Three Rivers Southeast Arkansas Study

Appendix I: Hydrogeomorphic (HGM) Analysis

THREE RIVERS SOUTHEAST ARKANSAS

Introduction

The Three Rivers Study, which encompasses the confluence of the Arkansas and White rivers with the Mississippi River in southeast Arkansas, is being conducted by the U. S. Army Corps of Engineers (USACE) to study the McClellan-Kerr Arkansas River Navigation System (MKARNS) in an effort to seek a long-term sustainable navigation system that promotes the continued safe and reliable economic use of the MKARNS.

There is a risk of breach of the existing containment structures near the entrance channel to the MKARNS on the White River. During high water events, water backing up the Mississippi can create significant head differentials between the Arkansas and the White rivers. The existing containment structures are subject to damaging overtopping, flanking and seepage that could result in a catastrophic breach. The uninhibited development of a breach, or cutoff, has the potential to create various navigation hazards, increase the need for dredging, and adversely impact an estimated 200 acres of bottomland hardwood forest in the isthmus between the Arkansas and White rivers.

Stage of Planning Process

This is a feasibility study. A planning Charette was conducted in September 2015, and an Alternatives Milestone Meeting was completed in December 2015. The study is in the Alternative Formulation and Analysis Phase. Utilizing a reasonable level of detail, the PDT has analyzed, compared, and evaluated the array of alternatives to identify a Tentatively Selected Plan.

Study Authority

Section 216, Flood Control Act of 1970 (Public Law 91-611) authorizes a feasibility study due to examine significantly changed physical and economic conditions in the Three Rivers study area. The study will evaluate and recommend modifications for long-term sustainable navigation on the MKARNS. Section 216 of the Flood Control Act of 1970 (Public Law 91-611) states:

> *"The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."*

Non-Federal Sponsor

The Arkansas Waterways Commission is the non-federal sponsor for the Three Rivers Southeast Arkansas Study. An amended feasibility cost-sharing agreement was executed in June 2015.

Purpose

Based on the Section 216 authority, the study is investigating alternatives that would minimize the risk of cut off development, including reducing the cost of maintence associated with preventing cutoff development, while minimizing impacts to the surrounding ecosystem.

Introduction

The White River and Arkansas River are confluent with the Mississippi River in southeastern Arkansas, but all three channels are highly dynamic, and the actual points of confluence have changed dramatically and often over time. The Rivers and Harbors Act of 1946 authorized construction of the McClellan-Kerr Arkansas River Navigation System (MKARNS), originating at the Tulsa Port of Catoosa and running southeast through Oklahoma and Arkansas to the Wilber Mills Dam on the Arkansas River (Dam #2). From there, the MKARNS is diverted through a man-made canal to its intersection with the lower 10 miles of the White River, where it continues to the Mississippi River. This lower 10 miles of the White River is termed the “White River Entrance Channel” to MKARNS.

As part of the MKARNS project, the U.S. Army Corps of Engineers (USACE) closed a natural, hydrologic connection between the Arkansas and White Rivers at the Historic Cutoff (at approximate White River mile 4.2) in the 1960’s. Since the closure of the Historic Cutoff, the two rivers have attempted to re-establish that connection in other areas. In response, USACE has built (and repaired) numerous structures on several occasions since the 1970’s to prevent an uncontrolled cutoff from occurring. Such a cutoff would result in the closure of the lower White River to barge traffic for a significant amount of time. Despite continuing repair efforts, the risk of a cutoff remains.

Besides navigation concerns, an uncontrolled cutoff would destroy approximately 200 acres of bottomland hardwood forest (BLH) in the likely path of the flows due to scouring and erosion. This acreage is based on a possible 1,000 foot-wide cutoff occurring along the Jim Smith Lake corridor (~130 acres) and the Owens Lake/Melinda Corridor (~70 acres). These BLH acres would convert to deep, open water channels similar to the existing Melinda Corridor.

The purpose of the Three Rivers Feasibility Study is to develop and analyze alternatives that will lead to long-term, environmentally sustainable navigation on the MKARNS. As mentioned, navigation is currently threatened by a risk of failure of existing containment structures, resulting in a cutoff occurring. An uncontrolled cutoff would result in the loss of navigation reliability on the MKARNS for an extended period of time.

The Study Area and Project Alternatives

The potential for a cutoff to develop between the White and Arkansas Rivers is greatest during high stages on the Mississippi River when the White River backs up, causing overland flows to the Arkansas River. Three project alternatives are under evaluation as part of the study, including the No Action Alternative. The two Action Alternatives include various combinations of changes to existing containment structures, and construction of a new containment structure segment. Each alternative is designed to reduce head differentials between the two rivers during flood events, reducing the risk of an uncontrolled cutoff from occurring. A detailed description of each alternative can be found in the main report.

Two of the three alternatives will have direct impacts due to construction activities. These impacts involve removal of BLH forest within the project area. Table 1 lists the acres of direct impact associated with each alternative.

Table 1. Summary of acres impacted by each of the project alternatives

ALTERNATIVE	DIRECT IMPACTS (ACRES)	INDIRECT IMPACT (ACRES)
Future Without Project Condition/No Action (cutoff damage and related structural work)	**156**	**0**
1 – New containment structure/open historic cutoff	**25**	**0**
2 – Multiple openings	**0**	**0**

Direct Impacts

Future without Project Condition (FWOP) Alternative / No Action

This alternative anticipates reconstruction of the existing Melinda Structure closer to the Arkansas River, as well as three new structures during the planning horizon (50 years) to stop active headcutting in the project area (Figure 1). The acreage estimate for the FWOP includes permanent impacts to forested wetlands due to construction, plus forested acreage that would be destroyed in the event that an uncontrolled cutoff occurs. The direct project construction footprint is projected to cause a loss of all wetland functions immediately, while future headcutting would result in a loss of wetland functions gradually over time as the area converts to open water or dry channel. The direct impact acreage was estimated in the Ark-White Cutoff Study and carried forward for analysis, since the No Action Alternatives from both studies are the same.

Figure 1 - Future without Project Condition / No Action

Alternative 1 – New Containment Structure

Acreage associated with Alternative 1 (Figure 2) reflects anticipated permanent direct impacts to approximately 25 acres of forested wetlands due to construction of a new containment structure. This structure would be approximately 2.5 miles long and begin on natural high ground just south and west of the existing Melinda Weir located on the south side of Owens Lake. It would continue east and cross south of the existing Melinda Weir and then head northeast and connect to the existing soil cement containment structure north of J. Smith Lake. It would then follow the existing containment alignment and terminate at the Historic Cutoff Containment Structure (HCS). This alternative would incorporate the use of existing and natural high ground in the project area which will result in minimal disturbance to the terrain and to the natural hydrology of the land. BLH trees will be permanently removed from this area.

Alternative 1 would also provide an opportunity to restore form and function to oxbow lakes in the isthmus while providing a long-term solution for reducing the risk of a breach between the Arkansas and White Rivers by reducing the frequency, duration, location, and damaging head differentials of overtopping events. Variations of this alternative includes the addition of a relief channel ranging from 500 feet to 1,000 feet wide, at elevation 145 feet, through the HCS. This is the current elevation that the White and Arkansas Rivers exchange flow through the Melinda Corridor. Some trees may be removed from the structure during construction, depending on final design and location of the opening. The HCS is already a heavily altered site, thus no mitigation is warranted. Material removed from the HCS will be deposited downstream of the structure along the southwest bank. This area is already impacted by the HCS footprint, and a portion is experiencing active headcutting.

A drainage structure (culvert, arched span, etc.) will be placed in the existing Owens Lake Structure to prevent a change in flood duration of forested wetlands around Owens Lake. This structure will also provide fish passage between Owens Lake and the White River at a frequency matching or exceeding what occurs presently. Construction will be limited to the concrete weir, thus there will be no impacts to forested wetlands. There will be no impacts due to demolition of the Melinda Structure.

Approximately 25 acres of bottomland hardwoods will be impacted by temporary roads needed to access construction sites. These sites will be allowed to revegetate after construction, thus will not require mitigation.

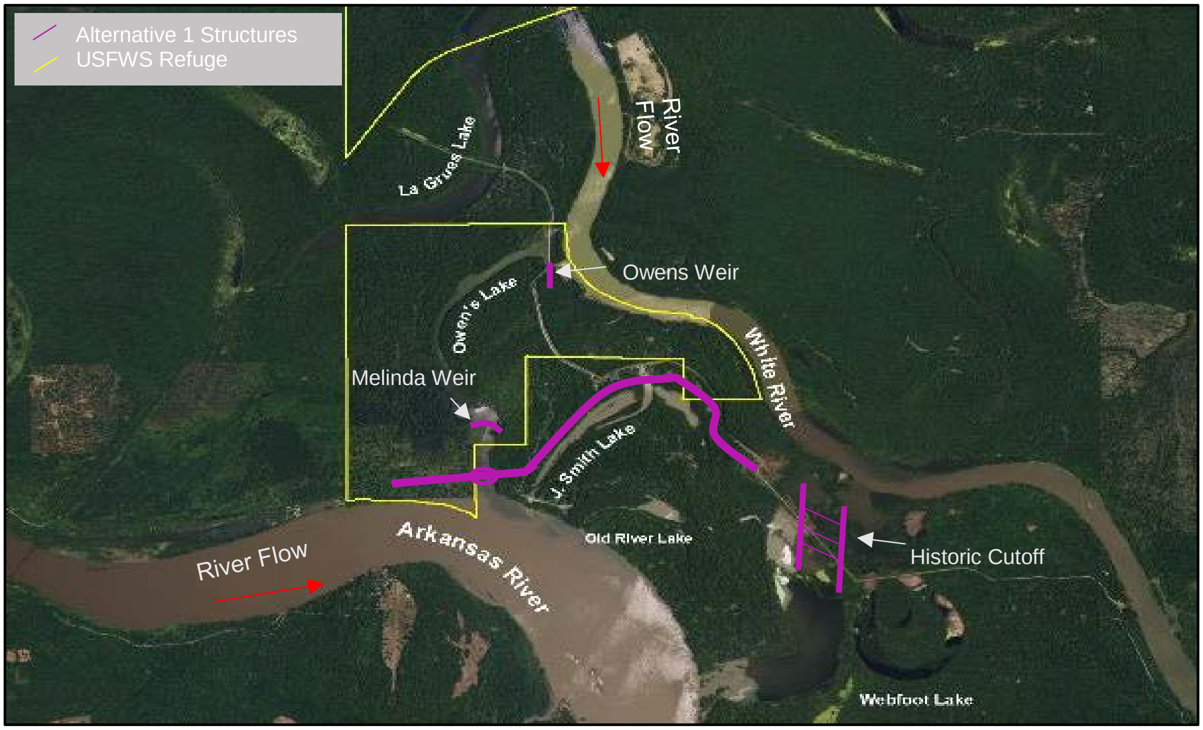

Figure 2: Alternative 1: New Containment Structure

Alternative 2 – Multiple Openings

This alternative would utilize the existing footprints of oxbow lakes in the isthmus and the HCS as multiple relief openings, See Figure 3 for approximate locations of structures. Several step-down structures would be placed in Owens Lake, Historic Cutoff, and possibly J. Smith Lake that would facilitate the exchange of water at an environmentally optimized elevation between 115 feet and 135 feet. This alternative would restore some of the pre-Historic Cutoff Containment Structure hydrology between the Arkansas and the White Rivers and therefore restore some historic ecological conditions. Some trees may be removed from the HCS during construction, depending on final design and location of the opening. The HCS is already a heavily altered site, thus no mitigation is warranted. Material removed from the HCS will be deposited downstream of the structure along the southwest bank, and at other existing material storage sites. The area below the HCS is already impacted by the HCS footprint, and a portion is experiencing active headcutting. Placement of this material will fill the eroded area, thus serves as restoration, rather than an impact requiring mitigation. There will be no direct impacts due to altering the elevation of the Owens Lake or Jim Smith Lake structures. Impacts to forested wetlands will be limited to temporary roads built to access construction sites and the banks adjacent to each structure. All disturbed sites will be allowed to revegetate after construction, thus mitigation isn't warranted.

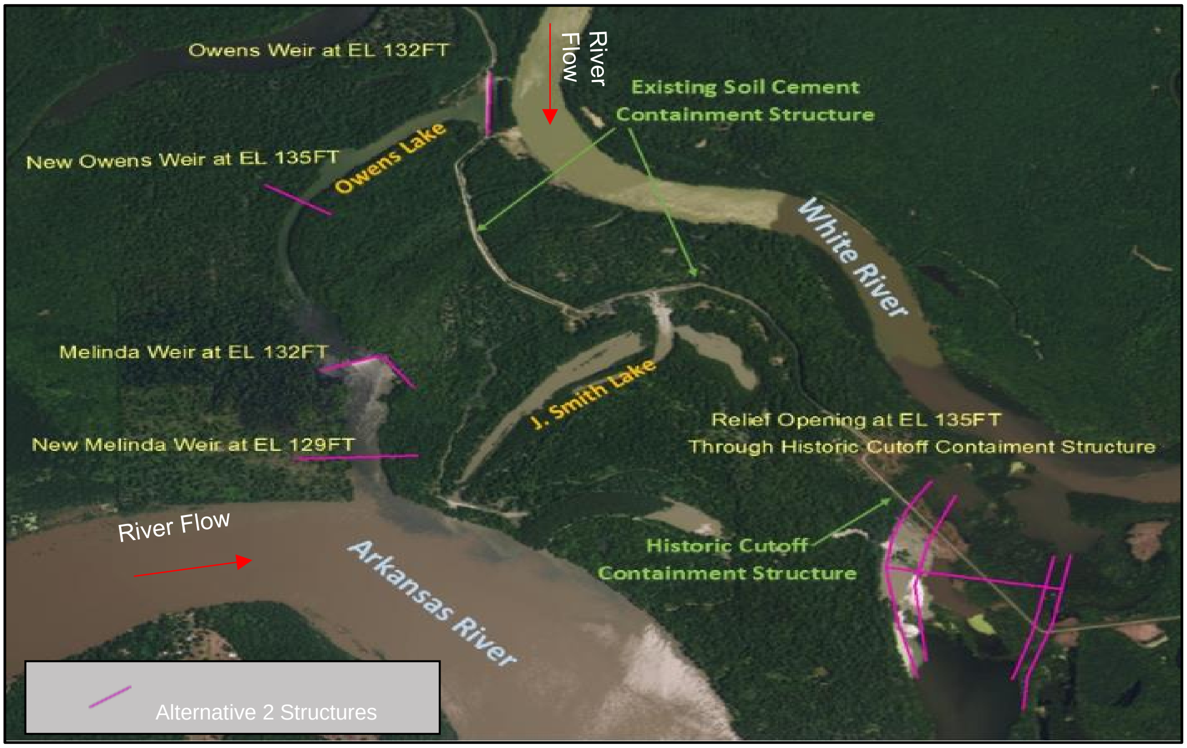

Figure 3: Alternative 2: Multiple Openings

Analysis of Direct Impacts

Background on the Assessment Approach

Hydrogeomorphic (HGM) classification identifies groups of wetlands that function similarly using three criteria that fundamentally influence how wetlands function: geomorphic setting, water source, and hydrodynamics. Geomorphic setting refers to the position of the wetland in the landscape. Water source refers to the primary origin of the water that sustains wetland characteristics, such as precipitation, floodwater, or groundwater. Hydrodynamics refers to the level of energy with which water moves through the wetland, and the direction of water movement. Based on these three criteria, any number of functional wetland groups can be identified at different spatial or temporal scales (Klimas et.al. 2004).

Utilizing the criteria above, four wetland classes (Flat, Riverine, Depression, and Fringe wetlands) have been identified as occurring within the Delta Region of Arkansas. One fundamental criterion of wetland classification is that a wetland must be in the 5-year floodplain of a stream system to be included within the Riverine Class. This return interval is regarded as sufficient to support major functions that involve periodic connection to stream systems.

Klimas et.al. (2004, 2011) identified six wetland subclasses for the Mississippi Alluvial Valley: Flats, Low-Gradient Riverine Overbank, Low-Gradient Riverine Backwater, Headwater Depression, Unconnected Depression, and Connected Depression. Most of the Three Rivers Study Area is within the five-year floodplain and classified as Low-Gradient Riverine Backwater (LGRB) wetland subclass, including the majority of direct impact areas. Klimas and Smith (2009) grouped sites that may have been Riverine Overbank or Depression subclasses in with LGRB for analysis purposes. The same was done for the Three Rivers HGM analysis. Smaller, dispersed sites throughout the study area located outside the five-year floodplain are classified as a Flats subclass. This classification is consistent with that for the Ark-White Cutoff Study.

The HGM Approach is a method for developing functional indices and the protocols used to apply these indices to the assessment of wetland functions at a site-specific scale. The Three

Rivers Environmental Team utilized the HGM Approach for Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley (Klimas et.al. 2004) to assess wetland functions in areas identified as having direct, permanent impacts to forested wetlands from the alternatives being considered. This is the same assessment method used in the Ark-White Cutoff Study. The following discussion comes from the analysis in the Arkansas-White Rivers Cutoff Study, Draft EIS, Appendix D (Klimas and Smith 2006).

The HGM Approach incorporates several components. Wetlands are first grouped into regional subclasses based on functional similarities, as represented by hydrogeomorphic setting. Thus, wetlands in isolated depressions function differently than wetlands on river floodplains in various respects. For example, a functional riverine wetland exports organic materials to downstream aquatic systems during floods, whereas a depression that lacks a surface connection to a stream does not perform that function. Therefore, a group of functions can be identified for each regional subclass, and other regional subclasses may not perform those functions, or may perform them to different degrees.

In order to estimate the degree to which a wetland performs a particular function, HGM represents each function in terms of a simple logic model made up of variables that can be measured in the field or derived from existing information sources. For the example above, the ability of a riverine wetland to export organic carbon can be represented by the following equation.

$$FCI = V_{FREQ} \times \frac{\frac{[V_{LITER} + V_{OHOR} + V_{WD} + V_{SNAG})]}{4} + \frac{[V_{TBA} + V_{SSD} + V_{GVC}]}{3}}{2}$$

In this case, a relative measure of functionality, the Functional Capacity Index (FCI), is determined by 3 primary model terms.

1. Flood frequency (V_{FREQ}) which represents how often the wetland is inundated by overflow from a stream system, and provides the export mechanism for delivering organic carbon to the stream;

2. Detrital pools, comprising litter (V_{LITTER}), O-horizon thickness (V_{OHOR}), woody debris (V_{WD}), and snags (V_{SNAG}), represent the current and future availability of mobile particulate organic matter and sources of dissolved organic matter; and

3. Organic production sources, represented by tree basal area (V_{TBA}), shrub and sapling density (V_{SSD}), and ground vegetation cover (V_{GVC}), which represent the major sources of material that will replenish the detrital pools.

In order to apply the models to a specific wetland, the variable values must be determined or estimated. The flood frequency component can be estimated for a specific site based on gauge data, flood zone mapping, and similar sources. Information on living and dead vegetation can be obtained using standard forest sampling methods. Models used to assess all of the other functions use similarly obtained information as model variables.

The FCI value generated by the assessment model is an index between zero and 1.0, where a value of 1.0 represents a fully functional condition. Under HGM methodology, the FCI is multiplied by a measure of the area of the wetland (e.g., acreage) to calculate the Functional Capacity Units (FCU) present for each assessed function. This is essentially the same process used in the Habitat Evaluation Procedures (HEP) (U.S. Fish and Wildlife Service 1980), where indicators of habitat quality are combined into simple models to calculate a Habitat Suitability Index (HSI) and multiplied by a measure of area to produce Habitat Units (HU). There is one fundamental difference between the ways these two assessment approaches are developed, however. Whereas the indicators employed in HEP models are calibrated based on literature and expert opinion, the calibration curves for HGM indicators are derived from extensive field sampling of reference wetlands.

As with all of the HGM guidebook development efforts, the Delta Region models, calibration curves, and application tools such as sampling methods and data summary spreadsheets were developed by a team of regional experts. Users of the guidebooks apply this information to specific assessment tasks, and can use the same models and reference data on various projects throughout the region. The models and calibration curves are applied in an assessment scenario by following detailed guidance presented in the Delta HGM Guidebook. The user collects field data from the assessment area to populate the model. The model then generates a FCI for the function being assessed. Multiplying the FCI by acreage generates FCUs, which represent the functional units associated with the assessment area, and which can be compared among assessment areas of the same regional subclass. Pre- and post- project FCUs can be compared to determine impacts, and project alternatives can be compared to help identify those with the least environmental impacts.

Application of the Assessment Approach

In typical HGM applications, the impacts being assessed involve vegetation clearing, fill placement, and similar physical changes to the wetland. The alternatives assessed here include relatively small, direct impact areas (Figures 1-3). The entire Three Rivers Study Area was evaluated to identify possible indirect effects of altered hydrology resulting from project features (termed *indirect* impacts).

Direct Impact Assessment

To determine the direct impact areas, USACE design engineers provided GIS shapefiles that delineated the project footprints (direct construction impacts) for each of the action alternatives. Utilizing these shapefiles, forested areas in the project footprint were evaluated to determine whether sampling was necessary. Sample sites were selected to ensure different condition classes (i.e. scrub, young forest, mature forest) were represented. Since all of the direct impact areas are in LGRB, no delineation of subclass boundaries was necessary. Table 1 lists the forested acreage contained within the footprint of each project alternative that will be permanently impacted.

FWOP Alternative

Direct impact footprints for the FWOP alternative are the same as the Arkansas-White Rivers Cutoff Study. As such, the HGM analysis from Ark-White is used here. The direct impact acres for the FWOP (Table 1) includes an estimate of forested acreage that would be destroyed in the event that an uncontrolled cutoff occurs.

Alternative 1

To calculate impacts to wetland functions associated with the new containment structure, the environmental team analyzed aerial images to identify different condition classes (i.e. scrub, young forest, mature forest) to ensure representative samples were taken during data collection. The majority of the structure footprint consists of mature forest. From this review, the team selected eleven sites. These sites were spaced approximately 1,200 feet apart. Latitude and longitude coordinates were recorded for each site to enable field crews to locate the sites.

Field sampling was conducted November 2, 2016, following the procedures specified in the Arkansas Delta HGM Guidebook (Klimas et al. 2004). Representatives of the Little Rock District USACE, Arkansas Game and Fish Commission, and the U.S. Fish and Wildlife Service participated in data collection. HGM field data sheets are attached as Appendix A. The analysis used to quantify impacts to wetland functions was based on the assumption that the entire area within the containment structure footprint would lose all wetland functionality for the entire life of the project. The resulting FCU values represent the direct project impacts. Existing structures, roads, and open areas that occur within the impact area polygons were assumed to have the same functional capacity as the sampled areas, which has the effect of somewhat overestimating project impacts within the direct impact area.

Alternative 2

Direct impact areas in Alternative 2 have already been disturbed from previous construction activity. Impacts to unaltered forested wetlands will be limited to roads built to access construction sites. These areas will be allowed to revegetate after construction, thus impacts would be temporary.

Direct Impact Assessment Results

Permanent impacts to forested wetland functions occur with the FWOP and Alternative 1. Construction associated with Alternative 2 will occur on areas already altered by prior activity, thus no permanent direct impacts will occur that would require mitigation. All alternatives will have impacts associated with road construction to access sites. All roads will be allowed to revegetate, thus impacts will be temporary.

Future without Project Alternative

For the FWOP, losses of wetland functions for LGRB and Flat sites are due to anticipated construction activities necessary to prevent an uncontrolled cutoff from occurring. Table 2 depicts the changes in FCUs for each wetland function. All of the impacts are direct and total (all functions lost for all impacted acres). Because much of the existing forest in the impact area is not in a mature, fully functional condition, the FCUs lost are less than the total number of acres impacted, meaning that the FCI values for all functions were less than 1.0. Most of the impact is in the LGRB subclass, reflecting the small amount of acreage in the Flats class within the impact area, and the relatively poor condition of the impacted Flats forests.

Note that Table 2 indicates no gains or losses at all for Flats with regard to three functions – Floodwater Detention, Organic Carbon Export, and Removal of Elements and Compounds. That is because these functions all require flooding as drivers. Flats, by definition, are controlled primarily by precipitation.

Table 2. Changes in Functional Capacity Units for Riverine Backwater and Flats wetlands under the FWOP Alternative. *Data from Arkansas-White Cutoff Study*

FWOP ALTERNATIVE							
Riverine Change in FCU's	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	*Remove Elements and Compounds	Maintain Plant Communities	Provide Wildlife Habitat
Direct Impacts to Riverine Forests and Fallow Ag	-120	-115	-114	-116	-134	-121	-121
Flats Change in FCU's							
Direct Impacts to Flats Forests and Fallow Ag	0	-1	-1	0	0	-1	-1

***Functions from Klimas et.al. 2004**

Alternative 1

Twenty-five acres of direct, permanent impact will occur in the LGRB wetland subclass. Table 3 depicts the changes in FCUs for each wetland function. All of the impacts are direct and total (all functions lost for all impacted acres). Because much of the existing forest in the impact area is not in a mature, fully functional condition, the FCUs lost are less than the total number of acres impacted, meaning that the FCI values for all functions were less than 1.0.

Table 3. Changes in Functional Capacity Units for Riverine Backwater wetlands under Alternative 1.

ALTERNATIVE 1						
Riverine Change in FCU's	Detain Floodwater	Detain Precipitation	Cycle Nutrients	Export Organic Carbon	Maintain Plant Communities	Provide Wildlife Habitat
Direct Impacts to Riverine Forests	-1.6	**-4.00**	-1.7	-1.7	-3.1	-4.40

***Functions from Klimas et.al. 2011 ("Remove Elements and Compounds" removed)**

Alternative 2

Impacts to forested wetlands from implementation of Alternative 2 are restricted to previously disturbed areas, or are temporary in nature. As such, there is no permanent loss of wetland functions of undisturbed areas that would require mitigation.

Indirect Impact Assessment

No Action/Future without Project Alternative

The FWOP Alternative includes the continued maintenance, repair, and rehabilitation of existing structures. These actions will not change the hydrology in the study area. No indirect impacts will occur by implementation of the FWOP / No Action Alternative.

Action Alternatives

At the beginning of the study, the U.S. Fish and Wildlife Service (FWS), Arkansas Game and Fish Commission (AGFC), Arkansas Natural Heritage Commission (ANHC), and other agency representatives expressed concern that the closure of the Historic Cutoff in 1964 altered the hydrology in the southern part of the Dale Bumpers White River National Wildlife Refuge (DBWRNWR) by making it a wetter environment. The consensus among some environmental team members was that the forest composition in the area had responded to this change by shifting towards more flood tolerant species, and that any alternative considered should “move” the hydrology on the DBWRNWR towards a dryer condition (i.e. back to pre-1964 hydrology).

During the course of alternative development and hydraulic modeling, new information became available that contradicted earlier opinions that the lower DBWRNWR had become wetter. Edwards et.al. (2016) reported that the lower White River had experienced significant incision – up to 2 meters near its confluence with the Mississippi River. Hydraulic modeling indicated that geomorphic adjustments to this change likely reduced flooding by 58% during frequent floods (1- and 2-year flood events) in the incised, lowermost White River floodplain affected by backwater flooding from the Mississippi River. Data indicated that while forest growth has been impacted by the incision, there was limited evidence of incision impacts on forest structure. Data from King et.al. (2016) documented that, based on basal area, overcup oak (*Quercus lyrata*) and sugarberry (*Celtis laevigata*) are the dominant overstory species in the lower White River floodplain (including the Three Rivers Study Area). Core samples indicated that overcup oak has been the dominant species since the 1930’s, with sugarberry becoming co-dominant to dominant around the 1950’s. The increasing presence of American elm (*Ulmus americana*) and Nuttall oak (*Quercus texana*) in the 1940’s is perhaps another indicator of a drier ecosystem. Despite an apparent drier condition, overcup oak, water hickory, and sugarberry continue to provide the majority of regeneration in the Three Rivers Study Area. In summation, King et.al. (2016) stated that their data revealed no evidence indicating that the bottomland hardwood forest in the study area has responding to any past hydrologic or geomorphic changes, however it was noted that minor vegetation changes could not be ruled out.

Based on this new research, and after considerable discussion among the environmental team, it was decided that the best course of action would be to design alternatives that would have the least impact to the existing hydrology occurring on the DBWRNWR (i.e. no hydrologic change).

2-Dimensional HEC-RAS modeling

USACE H&H engineer’s utilized the 2-Dimensional Hydrologic Engineering Center – River Analysis System (2-D HEC-RAS) program to model existing hydrologic conditions in the study area, as well as in a much larger HEC-RAS analysis area. Hydrologic conditions associated with each alternative were also modeled to determine possible indirect impacts to forested wetlands in the study area. Detailed information on the 2-D HEC-RAS program can be found in the H&H Appendix.

Terrestrial habitat and bottomland hardwood health is directly related to the timing, duration, and location of flooding events. To assess potential indirect impacts to forested wetlands, flood frequency and flood duration were analyzed for each alternative.

<u>Flood Frequency Analysis – Three Rivers Study Area</u>

To assess changes in flood frequency, 2- and 5-year floodplain inundation maps were developed. Figures 5 and 6 display the 2- and 5-year flood zones for existing conditions, Alternative 1 (C157) and Alternative 2 (M135). HEC-RAS modeling of Alternative 1 included only the new containment structure at elevation 157’ (C157). Opening the HCS was added later in the planning process, and has yet to be modeled. However, based on other model outputs, flood frequency maps with a 500’ or 1,000’ opening in the HSC at elevation 145’ will map almost identically to existing conditions.

HEC-RAS modeling for Alternative 2 was only conducted for the HCS opening at elevation 135' (M135). Model runs to evaluate changes in velocities identified concerns of opening the HCS at lower elevations (115' and 125' MSL), thus they were dropped from consideration.

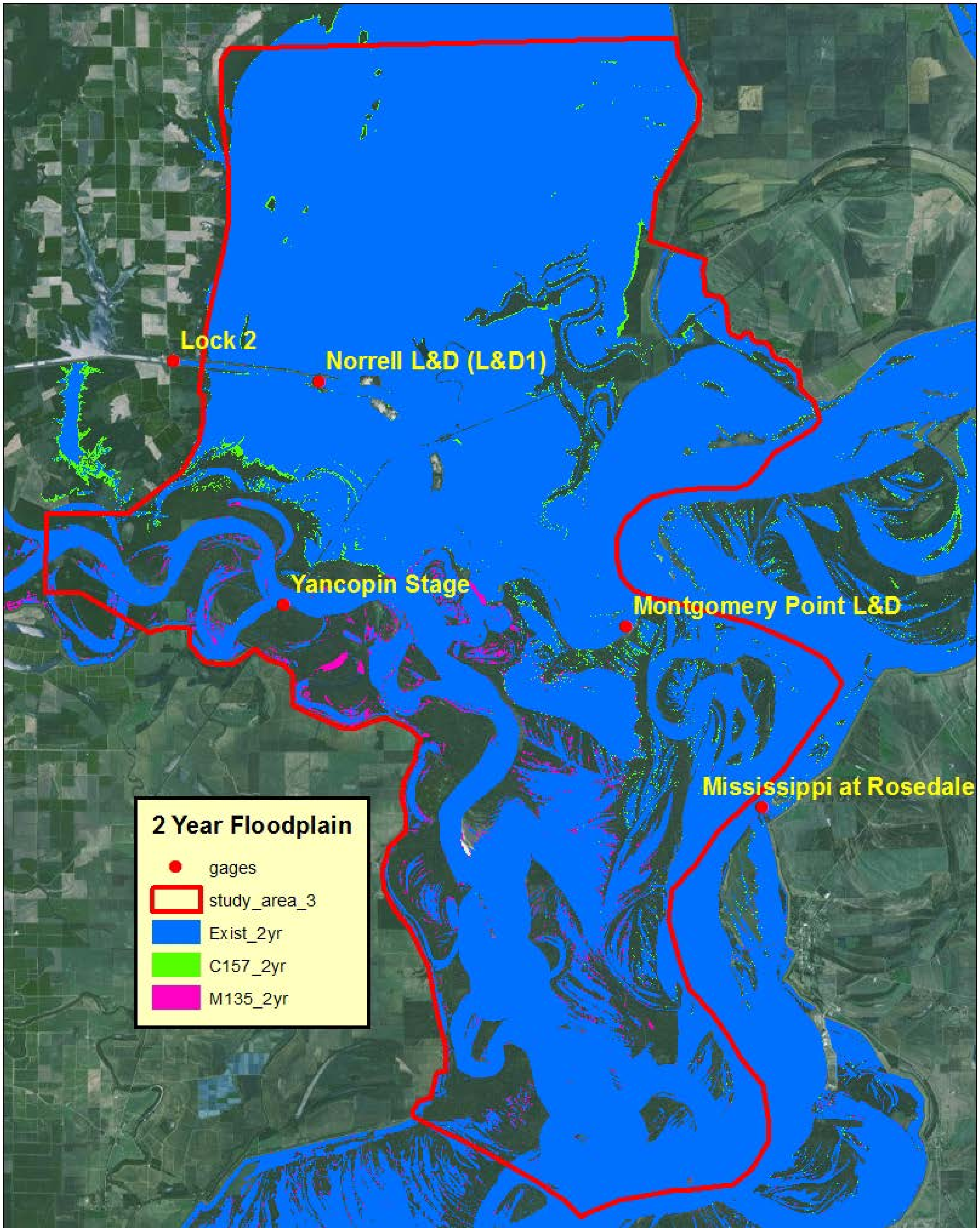

Figure 4: 2-Year Floodplain Map

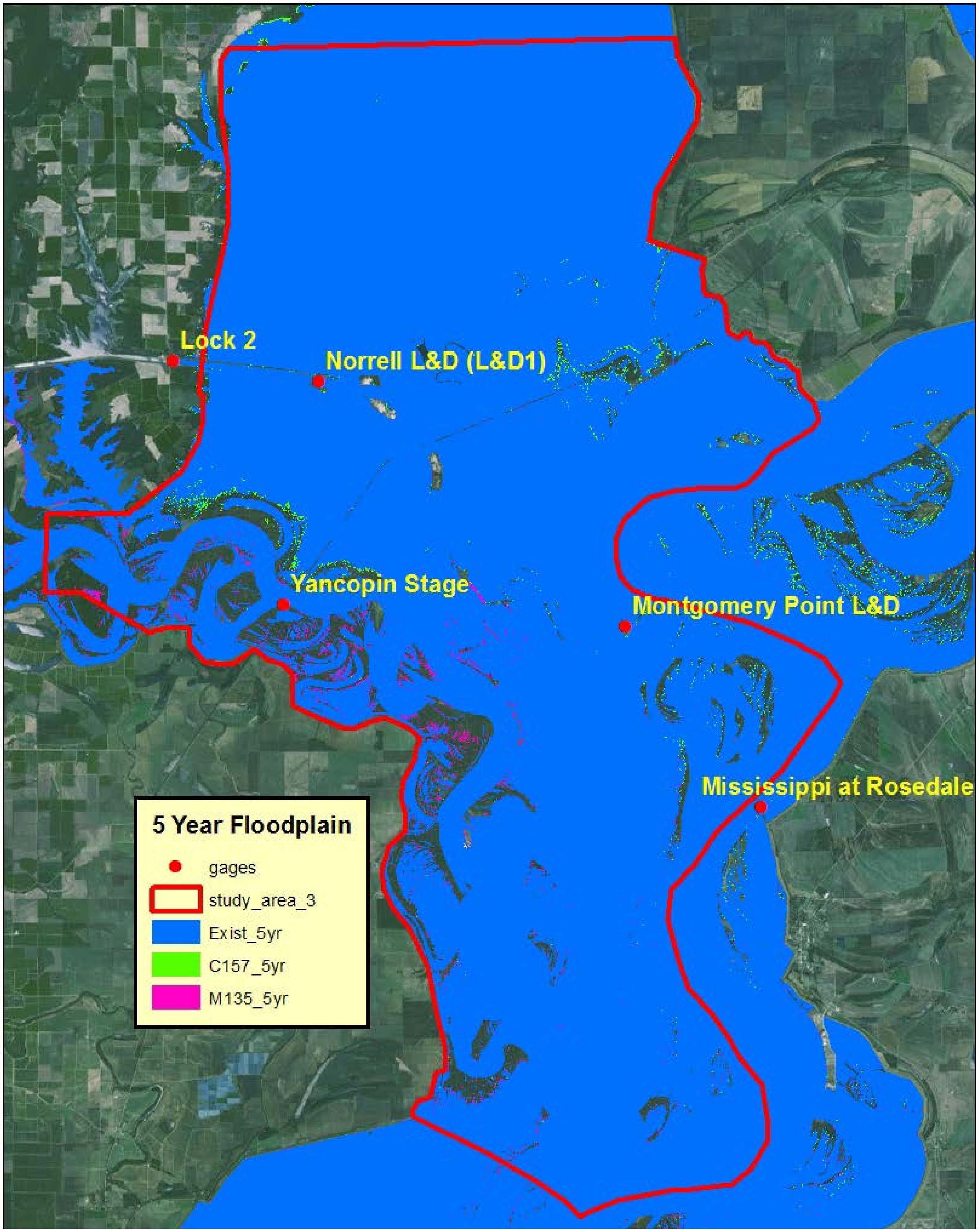

Figure 5: 5-Year Floodplain Map

As discussed previously, a fundamental criterion of wetland classification is that a wetland must be in the 5-year floodplain of a stream system to be included in the Riverine Class. The blue area depicted in Figure 5 highlights the 5-year floodplain, thus fits the Riverine classification. Following the Key to Wetland Subclasses and Community Types in the Delta Region of Arkansas (Klimas et.al. 2004, 2011), the majority of the Three Rivers Study Area is classified as

Low-Gradient Riverine Backwater (LGRB) wetland subclass. Klimas and Smith (2009) grouped sites that may have been Riverine Overbank or Depression subclasses in with LGRB for analysis purposes. The same was done for the Three Rivers HGM analysis. Smaller, uncolored sites (Figures 4 and 5) dispersed throughout the study area are located outside the five-year floodplain. Consistent with Klimas et.al. (2004, 2011), and the Ark-White Cutoff Study, these sites are classified as a Flats subclass.

Areas depicted in green and pink on Figures 4 and 5 represent sites that shift from a Flats subclass (outside 5-year floodplain) to a LGRB subclass (inside 5-year floodplain) from implementation of Alternatives 1 and 2, respectively. As visually depicted, there are only very minor changes in flood frequency from either alternative. Table 4 presents changes for the 5-year floodplain in study area, and for the entire 2D HEC-RAS analysis area, in spreadsheet format for better comparison.

Table 4: Flood Frequency Analysis

	Study Area			HEC-RAS 2D Area		
Alternative	5-year floodplain in Study Area	Difference in 5-year floodplain in Study Area (Existing Condition)	Study Area 5-year floodplain Percent change	5-year floodplain in RAS 2D area	Difference in 5 year floodplain in RAS 2D Area (Existing Condition)	RAS 2D Area 5 year floodplain Percent change
	Acres	Acres	%	Acres	Acres	%
Existing 5-year floodplain	**127,090**	**0**	**0.0%**	**527,779**	**0**	**0.0%**
C157HC145_500ft_5yr	**126,910**	**180**	**0.1%**	**527,760**	**19**	**0.0%**
C157HC145_1000ft_5yr	**126,989**	**102**	**0.1%**	**527,722**	**57**	**0.0%**
M135	**122,268**	**4,822**	**3.8%**	**504,864**	**22,915**	**4.3%**

C157HC145_500ft_5yr: Containment Structure Elevation 157 feet, Historic Cutoff Structure opened 500 feet at elevation 145 – Alternative 1 variation

C157HC145_1000ft_5yr: Containment Structure Elevation 157 feet, Historic Cutoff Structure opened 1,000 feet at elevation 145 – Alternative 1 variation

M135: Multiple openings at Elevation 135 feet – Alternative 2

Implementation of Alternative 1 with either opening width in the HSC will result in approximately 0.1% of existing Flats subclass acres (180 acres @ 500ft; 102 acres @ 1,000ft) becoming wet enough to move into a Riverine Backwater subclass. For Alternative 2, 3.8% of existing Flats subclass acres (4,822 acres) would become wet enough to shift to a Riverine Backwater subclass. Based on these model results, the 2- and 5- year floodplains remain essentially the same across the alternatives. Minor acreage differences reported are likely unmeasurable in the field, and could be an artifact of the 10-meter digital elevation model (DEM) data used in the analysis.

Flood Duration Analysis – Three Rivers Study Area

To assess changes in flood duration, percent time inundated grids for the growing season, defined as starting on 15 March and ending on 15 November, for the period of record (2000-2014), were produced for each alternative and compared to existing conditions. Growing season flood duration refers to the maximum number of days in the growing season that overbank or backwater flooding from a stream inundates a particular area (in this case, the Three Rivers Study Area).

To identify areas that might be impacted by each alternative, U.S. Fish and Wildlife Service (FWS), Arkansas Game and Fish Commission (AGFC), and Arkansas Natural Heritage Commission (ANHC) team members requested the percent time inundated grids be changed into grids that identify areas that would experience an average of seven days or more inundation and seven days or less of inundation during the growing season for each alternative. Results of this analysis indicate less than one percent of the Three Rivers Study Area would experience a change in flood duration of seven days or more, during the growing season, by implementation of Alternative 1 (study area = 132,665 acres) (Table 5). The net change in acres becoming slightly wetter or dryer is even less. For Alternative 1 scenario with a 1,000ft opening in the HCS, 0.65% of the entire study area (~860 acres) would be slightly dryer, while 0.63% (~835 acres) would be slightly wetter. Alternative 2 would result in approximately 7% (~9,600 acres) of the study area becoming slightly dryer, while almost 4.5% (~5,900 acres) would become slightly wetter. Maps identifying the locations of these changes are located in Appendix B of the H&H Appendix.

It is important to note that the seven days or more change (wetter or dryer) is for the entire 245-day growing season, not consecutive days of change. These changes represent only a few hours to perhaps a day of variation in each flood event occurring during the growing season. Klimas et.al. (2011) presented "zone changes" as a measure of change for HGM analysis, where a single zone change corresponded to approximately one week additional or reduced **continuous** flooding during the growing season. Any change in flood duration of less than a consecutive week (i.e. 7 days) would not be detectible using HGM.

Table 5: Percent Change in Growing Season Flood Duration – Three Rivers Study Area

Alternative	% change in Flood Duration across Study Area = -7 days or more	% change in Flood Duration across Study Area = No Change	% change in Flood Duration across Study Area = + 7 days or more
Alternative 1 – C157	0.81 (1074 acres)	98.83	0.35
Alternative 1 – C157HC145_500 ft.	0.71 (941 acres)	98.65	0.64
Alternative 1 – C157HC145_1000 ft.	0.65 (862 acres)	98.72	0.63
Alternative 2 – M135	7.26 (9,631 acres)	88.26	4.48

Flood Duration Analysis – Dale Bumpers White River National Wildlife Refuge

For purposes of determining compatibility with refuge functions, H&H engineers modeled growing season flood duration on the DBWRNWR. The FWS provided shapefiles of land forms (Saucier classifications), microsite (flat, ridge, natural levee), and elevation (Figure 6). Flood duration changes caused by alternative 1 (C157-E – Table 6) resulted in no more than a one day average annual increase in flood duration from existing conditions (EXIST). The addition of either opening width in the HCS (C157HC145-500ft, C157HC145-1000ft) results in no changes to the growing season flood duration.

The 2-D HEC-RAS model results for Alternative 2 (multiple openings) is presented for three scenarios (M115-E, M125-E, and M135-E), where the number corresponds to an elevation at which the HCS would be opened and lowered (from an existing elevation ~170' MSL).

Alternative 2 does shift forested wetlands in the DBWRNWR toward a drier hydrology, but not for a significant duration (seven consecutive days). PVL2 Flats above 147.5ft would have an average annual decrease of eight days of growing season flood duration. This change represents only a few hours to perhaps a day of variation in each flood event occurring during the growing season.

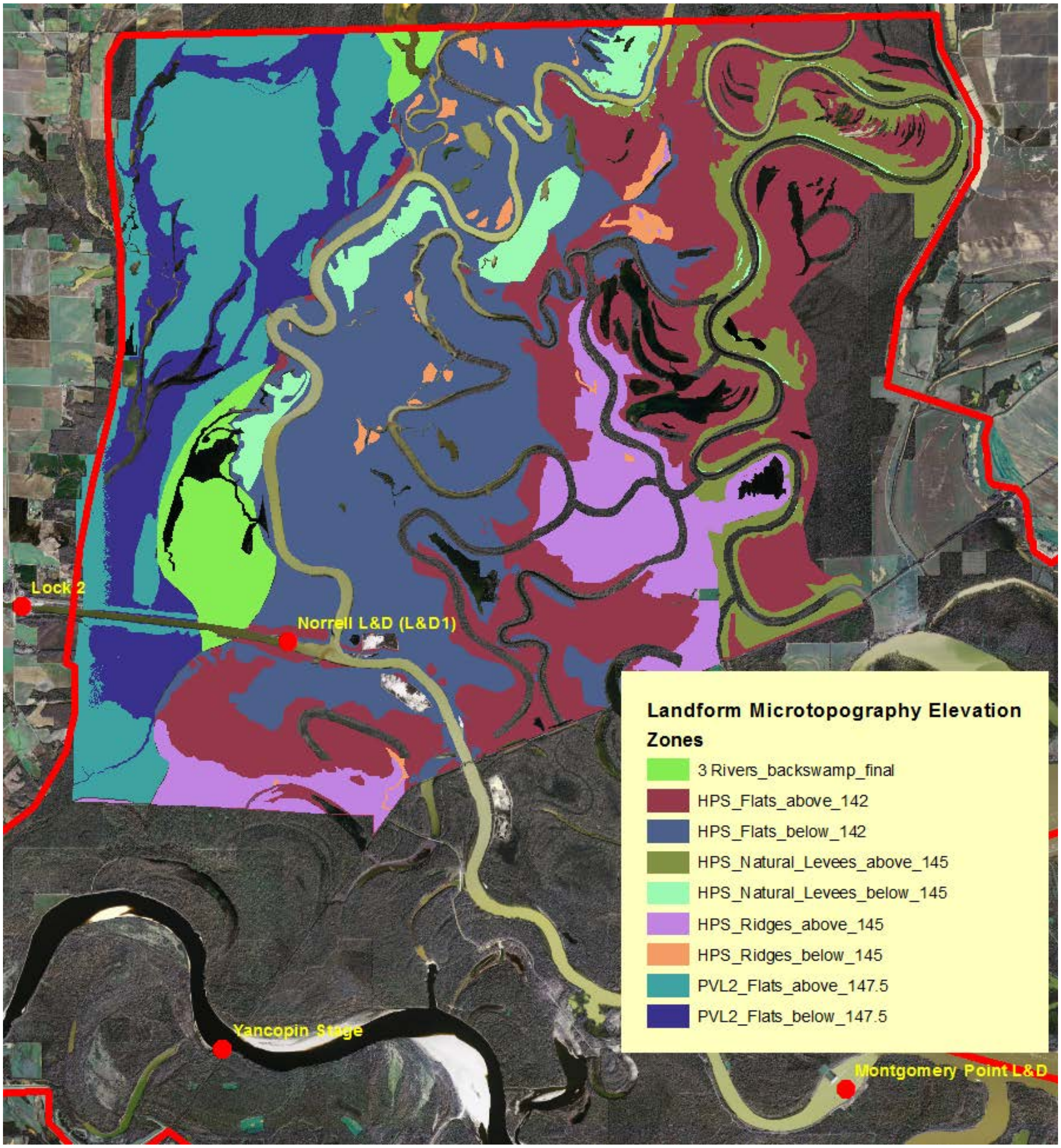

Figure 6: DBWRNWR Landform Microsite Elevation Zones

Table 6: Change in Seasonal Inundation based on Refuge Landform, Microsite, and Elevation

Growing Season (15 March - 15 November, 245 days) Average Annual Days Inundated (Period of Record 2000-2014)							
	ANNUAL AVERAGE DAYS INUNDATED	AVERAGE ANNUAL DAYS DIFFERENT FROM EXISTING (-) Drier (+) Wetter					
		Alternative 1			Alternative 2		
Landform, Microsite based on Elevation	EXISTING	C157	C157HC145 500ft	C157HC145 1000ft	M115	M125	M135
PVL2 Flats below 147.5 feet	50	0	0	0	-4	-4	-4
PVL2 Flats above 147.5 feet	13	1	0	0	-8	-8	-8
HPS Ridges below 145 feet	42	0	0	0	-2	-2	-2
HPS Ridges above 145 feet	20	1	0	0	-4	-4	-4
HPS Natural Levees below 145 feet	55	0	0	0	0	0	0
HPS Natural Levees above 145 feet	13	1	0	0	-7	-7	-7
HPS Flats below 142 feet	66	0	0	0	0	0	0
HPS Flats above 142 feet	43	0	0	0	-3	-3	-3
Three Rivers back swamp final	73	0	0	0	0	0	-1

NOTE: Data represents 15-year average annual increase/decrease in days inundated - NOT consecutive days.

C157: Containment Structure at Elevation 157 feet – Alternative 1 variation

C157HC145 500ft: Containment Structure Elevation 157 feet, Historic Cutoff Structure opened 500 feet at elevation 145 – Alternative 1 variation

C157HC145 1000ft: Containment Structure Elevation 157 feet, Historic Cutoff Structure opened 1,000 feet at elevation 145 – Alternative 1 variation

M115: Multiple openings at Elevation 115 feet – Alternative 2 variation

M125: Multiple openings at Elevation 125 feet – Alternative 2 variation

M135: Multiple openings at Elevation 135 feet – Alternative 2 variation

Under Alternative 2, lower areas near the main channel of the White River would experience an increase of more than two weeks of flooding due to the Arkansas River having more influence on the White River, especially at lower elevations. However, these areas are already inundated much of the year and are predominantly open water. Some oxbow lakes several miles away from the main stem of the White River would receive up to 40 days less inundation (connection to the river). These 15-year average increase and decrease in days inundated are not consecutive days. They reflect a couple of days on the rising and lowering limbs of multiple flood hydrographs throughout a growing season.

Indirect Impact Assessment Summary

2-D HEC-RAS modeling of flood frequency and growing season flood duration determined that none of the alternatives being considered would have a significant impact to forested wetlands in the Three Rivers Study Area. Changes in flood frequency are extremely minor, and could well be the result of model "noise" (e.g. 10 meter DEM data utilized). Changes in growing season flood duration are equally minor as well. Neither alternative results in a duration change of seven consecutive days, which is the threshold used by the HGM methodology.

Based on extensive modeling, the environmental team determined that implementation of any of the three alternatives (FWOP, alternatives 1 & 2) would not result in any measurable indirect impacts to forested wetlands in the Three Rivers Study Area.

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