

APPENDIX G
HABITAT EVALUATION & QUANTIFICATION

*Feasibility Report with Integrated Environmental Assessment
Rip Rap Landing HREP*

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RIP RAP LANDING HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX G HABITAT EVALUATION AND QUANTIFICATION

1. INTRODUCTION

This appendix provides documentation of the habitat evaluation and quantification process that was conducted to evaluate the potential benefits of various habitat improvement features for Rip Rap Landing. Active participants included biologists from the St. Louis District of the Corps of Engineers; the U.S. Fish and Wildlife Service, Southern Illinois Ecological Service Office; the Illinois Department of Natural Resources; and HDR, Inc., the contractor assisting with preparation of the Feasibility Report with Integrated Environmental Assessment.

Table G-1. The team that participated in the Habitat Benefits Evaluation for the Rip Rap Landing Habitat Rehabilitation and Enhancement Project.

Team Member	Discipline	Affiliation
Elmer "Butch" Atwood	Fishery Biologist	Illinois Department of Natural Resources
Jon Handel	Wildlife Biologist	Illinois Department of Natural Resources
Kim Postlewait	Site Superintendent	Illinois Department of Natural Resources
Neal Booth	Former Site Superintendent	HDR, Inc.
T. Miller	Fish and Wildlife Biologist	HDR, Inc.
Joe Bartletti	Environmental Scientist	HDR, Inc.
Charley Hanneken	Ecologist	Corps of Engineers
Brandon Schneider	Biologist	Corps of Engineers
Matt Mangan	Fishery Biologist	U S Fish and Wildlife Service

Quantification is needed in the project planning process to evaluate benefits of project features because traditional benefit/cost evaluation is not applicable. To determine environmental restoration project benefits, models have been developed to quantify habitat benefits of project features for selected species.

We used both wildlife and fisheries based models to evaluate the effects of project features on habitat at Rip Rap Landing. For wildlife, we used the Wildlife Habitat Appraisal Guide (WHAG) developed by the Missouri Department of Conservation and the U.S. Department of Agriculture, Soil Conservation Service (now NRCS) (MDC and NRCS 1990). The WHAG was adapted from the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (USFWS 1976). WHAG is widely accepted by local agencies, and it has become the primary terrestrial habitat evaluation method used in the St. Louis District.

The aquatic model that has gained the most acceptance within the St. Louis District and along the entire Upper Mississippi River is the Aquatic Habitat Appraisal Guide (AHAG) (Killgore &

Hardy 1992; Mathias et al. 1996). It was developed by the Corps of Engineers Waterways Experiment Station (WES) and the Rock Island District Corps of Engineers (Killgore & Hardy 1992; Mathias et al. 1996). The layout and methods to use the AHAG follow the format of the Wildlife Habitat Appraisal Guide (WHAG; MDC and USDA 1990).

The WHAG and AHAG models for Rip Rap Landing were endorsed by the ECO-PCX. After evaluation of the models, methods, and assumptions, the Rip Rap Landing WHAG and AHAG were approved for single use by the headquarters model certification team on November 5 2013.

2. HABITAT EVALUATION METHODOLOGY

The WHAG and AHAG are numerical models that evaluate the quality and quantity of particular habitats for species selected by team members (Table 1). The qualitative component of the analysis is known as the habitat suitability index (HSI) and is rated on a 0 (AHAG) and 0.1 (WHAG) to 1.0 scale, with higher values indicating better habitat. The evaluation team determines the HSI for a particular habitat type by answering questions that establish values for various biotic and abiotic conditions under present and future conditions. Future conditions are determined using management plans and best professional judgment. The quantitative component is the number of acres of the habitat being evaluated. From the calculated qualitative and quantitative values, the standard unit of measure, the habitat unit (HU) is calculated using the formula ($HSI \times Acres = HUs$). Habitat units are calculated for specific target years to forecast changes in habitat values over the life of the project for with-project and without-project conditions and are then annualized to yield the Average Annual Habitat Unit (AAHU). Target years are set to capture the change in habitat that occurs with habitat maturation and changes caused by constructed features. The benefits of each proposed project feature are then determined by subtracting with-project benefits from without-project benefits, expressed as net AAHUs. The effects of various habitat improvement feature combinations (alternatives) can then be evaluated by comparing the net AAHUs and costs for each alternative considered.

In preparation for using the WHAG and AHAG models, the evaluation team conducted a site visit and took part in a Value Engineering Study that included a Hydrogeomorphic-Based Workshop. They also reviewed aerial photography, topographic maps, and preliminary design drawings. During the field evaluation, assumptions were developed regarding existing conditions and projected post-project conditions relative to limiting factors, habitat changes over time and management practices.

For the purpose of planning, design, and impact analysis, period of analysis was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions), 1, 5, 25, and 50 years. HSIs and average annual habitat units (AAHUs) for each evaluation species were calculated at each of these target years.

It was assumed by the evaluation team that the project with all of the potential features would generate the most habitat units. The team then used best professional judgment to determine at what percentage each individual feature would contribute to the total number of habitat units. This was done prior to calculating the habitat units so that the team was not biased in their decision. The total of the percentages for all the potential project features had to equal 100%.

This approach allowed the team to utilize one spreadsheet for each habitat type. Developing multiple spreadsheets for each habitat type and each feature would have quickly become cumbersome and would have resulted in hundreds of spreadsheets. The St. Louis District has previously used this approach on other EMP-HREP sites such as the approved and completed Swan Lake and Batchtown HREPS.

3. EVALUATION SPECIES SELECTION

To begin the habitat evaluation process, the team reviewed the species that can be evaluated under each model. They selected two fish species and two wildlife species. Each species was chosen by the team because it represents a guild of species that is unique from other species within the model. Also, these species were used in the habitat analysis because the site is managed for these species and because they utilize habitat that will be restored by the project.

Table D-2. Aquatic and wildlife evaluation species selected for analysis.

Species Evaluated	Scientific Name	Family	Habitat Type
Aquatic (AHAG)			
Smallmouth Buffalo	<i>Ictiobus bubalus</i>	Catostomidae	Lentic
Bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	Lentic
Terrestrial (WHAG)			
Mallard	<i>Anas platyrhynchos</i>	Anatidae	Non-forested Wetland, Cropland to Bottomland Forest, Bottomland Forest
Northern Parula	<i>Parula americana</i>	Emberizidae	Bottomland Forest

AHAG species chosen were the smallmouth buffalo and the bluegill. The smallmouth buffalo is in the family Catostomidae and is an important commercial fish in the Mississippi River drainage. This riverine species occurs in deep, flowing water, but also frequents sloughs, oxbow lakes and other backwaters for resting, spawning, and rearing. They feed on organisms in the substrate of large rivers and backwater lakes. Bluegill are in the family Centrarchidae and are abundant in the Mississippi River system. They are popular panfish and prefer backwaters of rivers where they feed on zooplankton, aquatic and terrestrial insects, and some plant materials. (AHAG Default Matrix, 1996)

WHAG species chosen were the mallard and the northern parula. The mallard is a migratory wildlife species that utilize early successional non-forested wetland habitats and forage in bottomland forest and cropland. Mallards are an important game species and the focus of much of the site management efforts. The Northern parula is a Neotropical migratory songbird that seems to prefer riparian vegetation, especially large tracts of mature bottomland forest, where they often nest in flood-deposited debris caught in the branches of trees overhanging water. It is considered a species of concern by the U.S. Fish and Wildlife Service. (Moldenhauer and Regelski, 1996).

4. SITE SPECIFIC ASSUMPTIONS AND METHODOLOGY

During the second step of the evaluation process, the team determined what habitats would be affected by the project features and locations in the project area to evaluate these changes. The project area was divided into five zones, each having a feature unique to that zone. The following WHAG spreadsheets were used: Zone 1, non-forested wetlands, and bottomland hardwood wetlands; Zone 2-5, non-forested wetlands and bottomland hardwood wetlands. There were fourteen evaluation locations, one in the center of each habitat type in each zone.

For the AHAG, the 1996 AHAG was used to evaluate aquatic areas in Roadside Lake and various sections of Sny Creek and Roadside Lake proposed for dredging. The 1996 AHAG was selected because it was thought to provide a better analysis of the aquatic habitats in the project area, all of which are currently and proposed to remain connected to the Mississippi River.

Final calculations included determining the acreage of non-forested, cropland, bottomland hardwood, and aquatic habitats using topographical data, management plans, land coverage data files, and aerial photography. Finally, the habitat units for each measure were determined by the habitat units generated for each species. Single species were used for WHAG and AHAG features, while WHAG and AHAG AAHUs were summed if both were affected by a particular feature.

Table D-3. Table of feasible project features analyzed in the incremental cost analysis (ICA)

Feature Code	Description	Purpose
Zone 1 – Sny Island Drainage and Levee District		
1A	Water Control Structure	Water level control
1B	2,500 gpm Well	Maintain water levels
1C	Tree planting – 62.9 acres	Convert cropland to bottomland forest
1D	Channel to Goose Pasture Lake	Water Control to Goose Pasture Lake
Zone 2 – State Natural Area		
2B	Tree Planting – 34.8 acres	Convert cropland to bottomland forest
Zone 3 – Roadside Lake and Waverly Lake Wetland Management Areas		
3A	Channel to Waverly Lake	Water Control to Waverly Lake
3B	Water Control in Pump Station Channel	
3C	WCS in North Units	
3D	Sny Creek Excavation from Sny Levee to Bridge	Water conveyance
3E	43% of Pump Station	Water conveyance
3F	43% Pump Channel Widening	
3G	43% Pump Station Pipe and Concrete for Road	
3H	WCS Pipes Under Sand Levee	Water control
3I	Tree planting – 36.5 acres	Convert cropland to bottomland forest
3J	Roadside Lake Channel from Sny Creek	Deepen connection from Sny Creek to Roadside Lake

Feature Code	Description	Purpose
3K	Portable pump and water control structure for Roadside Lake	Water control at Roadside Lake
Zone 4 – Rust Land Company - WRP		
4A	Sny Creek Excavation Bridge-Old Levee End	Reconnection to Mississippi River
4B1	Sny Creek Excavation Old Levee to Roadside Lake Channel	Reconnection to Mississippi River
4B2	Sny Creek Excavation Roadside to Dog Island	Reconnection to Mississippi River
4C2	River Ridge Scour Embankments	Reduce scouring flows into wetlands
4D	South Spillway	Water control
4E	WCS South Spillway	Water control
4G	57% of Pump Station	Increased water conveyance
4H	57% Pump Channel Widening	
4I	57% Pump Station Pipe and Concrete for Road	
4J	WCS Pipes Under Road	Water control
4K	Tree planting 220 acres	Convert cropland to bottomland forest
Zone 5 – Dog Island		
5B	Sny Creek Excavation @ Dog Island	Reconnection to Mississippi River

General Assumptions and Habitat Characteristics

1. It was assumed that target years of 0 (baseline condition), 1, 5, 25, and 50 (future without and future with project conditions) are sufficient to analyze HUs and characterize habitat changes over the estimated period of analysis.
2. Two floods have breached the sand levee extension from the Sny Levee in the last 50 years: 1993, 2005. It was assumed that at least two more floods will breach the levee over the period of analysis, the next 50 years, resulting in some amount of sediment accumulation in and around Waverly Lake and upper Sny Creek.
3. The duration, elevation, and severity of Mississippi River floods have increased with floodplain development and changes in agriculture. Navigation pool formation has increased sedimentation within the pools and side channels. We expect that this will not change in the next 50 years but flood event impacts to the project area from overbank scouring are expected to be less severe as the natural levee along the river increases in elevation and riverfront forest becomes better established.
4. After the flood of 1993, tree mortality was severe in the old growth bottomland hardwood forested natural area in Zone 2. Most of the oaks and some pecans have died in the period after the flood, likely due to stress from the flood height, duration and a later flood event in 1995. The area has been resurveyed recently, and still retains enough of the old growth forest component to justify the natural area designation.

5. Scouring, overbank flows from the river as flood waters rise have damaged some of the structures installed to enhance wetlands as part of the WRP easement acquired by NRCS. They also have provided funding for establishment of approximately 190 acres of wet prairie in 2010. Without the project, the continued existence of the prairie after establishment is unknown. With or without the project, some of the prairie area established may revert to bottomland forest and/or wet meadow, depending upon the hydrology and management at some of the prairie sites.
6. Without the project, IDNR will continue to manage the project area as in the past except for the WRP lands in Zone 4 that have the NRCS easement in place, and thus have restrictions on the type of management actions that can occur.
7. Without the project, IDNR will not have adequate water management capabilities for the entire site. Without additional water management capability, moist soil and other wetland vegetation will be heavily degraded by year 25. Sedimentation and scour will further damage existing wetlands. Additionally, inability to manage water levels across the entire site may favor establishment of invasive reed canary grass resulting in a monoculture that has little benefit for wildlife, especially migratory birds.
8. Without the project, the former cropland in Zone 4 will continue to be dominated by herbaceous vegetation, inhibiting the natural conversion of those acres to bottomland forest, except along the riverfront. Cropland in the other zones would continue to be farmed providing little benefit to migratory birds. With project, the conversion to bottomland forest in Zone 4 will be a management objective requiring the chemical or mechanical manipulation of the herbaceous vegetation to favor natural bottomland forest establishment. Other cropland acres in Zones 1, 2 and 3 would be converted to bottomland forest through the use of containerized or other planting stocks of trees, thus allowing the forest canopy to close in those areas over time.
9. Under with-project conditions water control and movement would be enhanced and operated at a higher level of effectiveness throughout the 50-year planning period.
10. We assumed that operation of Rip Rap Landing Fish and Wildlife Area would continue with the current management objectives and plans for at least the life of the HREP.
11. Without the project, fish use of the backwaters and Sny Creek will continue to be restricted in many years by the lack of access for spawning, rearing and overwintering.

Site Specific Assumptions and Methodology

a. Zone 1.

This zone is within and protected by the Sny Island Drainage and Levee District levee, a 100-year levee that has only failed once (1993) in the past 50 years. The water level in this zone is also influenced by pumping from the Sny Island Drainage and Levee District, resulting in drier conditions than are desired in the remaining native habitats. The area in Zone 1 is comprised of wet marsh, cropland and regenerating and maturing bottomland forest. Without the project, the

area is likely to be managed as at present, given the influence of dewatering as a result of Sny D&LD pumping. With or without project there are no fish habitat units generated for this zone, consequently there was no AHAG evaluation.

WHAG Evaluation – The four features proposed for this zone will allow the area to be managed more intensively for migratory wildlife and other migratory birds. We evaluated the habitat benefits using the non-forested wetland matrix for the marsh/wetland acres (Goose Pasture Lake), and the bottomland hardwood matrix for the existing forest and the cropland proposed for conversion to bottomland forest. The addition of three features to facilitate water level management greatly enhance the habitat benefits for migratory wildlife, consequently the mallard was used as the indicator species and is the management focus for the site. The water control structure in the Sny D&LD channel will prevent the area from being drained by pumping except as is required for water management to maintain water levels in Goose Pasture Lake and facilitate the growth of submersed aquatic vegetation and moist soil plants, emergent and herbaceous vegetation, and/or to dewater the bottomland forested areas as required in the annual cycle. The pump station will allow most of the zone to be flooded during the fall and winter as needed, facilitated by the channel to Goose Pasture Lake to maintain water levels during the summer, if required. The cropland acres will be planted to bottomland hardwood species such as pin oak, overcup oak, swamp white oak, pecan, green ash, hawthorn, and persimmon using containerized trees, bare root stock and transplanted stock from within the zone. Over time the reforested area canopy will close benefitting prothonotary warblers which prefer to nest near or over water and the northern parula which prefers unbroken tracts of bottomland forest.

b. Zone 2.

The zone is outside the Sny D&LD and subject to flooding from the Mississippi River. It is also designated as a State Natural Area due to the presence of high quality bottomland forest that is within the zone. The high quality forest was severely impacted by the flood of 1993 causing mortality of some of the trees, likely due to stress. A more recent assessment of the area has been conducted and determined that it remains of high enough quality to retain the natural area designation. The only features proposed for the zone include reforestation of the existing cropland. A feature was originally proposed to establish a riverside levee at elevation 450 msl, but the construction cost could not be justified by the benefits and the levee feature was dropped from consideration. No fisheries benefits are generated within the zone, consequently no AHAG evaluation was conducted.

WHAG Evaluation – We evaluated benefits in the zone using the bottomland hardwood forest matrix for the existing forest and the cropland proposed for conversion to bottomland forest. We used the non-forested wetland matrix to evaluate the slough that runs through the zone and connects with Zones 3 and 4. The slough is impacted by features proposed for zone 3 since it is an integral part of water movement to Waverly Lake and associated wetlands. The impact results from pumping water through the slough, which provides a water source for an area that likely goes nearly dry in late summer and fall. Although the habitat benefits from pumping accrue in Zone 2, the habitat units are added to the water control feature within Zone 3 since that is the structure responsible for maintaining the higher water level. The water control structure is located in the pump channel that traverses the south edge of the zone. The mallard was used as the indicator species. The northern parula was the indicator species chosen for the forested

portion of the zone because that species benefited most from the continued aging of the existing forest and the conversion of cropland to bottomland forest. Conversion of the cropland to bottomland forest generated sufficient habitat units over the life of the project to make it a viable feature, though the aging of the existing forest did not generate enough habitat units with the addition of a levee to 450 to justify the construction cost. The cropland acres would be reforested with a variety of bottomland species, utilizing containerized and bare root stock. Some of the zone may be allowed to reforest naturally. The forest canopy will ultimately close over the life of the project making Zone 2 nearly a solid block of bottomland forest. The forested riverfront natural levee is accreting and will result in fewer scouring overbank flows in the future. These features were removed from final analysis because they were determined to not be a Federal responsibility

c. Zone 3.

This zone encompasses both the Waverly Lake and Roadside Lake Wetland Management Areas. The zone includes nonforested wetlands, bottomland forest and cropland, along with a portion of Sny Creek.

WHAG Evaluation – We chose to evaluate features in the zone using the bottomland hardwood and nonforested wetlands spreadsheets. The mallard was used as the indicator species for the nonforested wetlands, while the northern parula was used for the forested and cropland conversion areas. Two features were proposed for Roadside Lake, a fish-friendly water control structure to provide control of the water level in the lake and a portable pump to allow drawdowns of the lake to solidify bottom material every five to seven years and facilitate the growth of submersed aquatic vegetation. Based upon the habitat units generated these two features were justified. The conversion of cropland to bottomland hardwoods was also justified and the cropland areas will be planted to hardwood species similar to Zone 1, with containerized or bare root stock. Waverly Lake and the associated wetlands are currently managed for migratory wildlife, but the existing pump and channel are inadequate to fill the wetland areas in some years. We assumed this zone would be overrun with non-desirable vegetation without the project. The with project condition would replace the pump, increase the size of the pump channel and provide new water control structures all with sufficient capacity to provide water to Zones 3 and 4. Based upon the amount of water needed in each zone, the project features costs were split 43 percent to Waverly Lake and associated wetlands, and 57 percent to wetlands in Zone 4.

AHAG Evaluation – The AHAG matrix was used to evaluate fish benefits in Sny Creek from Waverly Lake downstream to the entrance to Roadside Lake. One species was used representing the lentic-large fishes guild, smallmouth buffalo a common Mississippi River species frequents backwaters, bottomland lakes and sloughs. The lentic-large fish guild was selected because the fishes represented in this guild were thought to benefit the most from the proposed project. Without project conditions will have little benefit for spawning, rearing, or overwintering of fish due to the lack of access from the river caused by shallow water. We assumed that no fisheries benefits would accrue without a deeper water connection to the river. Excavating upper Sny Creek down to Roadside Lake could not be justified based upon the small number of habitat units generated compared to the high cost, there simply wasn't enough acres affected. Roadside Lake was also evaluated along with the remainder of Sny Creek, downstream to the confluence

with the Mississippi River. The dredge cut to the lake from Sny Creek, coupled with excavation down to the river confluence at Dog Island was justified because it provided a year round river connection for spawning, rearing and overwintering within Sny Creek and allowing fish access to Roadside Lake. The Sny Creek excavation to Dog Island is actually in Zone 4, while the excavation along Dog Island is in Zone 5. We assumed placement of excavated material along Sny Creek to strengthen the Sny levee extension down to Dog Island. Thalweg disposal of the excavated material was assumed for the excavation along Dog Island.

d. Zone 4.

Zone 4 encompasses all of the Rust Land Company property, on which NRCS holds a WRP easement and has developed some of the wetlands. Mississippi River overbank, scouring flows have damaged some of the water control structures, especially the one located at the lower end of the slough that traverses Zones 2 and 4. Included in the NRCS management plan for the property is the establishment of approximately 190 acres of prairie in conjunction with the wetlands and below approximate elevation 440. The balance of the zone would be reforested. Without project, management capabilities in the zone are limited because of a lack of water during much of the year. The area previously cropped is covered by herbaceous vegetation and very little bottomland forest regeneration is occurring. Areas adjacent to the existing wetlands are being invaded by willow and soft maple.

AHAG Evaluation – The portion of Sny Creek that is in Zone 4 was discussed with features in Zone 3. No other fisheries benefits will be generated by the features in proposed for the zone.

WHAG Evaluation – With project, wetlands in the zone were evaluated using the nonforested wetland matrix and included the area proposed for the establishment of prairie and wet prairie. The remaining forested area and the remaining cropland proposed for reforestation was evaluated using the bottomland hardwood matrix. The mallard was used the indicator species for the wetlands and the northern parula for the bottomland forest and the cropland area proposed for reforestation. The riverside levee was not justified based upon the construction cost and the small amount of habitat units generated by that feature. The slough that begins in Zone 2, is utilized as part of the water conveyance for Zone 3, and traverses nearly all of Zone 4 down almost to Dog Island, and its associated wetlands provides another opportunity for managed wetlands. The pump channel from the riverside pump station crosses the slough north of and adjacent to the Rip Rap Landing road. Water control structures at the road will enable the entire slough and wetlands in Zone 4 to be managed for moist soil plants. Fifty-seven percent of the cost of construction of the pump station and pump channel are allocated to the zone based upon the amount of water required. Chemical or mechanical manipulation of the herbaceous vegetation on the cropland will be required to facilitate regeneration of bottomland forest on most of the area. Bottomland forest was evaluated for this zone, but was not included in the final incremental cost analysis because it was determined that this feature was a responsibility of the NRCS as dictated by the existing WRP easement. Over time, fewer scouring river events will occur in the zone and the bottomland forest canopy will close providing a large unbroken tract of bottomland forest favored by the Northern parula.

e. **Zone 5.**

This zone encompasses all of Dog Island and is general plan lands owned by the Corps of Engineers and managed by IDNR. The entire zone is forested except for internal sloughs and the side of the island bounded by Sny Creek. Without project the bottomland forest will continue to age, the sloughs will become shallower due to siltation and the lack of water depth in Sny Creek will inhibit use of the upstream lake and wetlands by fish.

AHAG Evaluation – The portion of Sny Creek adjacent to Dog Island proposed for dredging was evaluated as part of the fisheries benefits including Sny Creek in Zone 4, and Roadside Lake and the dredge cut into the lake in Zone 3.

WHAG Bottomland Hardwood Evaluation – The bottomland forest on the island was evaluated using the bottomland forest matrix, and showed an increase in habitat benefits as the forest aged over the life of the project. However, no additional benefits accrued because no project features are proposed for the forested area of the island.

WHAG Nonforested Wetland Evaluation – Sloughs and rudimentary side channels traverse Dog Island in several locations. Without the project these areas are expected to disappear over the next 50 years due primarily to siltation from frequent river flooding. With project features proposed for these sloughs and side channels would deepen them and provide rock structures that would scour and maintain connections to the river.

5. RESULTS

WHAG habitat units were calculated at the six evaluation locations. For agency evaluation, the project effects on all species were evaluated (Table D-4 – D-10). However, only those species indicated were used to determine project benefits. This was done to avoid using species with similar habitat uses which could result in double counting benefits when Net AAHU were summed and to focus on those species of management and conservation concern.

Table D-4. Zone 1. With, without and net annualized habitat units for Zone 1. Only mallard values were used to evaluate project benefits.

WHAG Evaluation		Mallard	Canada Goose	Least Bittern	Lesser Yellowlegs	Muskrat	King Rail	Green-backed Heron	Wood Duck	Beaver	American Coot	Northern Parula	Prothonotary Warbler	Sum
Bottomland Hardwoods	With	72.27						54.02	50.80	46.24		43.14	43.58	72.27
	W/O	0.00						49.29	44.81	42.53		43.05	42.53	
	Net	72.27						4.73	5.99	0.08		0.08	1.06	
Nonforested Wetlands	With	35.42	25.69	26.29	28.86	26.40	20.13	35.05			32.69			35.42
	W/O	0.00	0.00	29.08	28.86	6.28	23.86	32.20			27.92			
	Net	35.42	25.69	-2.79	0.00	20.12	-3.72	2.85			4.77			
Cropland to Bottomland Hardwoods	With	51.16						19.15		14.18		14.18	4.49	51.16
	W/O	0.00						0.00		0.00		0.00	0.00	
	Net	51.16						19.15		14.18		14.18	4.49	

Table D-5. Zone 2. With, without and net annualized habitat units for Zone 2. Only Northern parula values were used to evaluate project benefits.

WHAG Evaluation		Mallard	Canada Goose	Least Bittern	Lesser Yellowlegs	Muskrat	King Rail	Green-backed Heron	Wood Duck	Beaver	American Coot	Northern Parula	Prothonotary Warbler	Sum
Bottomland Hardwoods	With							125.67	138.82	114.12		144.45	198.62	0.00
	W/O							125.67	134.48	114.12		144.45	192.12	
	Net							0.00	4.33	0.00		0.00	6.50	
Nonforested Wetlands	With													
	W/O													
	Net													
Cropland to Bottomland Hardwoods	With							20.55	3.45	18.70		11.90	3.18	11.90
	W/O							0.00	0.00	0.00		0.00	0.00	
	Net							20.55	3.45	18.70		11.90	3.18	

Table D-6. Zone 2 (With Riverside Levee). With, without and net annualized habitat units for Zone 2. Only Northern parula values were used to evaluate project benefits.

WHAG Evaluation		Mallard	Canada Goose	Least Bittern	Lesser Yellowlegs	Muskrat	King Rail	Green-backed Heron	Wood Duck	Beaver	American Coot	Northern Parula	Prothonotary Warbler	Sum
Bottomland Hardwoods	With							137.89	142.99	118.77		154.56	204.69	10.11
	W/O							125.67	138.82	114.12		144.45	198.62	
	Net							12.22	4.17	4.65		10.11	6.07	
Nonforested Wetlands	With													
	W/O													
	Net													
Cropland to Bottomland Hardwoods	With							16.46	17.06	14.17		18.44	24.42	18.44
	W/O							0.00	0.00	0.00		0.00	0.00	
	Net							16.46	17.06	14.17		18.44	24.42	

Table D-7. Zone 3 (Roadside Lake). With, without and net annualized habitat units for Zone 3, Roadside Lake and associated wetlands. Only the mallard values were used to evaluate project benefits for bottomland hardwoods and nonforested wetlands.

WHAG Evaluation		Mallard	Canada Goose	Least Bittern	Lesser Yellowlegs	Muskrat	King Rail	Green-backed Heron	Wood Duck	Beaver	American Coot	Northern Parula	Prothonotary Warbler	Sum
Bottomland Hardwoods	With	12.89						29.95	26.91	31.38		20.60	24.60	2.22
	W/O	10.67						29.95	24.08	30.57		20.60	24.60	
	Net	2.22						0.00	2.84	0.81		0.00	0.00	
Nonforested Wetlands	With	37.81	38.57	74.43	68.13	29.44	200.38	80.55			72.35			37.81
	W/O	0.00	0.00	0.00	66.43	66.87	157.10	82.85			61.34			
	Net	37.81	38.57	74.43	1.70	-37.42	43.28	-1.70			11.02			

Table D-8. Zone 3 (Waverly Lake). With, without and net annualized habitat units for Zone 3, Waverly Lake and associated wetlands. Only mallard and Northern parula values were used to evaluate project benefits. Mallard for bottomland hardwoods and nonforested wetlands and Northern parula for converted cropland.

WHAG Evaluation		Mallard	Canada Goose	Least Bittern	Lesser Yellowlegs	Muskrat	King Rail	Green-backed Heron	Wood Duck	Beaver	American Coot	Northern Parula	Prothonotary Warbler	Sum
Bottomland Hardwoods	With	63.24						146.95	132.04	153.94		100.12	120.69	10.88
	W/O	53.35						146.95	118.13	149.98		100.14	120.69	
	Net	10.88						0.00	13.92	3.97		-0.02	0.00	
Nonforested Wetlands	With	93.29	86.66	215.3	180.67	140.30	200.38	193.63			172.22			55.79
	W/O	37.50	35.35	163.96	164.07	131.33	157.10	228.68			160.09			
	Net	55.79	51.31	51.34	16.60	8.97	43.28	-35.04			12.12			
Cropland to Bottomland Hardwoods	With							11.11		11.74		8.23	10.61	8.23
	W/O							0.00		0.00		0.00	0.00	
	Net							11.11		11.74		8.23	10.61	

Table D-9. Zone 4. With, without and net annualized habitat units for Zone 4. Only mallard and Northern parula values were used to evaluate project benefits. Mallard for nonforested wetlands and Northern parula for converted cropland.

WHAG Evaluation		Mallard	Canada Goose	Least Bittern	Lesser Yel. legs	Muskrat	King Rail	Green-backed Heron	Wood Duck	Beaver	American Coot	Northern Parula	Proth. Warbler	Sum
Nonforested Wetlands	With	77.78	77.42	151.83	124.03	44.91	131.36	139.75			124.39			77.78
	W/O	0.00	0.00	0.00	120.94	76.10	0.00	142.97			99.78			
	Net	77.78	77.42	151.83	3.09	-26.19	131.36	-3.22			24.61			
Cropland to Bottomland Hardwoods	With							242.15		220.34		140.22	149.65	140.22
	W/O							0.00		0.00		0.00	0.00	
	Net							242.15		220.34		140.22	149.65	

Table D-10. Zone 5. With, without and net annualized habitat units for Zone 5. Only Northern Parula values were used to evaluate project benefits for bottomland hardwoods.

WHAG Evaluation		Mallard	Canada Goose	Least Bittern	Lesser Yellowlegs	Muskrat	King Rail	Green-backed Heron	Wood Duck	Beaver	American Coot	Northern Parula	Prothonotary Warbler	Sum
Bottomland Hardwoods	With							166.47	181.21	146.55		150.10	201.95	0.00
	W/O							166.47	181.21	146.55		150.10	201.95	
	Net							0.00	0.00	0.00		0.00	0.00	

AHAG habitat units were calculated at the six evaluation locations. AHAG evaluation questions are species specific unlike the evaluation questions for the WHAG. Therefore, habitat suitability indices and habitat units were only generated for species used to determine project benefits (Table D-11). Species were selected because they utilize the current or are anticipated to use the future habitat at Rip Rap Landing; they represented different guilds from different taxonomic families and because they are of management interest. Species from different guilds and taxonomic families were chosen to avoid using species with similar habitat uses which could result in double counting benefits when Net AAHU were summed.

Table D-11. With, without and net habitat units were determined using the AHAG evaluation in identified linear sections of Sny Creek and in Roadside Lake. Only the smallmouth buffalo values were used to evaluate project benefits.

Net AAHU for AHAG Evaluation				
Location AAHUs	Smallmouth Buffalo		Bluegill	
Sny Creek Waverly L. to Bridge	With	4.172	4.004	2.55
	Without	1.624	1.652	
	Net	2.548	2.352	
Sny Creek Bridge to Sand Levee	With	2.175	2.088	1.33
	Without	0.847	0.861	
	Net	1.328	1.227	
Sny Creek Sand Levee to Roadside L. Cut	With	1.388	1.320	.85
	Without	0.539	0.549	
	Net	0.849	0.771	
Roadside Lake	With	69.200	66.500	42.3
	Without	26.900	27.600	
	Net	42.300	38.900	
Sny Creek Roadside L. Cut to Dog Island	With	4.157	3.990	2.54
	Without	1.618	1.646	
	Net	2.539	2.344	
Sny Creek Adjacent to Dog Island	With	3.001	2.887	1.83
	Without	1.172	1.192	
	Net	1.829	1.695	

The alternatives used in the incremental cost analysis are single components of project features that could be implemented separately or in combination (Table D-3). The alternatives generate a variety of habitat units determined by how well they address the problems discussed in the DPR.

Table D-12. Rip Rap Landing AAHUS allocation by project feature

ZONE 1

ID#	Project Feature	AAHUs Allocated	Origin of AAHUs & Indicator Species
1A	Water Control Structures	15	Habitats Combined BLH/NFW- Mallard
1B	2,500 gpm Well	96	Habitats Combined BLH/NFW/Crop to BLH- Mallard
1C	Conversion of Crop to BLH	43	Conversion of Crop to BLH – Mallard

1D	Channel to Goose Pasture L.	5	Non-forested Wetland - Mallard
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Zone 2

ID #	Project Feature	AAHUs Allocated	Origin of AAHUs & Indicator Species
2A	River Levee @ 450'	17	BLH/Conversion of Crop – Northern Parula
2B	Conversion of Crop to BLH	12	Conversion of Crop to BLH – Northern Parula

Zone 3

ID#	Project Feature	AAHUs Allocated	Origin of AAHUs & Indicator Species
3A	Channel to Waverly Lake	20	Non-forested Wetland/BLH - Mallard
3B	Water Control in Channel	3	Non-forested Wetland - Mallard
3C	WCS in North Units	21	Non-forested Wetland/BLH - Mallard
3D	Sny Creek Dredging to Bridge	3	AHAG for Sny – Smallmouth Buffalo
3E	43% of Pump Station	20	Non-forested Wetland/BLH - Mallard
3F	Widening Pump Channel	3	Non-forested Wetland/BLH - Mallard
3G	Pump Station Pipe & Concrete for Roadway	2	Non-forested Wetland/BLH - Mallard
3H	WCS Pipes Under Sand Levee	6	Non-forested Wetland/BLH - Mallard
3I	Conversion of Crop to BLH	8	Crop Conversion to BLH – Northern Parula
3J	Roadside L. Channel from Sny	2	AHAG for Roadside – Smallmouth Buffalo
3K	Water Control Roadside L.	40	Non-forested Wetland Roadside - Mallard

Zone 4

ID#	Project Features	AAHUs Allocated	Origin of AAHUs & Indicator Species
4A	Sny Dredging Bridge-Levee	1	AHAG for Sny –Smallmouth Buffalo
4B1	Sny Dredging Levee to Roadside L. Channel	1	AHAG for Sny –Smallmouth Buffalo
4B2	Sny Dredging Roadside to Dog Island	30	AHAG for Sny & Roadside Lake –Smallmouth Buffalo
4C1	River Ridge Levee	39	Mallard & Northern Parula
4C2	River Ridge Scour Swales	15	Crop to BLH Conversion – Northern Parula
4D	South Spillway	50	Non-forested Wetland - Mallard
4E	WCS South Spillway	4	Non-forested Wetland - Mallard
4F	Diversion Levee on slough	6	Non-forested Wetland - Mallard
4G	57% of Pump Station	12	Non-forested Wetland - Mallard
4H	57% Pump Channel Widening	2	Non-forested Wetland - Mallard
4I	57% Pipe and Concrete @ Road	1	Non-forested Wetland - Mallard
4J	WCS Pipes Under Road	3	Non-forested Wetland - Mallard
4K	Cropland to BLH	125	Crop to BLH – Northern Parula

Zone 5

ID#	Project Feature	AAHUs Allocated	Origin of AAHUs & Indicator Species
5B	Sny Dredging @ Dog Island	15	AHAG for Sny and Roadside Lake - Smallmouth Buffalo

6. REFERENCES

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