HEP Evaluation and CE/ICA for Project Mitigation

Introduction

A mitigation plan for the proposed Greens Bayou project's impacts to 14.72 acres of wetlands was developed by utilizing Habitat Evaluation Procedures (HEP) for selected aquatic species.

In order to evaluate the impacts to wildlife from the resulting land use changes, it was determined that Habitat Suitability Index (HSI) models would be used in the HEP analysis. The models are based on the assumption that there is a positive relationship between the HSI and habitat carrying capacity and that habitat suitability can be summarized as scale, ranging from 0.0 to 1.0 (U.S. Fish and Wildlife Service, 1981). Due to the frequently qualitative nature of existing data and the amount of available quantitative habitat information, the HSI models vary in generality and precision. The value given by an HSI model serves to improve decision making and increase understanding of habitat relationships.

Multiple mitigation measures were developed and evaluated in the HEP analysis in order to determine which measure or combination of measures would provide full impact mitigation in a cost effective and incrementally justified manner by using IWR-Plan software. Table 1 presents the 8 mitigation measures and costs developed for the analysis.

Table 1. Mitigation measures developed for the HEP analysis.

Measure Symbol	Measure Abbreviation	Measure Description	Cost *
	No Action	The Green Bayou project would not be constructed.	
A	4.2 Ch	4.2 acres of wetland creation 5 feet wide on both sides to the Greens Bayou channel pilot channel for the length of the channel improvements (3.7 miles).	$67,842.60
B	1.1 Ba	1.1 acres of wetland creation within the detention basin area.	$17,768.30
C	1.2 Ba	1.2 acres of wetland creation within the detention basin area.	$19,383.60
D	2.3 Ba	2.3 acres of wetland creation within the detention basin area.	$37,151.90
E	2.6 Ba	2.6 acres of wetland creation within the detention basin area.	$41,997.80
F	3.0 Ba	3.0 acres of wetland creation within the detention basin area.	$48,459.00
G	5.3 Ba	5.3 acres of wetland creation within the detention basin area.	$85,610.90

* Cost for each measure only includes estimated initial planting costs, and operation and maintenance costs for the 50 year life of the project.

For the analysis each measure is considered as a stand alone mitigation alternative and measures are combined with one another to create numerous other mitigation alternatives with the exception of the No Action measure. Under the No Action measure or

alternative no mitigation would occur. The measures considered for the mitigation plan included the No Action, one wetland creation measure adjacent to the pilot channel of Greens Bayou, and seven measures of various sizes of wetland creation within the detention basin. The channel measure (A) is comprised of 4.2 acres of wetland creation along the sides of the meandering pilot channel for the length of the channel improvements (3.7 miles). Measures B through G are comprised of wetland areas of differing sizes that can be built within the detention basin. The sizes of measures B though G represent acreages that can be built individually or combined with one another based on the proposed detention basin configuration considering engineering and hydrologic concerns.

HEP Methods

The species selected for the HEP analysis were selected as representatives of the range of wildlife that could potentially utilize the existing wetlands and the proposed mitigation wetlands. The criteria used to determine the species selected for the analysis were limited to those with existing Habitat Suitability Index (HSI) models and parameters such as vegetation, climate, and water regime consistent with the study area. Based on site visits by Texas Parks and Wildlife (TPWD), U. S. Army Corps of Engineers (USACE), and PBS&J biologists it was decided that HSI models would be performed on the *Casmerodius albus* (Great Egret), *Rana catesbeiana* (Bullfrog), and *Chelydra serpentine* (Snapping Turtle) as shown in Table 2.

Table 2. FWS documentation for the HSI models used in the HEP analysis.

Title	Reference	Date
Great Egret	FWS/OBS-82/10.78	September 1984
Bullfrog	Biological Report 82(10.138)	June 1987
Snapping Turtle	Biological Report 82(10.141)	June 1987

For the great egret there are separate HSI models for feeding and nesting. Since the habitat being impacted would function as feeding habitat as opposed to nesting habitat, the feeding HSI model was used in the analysis.

The bullfrog and snapping turtle models base habitat values on factors such as water depth and vegetation that are relevant to the habitat being impacted and the mitigation measures ability to provide mitigation for the value of the habitat being impacted. When the outputs from the three models are combined they represent a diverse range of the types of wildlife that are expected to utilize both the existing wetlands and the wetlands created for mitigation.

An Excel spreadsheet was set up for each HSI model. Model parameters and assumptions for the bullfrog, great egret, and snapping turtle models are shown in Tables 3, 4, and 5 respectively. Many factors affect the amount of time required for a created wetland to become fully functional. According to the U.S. Department of Agriculture

Conservation Service, a wetland develops rapidly but is not fully functional the first five years following wetland creation (USDA, 1992). We conservatively assumed that the Greens Bayou wetland mitigation areas would be fully functional by Year 9.

Table 3. Assumptions for the Variables for the Bullfrog HSI Model.

Variable	Assumptions
V1 - mean distance from shore to water >1.5 m (4.9 ft) deep	It was determined that none of the water was > 1.5 m deep, leading to an HSI of 0.5 for all measures.
V2 - percent canopy cover of aquatic vegetation in the littoral zone	Since aquatic vegetation will be planted, it was assumed that there would be 25% cover immediately after project construction. Therefore, Year 1 was assigned a value of 0.25 and increased by one-eighth until Year 9, at which time it was assumed there would be optimal cover. The No Action was assumed to have optimal cover.
V3 - percent shoreline cover	Since trees and shrubs will be planted, it was assumed that V3 would equal 0.5 immediately after project construction. Therefore, Year 1 was assigned a value of 0.5 and increased by one-eighth until Year 9; existing conditions are 100% cover.
V4 - mean water transparency	V4 was assumed to equal 0.7 for all measures.
V5 - winter water depth	V5 was assumed to equal 1 for all measures.
V6 - percent silt substrate	The No Action was estimated to be a 0.9, while measure A was assumed to have an ultimate lower value (0.8), starting at 0.4. Measures B-G were assumed to reach an ultimate value equal to the No Action, starting at 0.45.
V7 - mean current velocity at mid-depth during summer in cm/s (centimeters per second)	V7 was assumed to equal 1 for all measures.
V8 - water pH	V8 was assumed to equal 1 for all measures.
V9 - mean water temperature at mid-depth during summer (°C)	V9 was assumed to equal 1 for all measures.
V10 - frequency of water level fluctuations >2m	V10 was assumed to equal 1 for all measures.
V11 - distance to permanent water (m)	V11 was assumed to have a value of 1 for all measures.

Table 4. Assumptions for the Variables for the Great Egret Feeding HSI Model.

Variable	Assumptions
V1 - percent of area with water 10 -23 cm deep	Estimated to be slightly over 50% for measure A and approximately 33% for measures B-G.
V2 - percentage of submerged or emergent vegetation cover in zone 10 - 23 cm deep	All areas were assumed to be in the optimum rage between 40 and 60% so all measures were assessed a 1.0.

Table 5. Assumptions for the Variables for the Snapping Turtle HSI Model.

Variable	Assumptions
V1 - mean water temperature at mid-depth during the summer (°C)	Assumed to be in the optimum range between 25 and 32 °C for all measures and the No Action.
V2 - mean current velocity at mid-depth during summer (cm/s)	Zero for the No Action and measures B-G, assumed 25 cm/s for measure A.
V3 - percent canopy cover of aquatic vegetation in the littoral zone	Assumed 50% cover for No Action and an end result of 50% for measures A-G.
V4 - winter cover component	All measures assigned a 1 based on the assumption that the winter water depth is greater than the maximum ice depth.
V5 - percent silt substrate	The No Action was estimated to be a 0.9, while measure A was assumed to have an ultimate lower value (0.8), starting at 0.4. Measures B-G were assumed to reach an ultimate value equal to existing conditions, starting a 0.45.
V6 - distance to small stream (km)	>5 km for all measures and the No Action.
V7 - Distance to permanent water (km)	Measure A and No Action were assumed to be permanent water. Measures B-G were estimated to be less than 1 km permanent water.

Using the HSI values computed and averaged over the 50 year project life for the existing condition (no action), the proposed mitigation measures were multiplied by their respective area in acres generating Average Annual Habitat Unit (AAHU) values. The AAHU values created a common metric to allow impacts and benefits to be quantified and compared across the measures and alternatives. The AAHU values for the 3 species were averaged for each measure. Table 6 presents the AAHU calculated by species and the overall average for the three species that is referred to as the Community AAHU value.

Table 6. AAHUs for the Potential Mitigation Measures (Three species averaged).

Description	No Action	4.2 Ch	1.1 Ba	1.2 Ba	2.3 Ba	2.6 Ba	3 Ba	5.3 Ba
Measure		**A**	**B**	**C**	**D**	**E**	**F**	**G**
Bullfrog	10.55	3.52	0.77	0.84	1.6	1.81	2.09	3.7
Snapping Turtle	9.4	2.66	0.7	0.76	1.46	1.65	1.9	3.36
Great Egret	11.04	3.276	0.7315	0.798	1.5295	1.729	1.995	3.5245
Community AAHU	10.33	3.15	0.73	0.80	1.53	1.73	2.00	3.53

Cost Effectiveness/Incremental Cost (CE/ICA) Analysis Methods

A CE/ICA analysis was performed to identify the least cost solution for each possible level of environmental output (AAHU) and to identify large increases in costs relative to outputs using IWR-Plan software version 3.33.

The Community AAHU values from Table 6 and costs from Table 1 for each measure were entered in the IWR-Plan software to generate mitigation alternatives and complete the CE/ICA analysis on the alternatives. The software identifies combinations of mitigation measures that produce alternatives that are cost effective and incrementally justified, known as Best Buy Plans or Best Buy Alternatives.

Figure 1. Cost Effective and Incrementally Justified Mitigation Alternatives Generated Using IWR-Plan Software for Measures A-G.

Incremental costs shown in dollars. The recommended Best Buy Plan is underlined.

Table 7. Costs and Outputs for the Best Buy Plans.

Alternative	Incremental Cost	Incremental Output	Incremental Cost Per Output	Total Output	Total Cost
No Action	$0.00	0.00	$0.00	0.00	$0.00
A	$67,842.60	3.15	$21,537.33	3.15	$67,842.60
AC	$19,383.60	0.80	$24,229.50	3.95	$87,226.20
AF	$29,075.40	1.20	$24,229.50	5.15	$116,301.60
ACF	$19,383.60	0.80	$24,229.50	5.95	$135,685.20
ACFG	$85,610.90	3.53	$24,252.38	9.48	$221,296.10
ACEFG	**$41,997.80**	**1.73**	**$24,276.19**	**11.21**	**$263,293.90**
ACDEFG	$37,151.90	1.53	$24,282.29	12.74	$300,445.80

Recommended Best Buy Plan shown in bold lettering.

The recommended mitigation alternative must provide an AAHU value greater than or equal to the 10.33 AAHUs that would exist under the No Action alternative. To allow some flexibility in the combination of measures without generating plans that would be unnecessarily large, a constraint was placed limiting the IWR-Plan software from combining measures that created an AAHU value higher than 13 since a value of 10.33 AAHUs would be sufficient to mitigate project impacts. Given the identified measures and the constraint of a maximum AAHU value of 13, the IWR-Plan software identified 127 different combinations of which 81 were cost effective and 8 were Best Buy Plans as shown in Figure 1. Table 7 shows the incremental cost, incremental output, incremental cost per output, total output, and total cost for each of the Best Buy Plans. Figure 1 and Table 7 both identify the alternatives by the measure or combination of measures that comprise the Best Buy Plans shown in Table 1.

The smallest Best Buy Plan with an AAHU value that met or exceeded the No Action AAHU value of 10.33 is the combination of measures A, C, E, F, and G, which provides 11.21 AAHUs by creating 4.2 acres of wetlands along the sides of the Greens Bayou pilot channel for the length of the channel improvements and 12.1 acres of wetlands within the detention basin at a total cost of $263,293.30. This combination of measures A, C, E, F, and G is therefore the recommended mitigation alternative since it provides full project mitigation and is both cost effective and incrementally justified. It additionally satisfies the request of TPWD that wetland mitigation be greater than 1:1 based strictly an acre per acre replacement.