Woodtick Peninsula Section 204 Beneficial Use of Dredged Material for Ecosystem Restoration Project, Monroe County, Michigan

Appendix E – Cost Effectiveness/Incremental Cost Analysis

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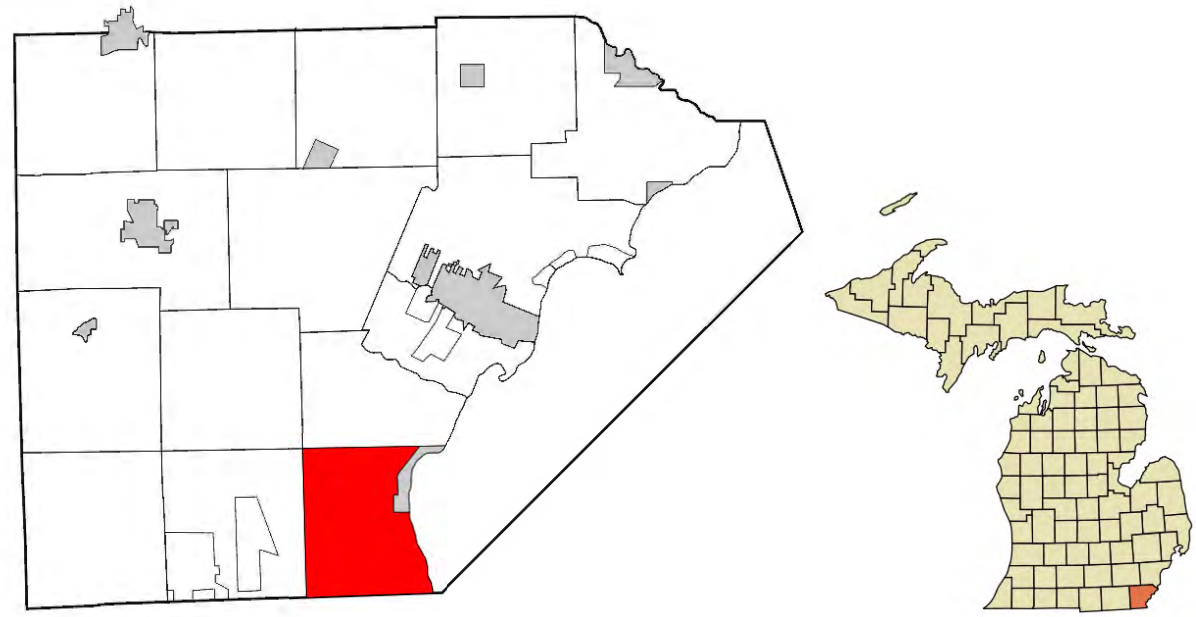
Woodtick Peninsula Economic Analysis

Monroe County is located in Southeastern Michigan. It shares a border with three other Michigan counties. Wayne County lies to the North, Washtenaw County lies to the Northwest, and Lenawee County is directly West of Monroe County. It also shares a border with Lucas County, Ohio which is South of Monroe County.

Figure 1: Map of Michigan highlighting Monroe County's location.



DEMOGRAPHICS

The 2020 census shows Monroe County with a population of 154,809. This is an increase of 1.8% from the 2010 census and is 0.2% less than the growth rate in the State of Michigan. Monroe County has a population that is 94.3% white, 3.7% Hispanic or Latino, and 2.7% black or African American. This is less than the State of Michigan which is 79.2% white, 5.3% Hispanic or Latino, and 14.1% black or African American. There are additional races present in both Monroe County and Michigan; however, their percentage of the total population are all below 5%.

Table 1: Demographics for Monroe County, MI and the State of Michigan, www.census.gov

Metric	Monroe County, MI	Michigan
Population, Census, April 1, 2020	154,809	10,077,331
Population, Census, April 1, 2010	152,021	9,883,640
Population Change	1.8%	2.0%
White alone, percent	94.3	79.2
Black or African American alone, percent	2.7	14.1
Hispanic or Latino, percent	3.7	5.3

High school graduate or higher, percent of persons age 25 years+, 2015-19	91.4	90.8
Per capita income in past 12 months (in 2019 dollars), 2015-19	$31,481	$31,713
Persons in Poverty, percent	9.7	12.6

***Note:** For Race and Hispanic Origin, demographic populations with less than a 5% share of the total population were not included.*

91.4% of Monroe County residents aged 25 or older are high school graduates or have obtained some level of higher education. This is compared to 90.8% for the State of Michigan.

The per capita income for Monroe County and the State of Michigan are very similar, $31,481 and $31,713 respectively (2019 dollars). Monroe County has a lower reported percent of people in poverty (9.7%) compared to the State of Michigan (12.6%).

RECONS

Figure 2: Map of Local Area for RECONS modeling.

ALTERNATIVE PLAN 4A

The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Monroe (MI) are estimated to be $5,529,000. Of this total expenditure, $4,847,574 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value

added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $5,529,000 support a total of approximately 80 full-time equivalent jobs, $3,932,374 in labor income, $3,865,956 in the gross regional product, and $7,800,314 in economic output in the local impact area. More broadly, these expenditures support approximately 130 full-time equivalent jobs, $8,366,920 in labor income, $9,844,214 in the gross regional product, and $17,646,610 in economic output in the nation.

Table 2: Local Purchase Coefficients (LPC), 2022 dollars

Industry	Expenditure	Local Purchase Coefficients		
		Local	State	US
Support activities for agriculture and forestry	$1,161,090	59%	59%	100%
Construction of other new nonresidential structures	$3,593,850	100%	100%	100%
Environmental and other technical consulting services	$55,290	63%	63%	100%
Office administrative services	$221,160	75%	100%	100%
* Employment and payroll of federal govt, non-military	$497,610	75%	100%	100%
Total	**$5,529,000**			

*Table 3: Overall summary, 2022 dollars *Jobs are presented in full time equivalent (FTE)*

Area	Local Capture	Output	Jobs	Labor Income	Value Added
Local					
Direct Impact		$4,847,574	60.3	$3,132,023	$2,415,498
Secondary Impact		$2,952,740	19.5	$800,351	$1,450,458
Total Impact	$4,847,574	$7,800,314	79.8	$3,932,374	$3,865,956
State					
Direct Impact		$5,028,204	64.0	$3,829,638	$2,885,493
Secondary Impact		$5,805,583	32.7	$1,920,488	$3,213,286
Total Impact	$5,028,204	$10,833,787	96.7	$5,750,125	$6,098,779
US					
Direct Impact		$5,526,260	74.2	$4,603,576	$3,316,386
Secondary Impact		$12,120,349	56.1	$3,763,344	$6,527,828
Total Impact	$5,526,260	$17,646,610	130.2	$8,366,920	$9,844,214

ALTERNATIVE PLAN 5A

The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Monroe (MI) are estimated to be $10,659,000. Of this total expenditure,

$8,833,280 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $10,659,000 support a total of approximately 136 full-time equivalent jobs, $7,912,588 in labor income, $7,422,411 in the gross regional product, and $13,568,433 in economic output in the local impact area. More broadly, these expenditures support approximately 268 full-time equivalent jobs, $15,945,656 in labor income, $19,082,855 in the gross regional product, and $34,019,752 in economic output in the nation.

Table 4: Local Purchase Coefficients (LPC), 2022 dollars

Industry	**Expenditure**	**Local Purchase Coefficients**		
		Local	**State**	**US**
Support activities for agriculture and forestry	$2,238,390	34%	58%	100%
Construction of other new nonresidential structures	$6,928,350	100%	100%	100%
Environmental and other technical consulting services	$106,590	99%	99%	100%
Office administrative services	$426,360	75%	100%	100%
* Employment and payroll of federal govt, non-military	$959,310	75%	100%	100%
Total	**$10,659,000**			

*Table 5: Overall summary, 2022 dollars *Jobs are presented in full time equivalent (FTE)*

Area	**Local Capture**	**Output**	**Jobs**	**Labor Income**	**Value Added**
Local					
Direct Impact		$8,833,280	104.0	$6,395,791	$4,838,682
Secondary Impact		$4,735,154	31.7	$1,516,796	$2,583,729
Total Impact	$8,833,280	$13,568,433	135.7	$7,912,588	$7,422,411
State					
Direct Impact		$9,717,114	126.6	$7,289,167	$5,629,509
Secondary Impact		$11,223,684	63.2	$3,714,157	$6,212,572
Total Impact	$9,717,114	$20,940,798	189.8	$11,003,323	$11,842,081
US					
Direct Impact		$10,653,718	159.4	$8,690,550	$6,498,279
Secondary Impact		$23,366,034	108.1	$7,255,106	$12,584,576
Total Impact	$10,653,718	$34,019,752	267.5	$15,945,656	$19,082,855

ECONOMICS APPENDIX

In order to make better informed decisions about the development and eventual selection of the NER Plan for the Woodtick Section 204 feasibility study, a Cost Effectiveness and Incremental Cost Analysis (henceforth CE/ICA) was conducted on the alternatives that were carried forward for evaluation and comparison. The CE/ICA analysis is contained within the USACE's Institute of Water Resources (IWR's) "Planning Suite" software tools, that have been developed to assist Water Resources Planners in conducting planning / economic analyses of potential water resources project alternatives. The analysis conducted for Woodtick included six alternatives, in addition to the No Action plan. As required by USACE Planning Guidance (ER 1105-2-100, Appendix E, E-36), these analyses were conducted utilizing annualized costs, annualized non-monetary benefits, and the IWR-Planning Suite II Software (version 2.0.9).

The Cost Effectiveness portion of the analysis identifies the plan, or plans, that produce(s) a level of environmental output that cannot be produced at a lower cost, or a greater level of output cannot be produced at the same or less cost. The environmental outputs, however measured, in turn reflect the environmental benefits, such as biological diversity, fish and wildlife habitat, and nutrient cycling, provided by the plan or plans. The Incremental Cost Analysis examines the changes in costs and the changes in environmental outputs for each additional increment of environmental output. The Best Buy Plans represent those plans that produce the greatest increases in environmental outputs for the least increases in cost.

DESCRIPTION OF ALTERNATIVES

The alternatives included in this analysis comprise of rebuilding the peninsula at Woodtick along with a variety of measures, with their combination creating a wide range of alternatives. The below alternatives (Table 1) were those remaining after multiple levels of screening of various proposed alternatives for the Woodtick Peninsula, as identified by the project team. The following alternatives, and the associated naming codes used in IWR Planning Suite, were carried forward for the CE/ICA analysis:

TABLE 1. ALTERNATIVES CARRIED FORWARD FOR CE/ICA

Plan	Alternative Description
2a	Rebuild Peninsula
2b	Rebuild Peninsula
3a	Rebuild Peninsula + Lakeside Reef
4a	Dredged Material Placement at Southern End + 1 Offshore Reef
4b	Dredged Material Placement at Southern End + 1 Offshore Reef
5a	Dredged Material Placement at Southern End + 2 Offshore Reefs

Figure 1 Google Earth view of Woodtick Peninsula

ANALYSIS OF CONCEPTUAL DESIGN COSTS AND BENEFITS DESCRIPTION OF COSTS

The costs for constructing the different alternatives were developed at the parametric level and are based on recent construction cost data for similar work features. These construction costs include a 30% contingency. Total Project Cost Spreadsheets (TPCS's) were used to estimate

costs for planning, engineering, design and construction management for each alternative, as well as applying escalation to the mid-point of construction in Q4 2024.

After the total first costs were determined, the cost of *Interest During (project) Construction* (IDC) was calculated, based on a six-year period of construction for the initial construction of each of the alternatives, and a 2-1/4-percent discount rate. The total first costs plus the costs of the interest during construction yield the initial investment cost, as seen in the following table.

TABLE 2. INITIAL INVESTMENT COST OF ALTERNATIVES (FY-22 PRICE LEVEL, 2.250 PERCENT DISCOUNT RATE)

Plan	Alternative Description	Total First Cost ($1,000)	IDC ($1,000)	Total Initial Investment Cost ($1000)
2a	Rebuild Peninsula	7,796	817	8,613
2b	Rebuild Peninsula	11,952	1,241	13,193
3a	Rebuild Peninsula + Lakeside Reef	13,301	1,379	14,680
4a	Dredged Material Placement at Southern End + 1 Offshore Reef	5,529	586	6,115
4b	Dredged Material Placement at Southern End + 1 Offshore Reef	10,567	1,100	11,667
5a	Dredged Material Placement at Southern End + 2 Offshore Reefs	10,659	1,109	11,768

MONITORING COSTS

Monitoring will be conducted for each of the alternatives to ensure that project objectives are being fulfilled. It is anticipated that six sampling sessions will be required over a span of the 10 years following project implementation. The cost associated with these sampling sessions is estimated to be $21,000.

ADAPTIVE MANAGEMENT

A contingency for an adaptive management cost of 3% of the construction costs for each alternative was included in the IWR Planning Suite, when inputting the data for the CE/ICA analysis.

AVERAGE ANNUAL COSTS

Using the total investment costs, average annual renourishment, LERRDS, and annual monitoring, the average annual equivalent costs were derived for each alternative plan, based on a 50-year period of analysis, a 2-1/4-percent discount rate, and February 2022 (FY22) price levels. The interest and amortization, average annual maintenance costs, and total average annual

costs for the alternatives carried forward for evaluation can be found in the following table (Table 3).

Table 3. AVERAGE ANNUAL COST OF ALTERNATIVES (FY-22 PRICE LEVELS, 2.250 PERCENT DISCOUNT RATE)

Plan	Alternative Description	Construction Cost ($1,000)	AAHU	Total Average Annual Cost ($1,000 / AAHU)
2a	Rebuild Peninsula	8,613	38.76	222.21
2b	Rebuild Peninsula	13,193	46.09	286.24
3a	Rebuild Peninsula + Lakeside Reef	14,680	50.27	292.02
4a	Dredged Material Placement at Southern End + 1 Offshore Reef	6,115	40.38	151.44
4b	Dredged Material Placement at Southern End + 1 Offshore Reef	11,667	40.99	284.63
5a	Dredged Material Placement at Southern End + 2 Offshore Reefs	11,768	51.50	228.50

DESCRIPTION OF ENVIRONMENTAL BENEFITS

To develop the environmental benefits, the Lake Erie Qualitative Habitat Evaluation Index (L-QHEI), developed by the Ohio Environmental Protection Agency, was used. It is designed to provide a measure of Lake Erie shoreline habitat quality that generally corresponds to those physical and biological factors that affect fish communities, and which are generally important to other aquatic life (e.g., invertebrates). The LQHEI consists of five metrics based on shoreline habitat quality: (1) substrate type/quality; (2) cover type; (3) shoreline morphology; (4) riparian zone and bank erosion; and (5) aquatic vegetation quality. Scores could theoretically range between zero and 100 (low scores represented low habitat quality/high human disturbance and high scores indicated high habitat quality/little human disturbance). This index will be one of the metrics used to characterize existing conditions and evaluate ecosystem restoration plans. The L-HQEI score was divided by 100 and then multiplied by the habitat acres to calculate the habitat units (HUs).

TABLE 4. AVERAGE ANNUAL ENVIRONMENTAL BENEFITS

Plan	Alternative Description	AAHU	Net AAHU
2a	Rebuild Peninsula	61.13	38.76
2b	Rebuild Peninsula	68.47	46.09
3a	Rebuild Peninsula + Lakeside Reef	81.46	50.27

4a	Dredged Material Placement at Southern End + 1 Offshore Reef	63.32	40.38
4b	Dredged Material Placement at Southern End + 1 Offshore Reef	63.93	40.99
5a	Dredged Material Placement at Southern End + 2 Offshore Reefs	82.69	51.5

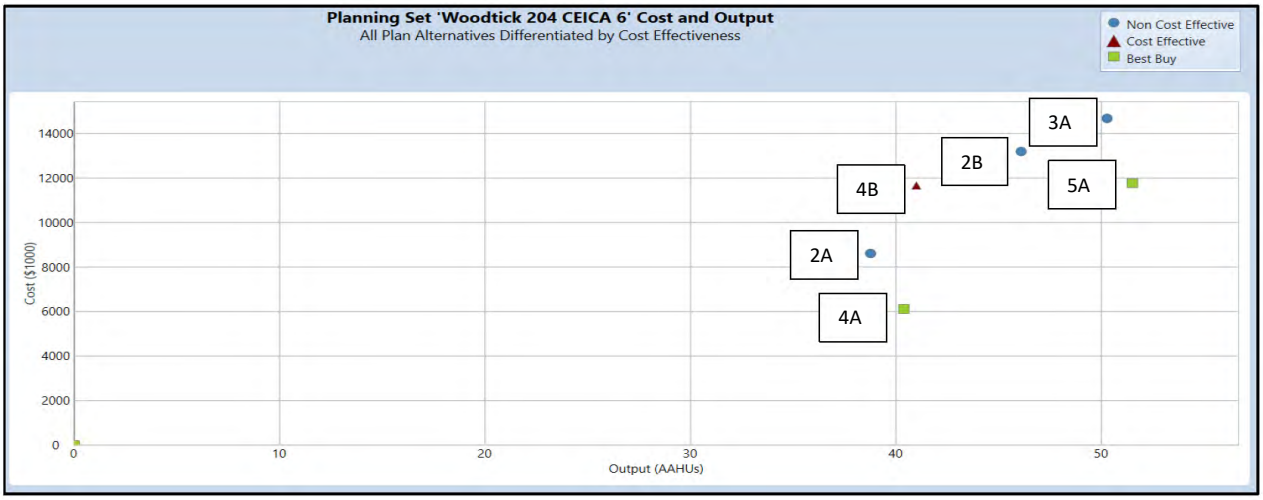
COST EFFECTIVENESS AND INCREMENTAL COST ANALYIS

The average annual costs and average annual benefits (combined benefit score) identified previously were used to conduct the CE/ICA, using IWR Planning Suite II, version 2.0.9. The results of the CE analysis indicated three of the considered plans to be cost effective - alternatives 4A, 4B and 5A. The cost-effective plans can be found in the following table. Each of these plans is the least-costly means of providing the associated level of output or benefit. The following figures illustrate the CE analysis results, showing average annual environmental benefits (horizontal axis) and average annual costs (vertical axis) of the alternatives, as well as the No Action Plan, which is carried forward for comparison purposes only.

Table 5. RESULTS OF COST- EFFECTIVENESS ANALYSES

Plan	Alternative Description	Average Annual Benefits (HUs)	Average Annual Cost ($1,000's / AAHUs)	Cost Effective or Best Buy
4a	Dredged Material Placement at Southern End + 1 Offshore Reef	40.38	151.44	Best Buy
4b	Dredged Material Placement at Southern End + 1 Offshore Reef	40.99	284.63	Cost Effective
5a	Dredged Material Placement at Southern End + 2 Offshore Reefs	51.50	228.50	Best Buy

Figure 2: Cost-Effectiveness Analysis Results



After conducting the CE analysis, the ICA examines the changes in costs and changes in environmental benefits for each additional increment of output. For each best buy plan there are no other plans that will give the same level of output at a lower incremental cost. The plan with the lowest overall average cost per unit of output, advancing from the No Action Plan, is the first Best Buy Plan. After the first Best Buy Plan is identified, subsequent incremental analyses are done to calculate the change in costs and change in outputs of advancing from the first Best Buy Plan to all of the remaining (and larger) cost-effective plans. The results of the ICA indicated two of the considered plans, in addition to the No Action Plan, to be Best Buy Plans. The following tables summarize the information from the ICA of the alternatives, and the figures display the information graphically.

Table 6. RESULTS OF INCREMENTAL COST ANALYSIS (BEST BUY PLANS)

Plan	Average Annual Costs ($1,000 / AAHU)	Average Annual Benefits (HUs)	Incremental Cost ($1,000)	Incremental Output (AAHU)	Incremental Cost/Output ($1,000 / AAHU)
No Action	0	0	0	0	0
4a	151.44	40.38	6.115	40.38	151.44
5a	228.50	51.50	5.653	11.12	508.36

Since plans 4A and 5A have lower incremental cost per output than plan 4B, the only other cost-effective plan under consideration, leaving these two plans as the only Best Buy Plans in this case. Therefore, the incremental cost per output in the previous table only shows economic information in relation to the No Action Plan. A comparison was made of the incremental costs per output for the Best Buy Plans to make a recommendation for implementation. After reviewing the output for the Best Buy Plans, plan 4A offers the greatest benefit given its cost. While plan 5A offers greater total benefits, the additional costs increase at a greater rate than the total benefits making it a less desirable choice.

Figure 3: Box Graph of Best Buy Plans

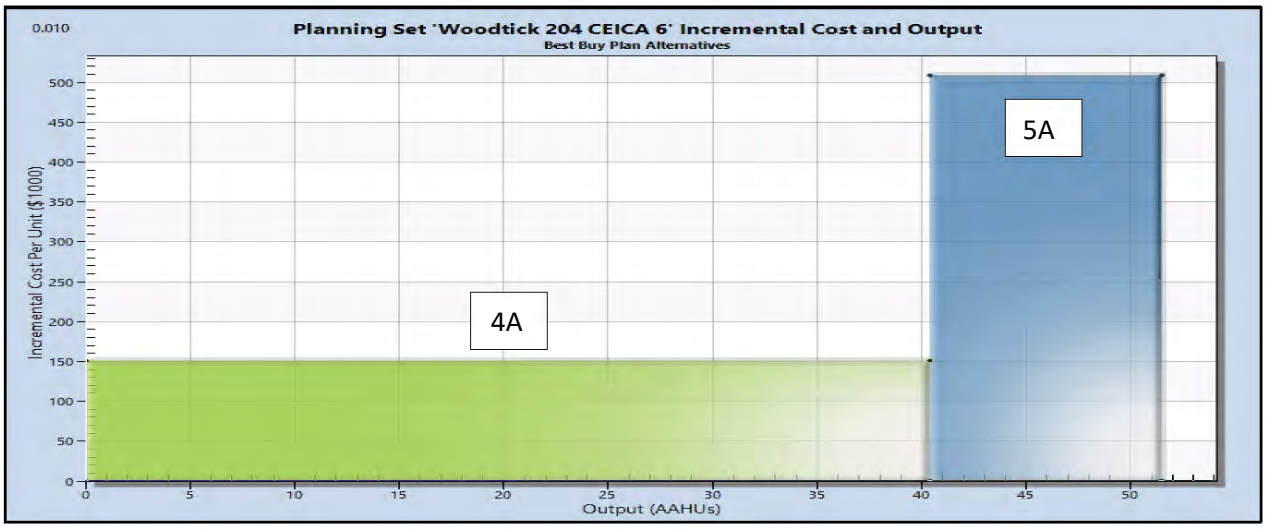


Table 7. TENTATIVELY SELECTED PLAN AVERAGE ANNUAL COSTS AND BENEFITS Federal Discount Rate FY22 = 2.250%, FY 2022 Price Levels, 50-Year Period of Analysis	
Element	Total ($1,000)
Project First Costs	
Construction	4,278
LERRDS	58
Preconstruction, Engineering, and Design	953
Construction Management	504
Total Project First Costs	5,793
Average Annual Costs	
Construction	115.86
Interest During Construction	11.72
Annual OMRR&R	10
Total Average Annual Cost	137.58
Average Annual Benefits (HUs)	40.38

TENTATIVELY SELECTED PLAN

Table 6 shows plans 4A and 5A as Best Buy Plans. However, after reviewing the output and incremental cost per unit, shown in figure 3, the additional incremental cost per unit of plan 5A is not justified for the additional output. Plan 4A provides the greatest output at the best incremental cost per output. An argument could be made for 5A with the additional output and use of dredged materials; however, from strictly looking at cost to output, 4A is a more economically justifiable plan.

The CE/ICA output is not a definitive measure of value. All plans should receive equal attention and discussion among the Project Delivery Team (PDT). This recommendation should only serve as an additional tool to help guide the selection of the Tentatively Selected Plan (TSP).