, surface condition, and infiltration capacity all affect the depth and uniformity of water delivery to the roots. Any runoff from the field or deep percolation would reduce application efficiency by a percentage of the total.

8.4.2.2. Surface Irrigation Losses

Surface irrigation losses include runoff, deep percolation, ground evaporation, and surface water evaporation. Evaporation loss percentages from a surface irrigated field are small and are dependent on system operation. The components of the loss are furrow-water evaporation (under canopy), tailwater evaporation (where there is no canopy protection), and tailwater pit evaporation.

Mitigation Strategies:

- **Field leveling to reduce runoff**: Runoff losses can be substantial if tailwater is not controlled and reused. Although use of tailwater reuse pits could generally increase surface application efficiency, many surface irrigators use a blocked furrow to prevent runoff. Leveling the lower portion of a field to redistribute the tailwater over that portion can be helpful. While runoff may be reduced to near zero, deep percolation losses may still be high with this practice.

- **Rapid advance**: This strategy allows better water distribution efficiency and smaller application amounts, which can reduce deep percolation losses and improve overall irrigation efficiency.

8.4.3. Poor Plant Conditions

Excessive soil salinity (sometimes caused by irrigation and fertilization) can reduce the productivity of many agricultural crops, including most vegetables, which are particularly sensitive throughout the ontogeny of the plant (Machado & Serralheiro, 2017).

Mitigation Strategies:

- Irrigation method, management (irrigation scheduling and leaching fraction), and artificial drainage can prevent and mitigate the effects of soil and water salinity by influencing water-use efficiency (WUE) and nutrient-use efficiency, salt accumulation and distribution, and salt leaching.
- Where foliar damage by salts in irrigation water is a concern, irrigation methods such as surface DI and subsurface drip irrigation (SDI) and low energy precision application (LEPA) irrigation must be used. DI and SDI, compared with other irrigation methods, allow for better salinity management by increasing WUE and nutrient-use efficiency.

8.4.4. Maintaining Fish and Wildlife Habitat

Poor water quality below an irrigation project can influence the health of aquatic species. The potential direct negative environmental impacts of the use of groundwater for irrigation arise from over-extraction (withdrawing water in excess of the recharge rate), waterlogging (excessive water levels), and salinization of soils.

Waterlogging results primarily from inadequate drainage and over-irrigation and, to a lesser extent, from seepage from canals and ditches. Waterlogging concentrates salts, drawn up from lower in the soil profile, in the plants' rooting zone. Alkalization, the build-up of sodium in soils, is a particularly detrimental form of salinization which is difficult to rectify.

Irrigation-induced salinity can arise as a result of the use of any irrigation water, irrigation of saline soils, and rising levels of saline groundwater combined with inadequate leaching. When surface water or groundwater containing mineral salts is used for irrigating crops, salts are carried out into the root zone. In the process of evapotranspiration, the salt is left behind in the soil, since the amount taken up by plants and removed at harvest is quite negligible.

Mitigation Strategies

- If withdrawing from surface water, site specific evaluations will be done by the USFWS. Ranking criteria set by the ALSWCC gives preference to sixth or seventh-order streams.
- Promoting flow meters by offering them to users at 100% cost share.
- Many of the soil-related problems could be minimized by installing adequate drainage systems. Drainage is a critical element of irrigation projects, that however still too often is poorly planned and managed.
- Waterlogging can also be reduced or minimized, in some cases, by using micro-irrigation which applies water more precisely and can more easily limit quantities to no more than the crops needs.

8.4.5. Inefficient Energy Use in Irrigation

Water saving irrigation strategies can reduce soil salinization and conserve soil to sustain land productivity and environmental benefits (Pedersen et. al, 2018).

Mitigation Strategies:

- Scheduling consistent irrigation schedule for specific crops.
- Integrating smart sensors into irrigation management systems so that water is only used when needed.
- Maintaining application uniformity.
- Monitor static and pumping water levels each year to monitor potential plugged screens impacting drawdown levels.
- Maintain pumps regularly, including proper greasing and filling oil reservoirs every year.

8.4.6. Pre-Construction

8.4.6.1. Application Ranking Process

The SLO or its associated districts will take applications from producers and rank applications according to a list of ranking questions. The NRCS will also evaluate each application to help determine the eligibility and ranking score of each. The ranking of each individual project site will help to mitigate the impact that this project might have on impaired waters and other biological resources.

8.4.6.2. Environmental Evaluation

Before implementing each site-specific project, the onsite Environmental Evaluation (EE) review will occur using the Form NRCS-CPA-52, Environmental Evaluation Worksheet. The onsite EE review is consistent with the tiering process which is when broad programs and issues are described in initial analyses then site-specific proposals and impacts are described in subsequent site-specific studies. The tiering process allows the lead agency to focus on issues that are ripe for decision and exclude from consideration issues already decided on or not yet ripe. Additionally, the CPA-52 Environmental Review and Cultural Resources Review would determine whether further action is required. The EE process will determine if that particular site project meets applicable project specifications, and whether the site-specific environmental effects are consistent with those as described and developed in this Plan.

8.5. Permits and Compliance

The NRCS-AL ensures compliance with NEPA policy and regulations when using federal dollars. The State Conservationist (STC) is the responsible Federal official who ensures that the Basin Plan-Environmental Impact Statement (EIS) or Plan-Environmental Assessment (EA) complies with NEPA. Additional permits and compliance required for the installation of the potential alternatives will depend on site-specific project proposals and agency consultations. Possible permits that may be required are described below. This list includes examples brought to the SLO's attention but may not be complete or inclusive of all possible permits and compliance necessary.

1) A Certificate of Use will be required by the Office of Water Resources (OWR) for the installation of irrigation systems that have the capacity for water withdrawals greater than 100,000 gallons per day.
2) National Pollutant Discharge Elimination System permits will be obtained if necessary. Permits can be issued to individual dischargers or can be issued for a group of dischargers (i.e., general permits). Both individual and general permits contain requirements for controlling pollutant dischargers, monitoring discharges, and reporting compliance.

The following permits and compliance measures have been considered and determined unnecessary regarding the proposed alternatives' project measures:

1) Public Law 83-566 projects are local projects installed with Federal assistance, not Federal projects, and are exempt from the provisions of the Fish and Wildlife Coordination Act (FWCA).
2) A Section 404 Permit will not be necessary for floating intake.

Furthermore, there are currently no State in-stream flow standards that must be met. The NRCS-AL will coordinate with the U.S. Fish and Wildlife Service (USFWS) on in-stream flow recommendations.

8.6. Costs

Table 40 shows estimated irrigation investment costs by type of irrigation. The cost of irrigation system installation would vary for each selected project site based on the Conservation Practice Standards selected for that site. To estimate total installation cost, the cost of a well and center pivot combination was used given the use of center pivots in basin. The installation of a 130-acre center pivot irrigation system and well is estimated to cost $3,162 per irrigated acre (Table 40).

Table 40. Installation costs for a 130-acre center pivot irrigation system and well, 2023$

Item	Cost per Acre	Total Cost (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**

8.7. Installation and Financing

8.7.1. Framework for Carrying out the Plan

The plan will be carried out through a partnership between the NRCS, the ASWCC, and the Alabama Agricultural & Conservation Development Commission (AACDC). The ASWCC and the AACDC through a memorandum of understanding will use applicable mechanisms of the existing AACDC cost-share program to implement the project in the basin. This program allows individuals and entities (producers) to apply for cost-share dollars to complete on-farm water supply, distribution, and irrigation practices necessary to install a completed AWM Element listed in the AACDC cost-share manual. The localized development of water sources and irrigation practices along with the required power supply will be funded by Federal funds at approximately 54.5 percent of purchase and installation costs. Federal funds will also be expended to provide NRCS Technical Assistance for installation of the systems.

8.7.2. Planned Sequence of Installation

The sequence for each on-farm installation of an approved AWM Element will be determined by the items that are required on-farm to complete the selected element. Before the start of construction or installation of any individual items of the AWM element, the CPA-52 Environmental and Cultural Resources Review will be completed, and all applicable permits will be obtained by the producer (See Appendix E, Figures E-16–E-21). Typically, water supply sources and power supplies will be developed first. After development of the water and power supply, the remaining practices which include piping, pumps, pivots or other irrigation methods can be installed in a practically parallel fashion. Mitigation measures will be identified and developed through on-farm consultation with the local NRCS district conservationists and will be completed in the same manner required for a typical EQIP practice. No real property must be acquired by the SLO for installation of the AWM elements since the elements will be installed on property or easements held by the producer.

8.7.3. Responsibilities

The SLO is responsible for implementing the cost-share program with the assistance of the NRCS District Conservationists. The SLO, through a Memorandum of Understanding with the AACDC, will be responsible for developing and implementing a cost-share program to install AWM Elements on-farm. The SLO or its associated districts will take applications from producers, rank applicants, enter into agreements, and pay successful applicants. The SLO or its associated districts will enter into O&M agreements with applicants for the operation and maintenance of the AWM Elements as per the program guidelines. The NRCS will evaluate each application to help determine the eligibility and ranking score of each. Additionally, the NRCS will perform a CPA-52 Environmental Review and Cultural Resources Review to determine whether further action is required. The producer will be required to obtain all applicable permits and certificates, an irrigation design completed by a Certified Irrigation Designer, a Professional Engineer, and/or a Professional Well Driller, necessary financing to complete the project; and enter into an O&M agreement with the SLO or its associated districts.

8.7.4. Contracting

The SLO (ASWCC) and its associated Soil and Water Conservation Districts will use the standard State of Alabama Cost-Share agreement to contract with the producer to install AWM elements. The ASWCC and the associated Districts will work with NRCS during installation of all practices. No long-term contract will be required for this project.

8.7.5. Financing

The plan does not require the SLO to finance installation. The NRCS will provide 54.5 percent of the equipment purchase and installation of the AWM Elements for each applicant. The remaining 45.5 percent will be provided by the producer through cash on hand or private financing. Operation and maintenance costs will be borne by the producer as per the standard NRCS operations and maintenance agreement. Estimated installation and technical assistance costs and the portion needed from Public Law 83-566 Funds are shown in Table 40.

8.7.6. Conditions for Providing Assistance

The NRCS will aid the SLO upon implementation of the Cost-Share program described above. The appropriation for funding for NRCS assistance has already been authorized.

8.8. Operation, Maintenance, and Replacement

Operation, maintenance, and replacement (OM&R) responsibilities of the AWM Elements will be assumed by the producer (see Appendix D.1 Section 2). The approved producers will sign an O&M agreement for the AWM Elements concurrently with the Cost-Share agreement. The AWM elements and the associated life span for each element is listed in the AACDC Cost-Share Manual, Book 2. Inspection of AWM Elements will follow EQIP standard procedure for similar practices.

The Alabama Irrigator’s Pocket Guide 2006 (Equipment Maintenance and Water Management) produced by the National Center for Appropriate Technology and provided by the NRCS-AL and the OWR, a division of the Alabama Department of Economic and Community Affairs provides detailed information for maintenance of pumps and distributions systems and will be available to all participants. Additionally, producers should follow the specific guidelines as outlined by the equipment’s manufacturer and distributor for best practices.

8.9. Economic and Structural Tables

The following tables summarize the estimated costs, cost distributions, and benefits associated with the Preferred Alternative. See Appendix D for a full economic analysis. Table 41 presents the projected installation costs and the percentages of costs to be shared by PL 83-566 and other funding sources. Table 42 presents the project’s cost distribution, as well as the proportion of PL 83-566 funding and other funding sources. The average annual costs are shown in Table 43.

Table 41. Economic Table 1 – Estimated Installation Cost, Middle AL Basin, Alabama, 2023$

Works of Improvement	Unit	Number			Estimated cost (dollars)[1,2,3]						
					Public Law 83-566 Funds			Other Funds			Total
		Federal Land	Non-Federal Land	Total	Federal Land NRCS	Non-Federal Land NRCS	Total	Federal Land	Non-Federal Land	Total	
Investment in Irrigation Equipment	Acres	0	3,052	3,052	$-	$6,614,000	$6,614,000	$-	$3,426,000	$3,426,000	$10,040,000
Total Project	Acres	0	3,052	3,052	$-	$6,614,000	$6,614,000	$-	$3,426,000	$3,426,000	$10,040,000

[1]Price Base: 2023 dollars
[2]Project cost includes 6.25% technical assistance costs
[3]Assume 70% of PL 83-566 funds go towards a 60% cost-share with farmers, while 30% of PL 83-566 funds go towards a 75% cost-share with farmer. Other funds represent farmer contributions.

Table 42. Economic Table 2- Estimated Cost Distribution Irrigation Equipment Investment, Middle AL Basin, Alabama, 2023$

Works of Improvement	Installation Costs-PL 83-566 Funds[1,2]			Installation Costs-Other Funds			Total
	Construction	Project Admin[3]	Total PL 83-566	Construction	Project Admin	Total Other	
Investment in Irrigation Equipment	$6,225,000	$389,000	$6,614,000	$3,426,000	$0	$3,426,000	$10,040,000
Total costs	$6,225,000	$389,000	$6,614,000	$3,426,000	$0	$3,426,000	$10,040,000

[1]Price Base: 2023 dollars
[2]Assume 70% of PL 83-566 funds go towards a 60% cost-share with farmers, while 30% of PL 83-566 funds go towards a 75% cost-share with farmer. Other funds represent farmer contributions.
[3]Project Admin includes project administration, technical assistance costs and permitting costs.

Table 43. Economic Table 4- Estimated Average Annual Costs, Middle AL Basin, Alabama, 2023$

Works of Improvement	Project Outlays (Amortization of Installation Costs)[1]	Project Outlays (OM&R Cost)	Other Direct Costs	Total[1]
Investment in Irrigation Equipment	$451,000	$343,000	$0	$794,000
Total	$451,000	$343,000	$0	$794,000

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

Table 44. 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.

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10. List of Preparers

The draft watershed plan and environmental assessment was reviewed and concurred with by State staff specialists having responsibility for engineering, soils, agronomy, range conservation, biology, cultural resources, forestry, and geology. This review will be followed by a review of the document by the NWMC.

Name, Title, Employer	Education	Discipline	Experience (Years)
Eve Brantley, Professor & Extension Water Resources Specialist, Auburn University	Ph.D.	Watershed Planning, Riparian Ecology	22
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Adam Newby, Auburn University, Research Assoicate	Ph.D.	Irrigation Management, Technical Writing	15
Max W. Runge, Auburn University, Faculty & Extension Professor Agricultural Economics	MBA, M.S.	Agriculture and Resource Economics	29
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Kevin Doty, UAH, Research Scientist	Ph.D.	Atmospheric Science, Weather/Climate Modeling, Hydrology Modeling	20
Lee Ellenburg, UAH, Research Engineer	Ph.D.	Civil/Environmental Engineering, Hydrologic Modeling, Crop Modeling, GIS	11
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Katie Nemec, UAH, Research Associate	M.S.	Environmental Sciences, Civil/Environmental Engineering, Groundwater Hydrology	11
Annie Blankenship, AL-NRCS		Cultural Resources	

11. Distribution List

To be distributed to the following groups:

- Alabama Agricultural & Conservation Development Commission
- Alabama Association of Conservation Districts
- Alabama Department of Conservation and Natural Resources
- Alabama Department of Economic and Community Affairs/Office of Water Resources
- Alabama Department of Environmental Management
- Alabama Governor's Office
- Alabama Natural Resources Conservation Service
- Alabama Rivers Alliance
- Geological Survey of Alabama
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration Fisheries
- Soil and Water Conservation District Offices in Barbour, Bullock, Coffee, Covington, Dale, Geneva, Henry, Houston, and Pike Counties
- State Historic Preservation Office
- The Nature Conservancy
- Tribal Governments and Tribal Historic Preservation Officers listed in Section 3.2
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture, Farm Service Agency
- U.S. Department of Agriculture, Rural Development
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service

12. Acronyms, Abbreviations, and Short Forms

Acronyms, abbreviations, or short form	Meaning
AACD	Alabama Association of Conservation Districts
AACDC	Alabama Agricultural & Conservation Development Commission
AADT	Average Annual Daily Traffic
ACES	Alabama Cooperative Extension System
ACHP	Advisory Council on Historic Preservation
ACROD	Alabama Cultural Resources Online Database
ADCNR	Alabama Department of Conservation and Natural Resources
AEP	Annual Exceedance Probability
AHC	Alabama Historical Commission
AHCR	Alabama Historic Cemetery Register
AL	Alabama
ALFA	Alabama Farmers Federation
ARLH	Alabama Register of Landmarks and Heritage
ASWCC	Alabama Soil and Water Conservation Committee
AU	Auburn University
AWM	Agricultural Water Management
BCC	Birds of Conservation Concern
BGEPA	Bald and Golden Eagle Protection Act
BLS	Below land surface
BMP	Best Management Practices
C	Celsius
cfs	Cubic feet per second
cps	Conservation Practice Standard
CWP	Clean Water Partnership
DI	Drip Irrigation
DO	Dissolved Oxygen
DPM	Diesel Particulate Matter
ECOS	Environmental Conservation Online System
EE	Environmental Evaluations
EIS	Environmental Impact Statement
EJ	Environmental Justice
EPA	Environmental Protection Agency
EQ	Environmental Quality
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ET	Evapotranspiration
FONSI	Finding of No Significant Impact
FR	Feasibility Report
FSA	Farm Service Agency

Acronyms, abbreviations, or short form	Meaning
ft	feet
FWCA	Fish and Wildlife Coordination Act
FWOP	Future Without Project
gpm	Gallons Per Minute
GSA	Geological Survey of Alabama
HU	Historically Underserved
HUC-12	Hydrologic Unit Code-12
IPA	Irrigation Potential Assessment
IPaC	Information for Planning and Consultation
Km	Kilometer
LAI	Leaf Area Index
LEPA	Low Energy Precision Application
MBTA	Migratory Bird Treaty Act
MCLG	Maximum Contaminant Level Guideline
MGD	Millions of gallons per day
MSL	Mean Sea Level
NED	National Economic Development
NEPA	National Environmental Policy Act
NGO	Non-Governmental Organization
NHDplusV2	National Hydrography Dataset Plus
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	U.S. National Park Service
NRCS-AL	Alabama Natural Resources Conservation Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NW FL WMD	Florida Northwest Water Management District
NWMC	National Water Management Center
NWPH	National Watershed Program Handbook
NWPM	National Watershed Program Manual
OAR	University of Alabama – Office of Archaeological Research
OMB	Office of Management and Budget
OM&R	Operation, Maintenance, and Replacement
OWR	Office of Water Resources
PBL	Planetary Boundary Layer
PET	Potential Evapotranspiration
P&G	Economic and Environmental Principles and Guidelines
PR&G	Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies

Acronyms, abbreviations, or short form	Meaning
PI	Preliminary Investigation
Plan	Plan-Environmental Assessment
PM2.5	Particulate Matter
PPT	Precipitation
RED	Regional Economic Development
RMSE	Root Mean Square Error
ROD	Record of Decision
R2NSE	Nash-Sutcliffe Efficiency Statistic
SAIPE	Small Area Income and Poverty Estimates
SDI	Subsurface Drip Irrigation
SGCN	Species of Greatest Conservation Need
SHUs	Strategic Habitat Units
SIA	Sustainable Irrigation Adoption
SLO	Sponsoring Local Organization
SMREC	Sand Mountain Research and Extension Center
SPPA	State-based Prototype Programmatic Agreement
SRA	Statewide Resource Assessment
SRRUs	Strategic River Reach Units
SSURGO	NRCS Soil Survey Geographic Database
STATSGO	State Soil Geographic Dataset
STC	State Conservationist
TDS	Total Dissolved Solids
T&E	Threatened and Endangered
THPOs	Tribal Historic Preservation Officers
TMDL	Total Maximum Daily Loads
TN	Total Nitrogen
TR	Technical Release
TSS	Total Suspended Solids
TVREC	Tennessee Valley Research and Extension Center
U.S.	United States
UAH	University of Alabama in Huntsville
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USDA NASS	United States Department of Agriculture- National Agricultural Statistics Service
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile Organic Compounds
VRI	Variable Rate Irrigation
WUE	Water-Use Efficiency