

MUSKINGUM RIVER ECONOMIC VALUATION

Fred J. Hitzhusen
Sarah Lowder
Radha Ayalasomayajula

**Department of Agricultural, Environmental
And Development Economics**

The Ohio State University

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I. Introduction

Rivers have the potential to play an important role in the development of an economically depressed region by providing water supply, transportation, waste assimilation, and a wide array of recreation and tourism activities. The Muskingum River, which flows through Coshocton, Muskingum, Morgan and Washington Counties in Southeastern Ohio, provides an example of the roles a river can play in regional development. Throughout the length of the river are ten sets of locks and dams that were constructed between 1837 and 1841 to facilitate transport of products by barge (Woolpert 1993). The original features of the locks have been maintained throughout the century, making them an interesting attraction for boaters and anglers as well as for tourists, even though little cargo moves through them now.

Several local officials have expressed concern that the Muskingum River is underutilized, but has the potential to become a more popular tourist attraction and catalyst for economic growth. Over the years, the condition of the river corridor has deteriorated and information is needed to determine the economic feasibility of various options for restoring and upgrading the corridor. Traditionally, development economics has focused on growth in private market activities whereas natural resource economics has focused on non-market valuation of natural resources and the environment. An increase in private market activities related to natural resources such as rivers and improved methods of non-market valuation make it possible for stronger complementarity of natural resource and development economics.

During Phase I of the study, the authors developed methodologies for preliminary estimates of recreation and tourism value of the river as well as the impact of property, community and environmental attributes on values of residential properties along the river.

The Phase I estimate of the average annual value (1995-97) of river-related recreation and tourism in the Muskingum River corridor was \$7.3 million. Adding the annual rental equivalent value of riverside residential properties of \$5.4 million, gave a corridor total of \$12.7 million annually for recreation, tourism and residential rent equivalents. The recreation and tourism values were seen as lower bound estimates and the rental equivalent values upper bound estimates, at least for residential property. However, commercial and industrial properties in the corridor were not included, so both estimates and thus the totals were probably conservative.

Several models of statistical inference including fishing use, Washington, Morgan and Muskingum County property values and Morgan County property values were estimated in Phase I to determine what factors influence corridor values. For example, variations in residential property value are explained by several characteristics of the property itself, plus existence of zoning or subdivision controls, availability of septic and gas hook-up and proximity to the river. The statistical results of residential property values provide a starting point for determining the economic payoff that might be expected from various improvements proposed for the corridor. Specifically, in this Phase II analysis, the authors determine the costs and benefits of improving water quality through residential septic systems, extending an existing bike trail, repairing the locks and dams and implementing zoning in the Muskingum River corridor.

Developing cost estimates for the various corridor improvements is fairly straightforward but time consuming. The benefit estimates involve more complex non-market estimation techniques. For example, we modified the Phase I hedonic pricing model by adding new variables, increasing sample size and redefining other variables to improve estimates of the impact of zoning, septic systems and other factors on residential property values. We also improved the analysis of corridor recreational use. In addition, we used the contingent valuation method to determine the willingness-to-pay of Ohio residents for historic preservation of the Muskingum River locks and dams, improved household septic systems and extension of the existing bike trail. Finally, we expressed all benefits and costs in discounted present values (both ratio and differences) to adjust for time.

II. Infrastructure

Attempts to determine the benefits and costs of fuel, dock and other related marina facilities were not successful due to time and resource constraints. It was also clear that with a few exceptions, these forms of infrastructure or service are currently provided by the private sector when it is profitable to do so. There are some instances in which market distortions may have prevented the development of infrastructure. For example, one marina owner claims that the high cost of insurance prevents him from providing fuel facilities. That is, the insurance costs that he would bear if he were to sell fuel are so large that they would prevent him from making any profit since he would only be able to sell a small quantity of gasoline.

The Muskingum River lock and dam system has historically required costly repairs and maintenance. From 1961 to 1996 the average annual cost of repairs made to

the locks and dams was approximately \$630,000 (the dollar values were adjusted to 1999 dollars using the consumer price index). Such costs do not include the employment of personnel that runs and oversees the operation of the locks. Furthermore, these repairs were typically made on an as-needed basis. That is, instead of performing preventative repairs, the locks were repaired once damage required that they be fixed. In a 1993 study of the condition of the locks and dams, Woolpert and Associates proposed a repair schedule that was based on a preventative regimen, suggesting that to do so would be to minimize the cost of repairs over time. The costs of repairing, maintaining, and operating the locks and dams (discounted to their 1999 net present value) for a twenty year period starting in the year 2000 total \$11,635,000. Given that these costs are relatively large, we were naturally curious whether recreational use value justifies them, as argued by the Army Corps of Engineers¹. In Phase 1 of the study we made preliminary estimates of the value of river-related recreation in the corridor that falls under the jurisdiction of Ohio Department of Natural Resources. In this phase of the study we have revised our original methodology resulting in more conservative estimates of the value.

Records maintained by Blue Rock State Park in Muskingum County provided us with data on the amount of river related recreation in the corridor. The data represents annual use of the river corridor; it is collected daily by lockmasters at each lock. Because of significant asymmetry in the data between years, this portion of the study uses an average of the values taken from 1983-1997. We examined five categories of corridor recreation: lock boaters, other boaters, anglers, picnickers, and visitors. Lock boaters are

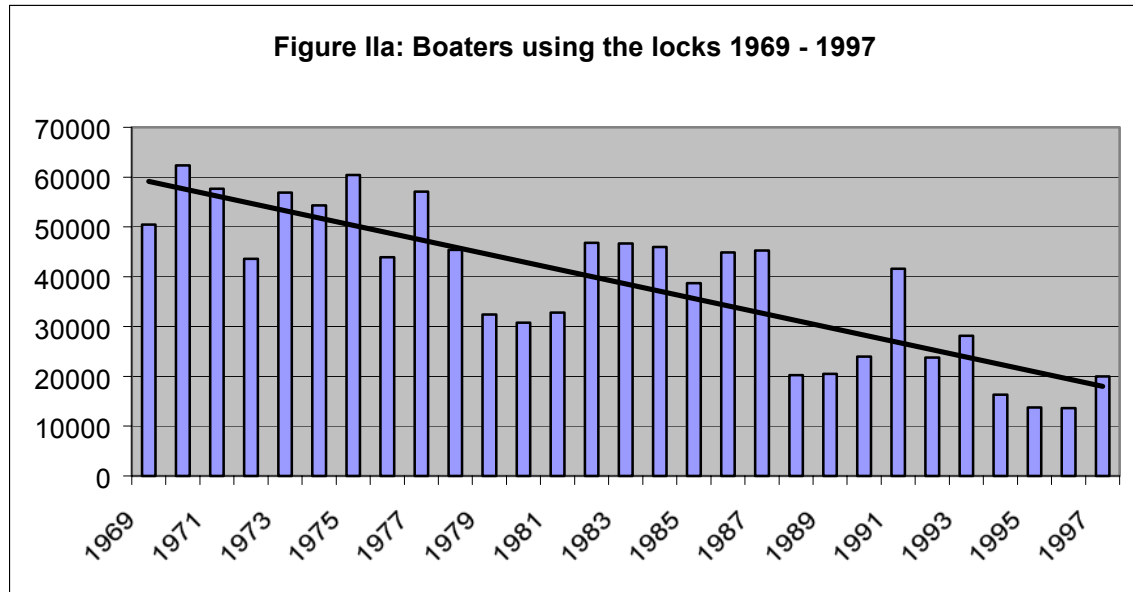
¹ The Army Corps of Engineers was fairly ambiguous regarding the methods it used to predict that repair of the locks would result in substantial increases in corridor recreation and the resulting benefits would greatly exceed costs.

the number of people in boats that use the locks; other boaters are those that navigate the pools without using the locks. Anglers are people that fish in the river either from a boat or the riverbank. People not in boats at the locks were classified as either picnickers or visitors according to what the lockmaster perceived was the primary purpose of their trip.

The data follows expected trends, such as increased usage in the summer, during lock related festivals and at those locks located in more densely populated areas. The boater data for boaters that use the locks most likely has the least measurement error; the lockmaster takes note of every boat that uses a lock. The number of boaters using the locks is therefore not the result of estimation, but rather of actual events. However, the other categories of usage have several weaknesses. Other boaters, anglers, picnickers, and visitors are based on estimations made by the lockmasters who are only on site for a portion of the day. Different people work at different locks; therefore the estimation skills and techniques may vary. Furthermore, lockmasters change over time as individuals stop working as a lockmaster and are replaced by a new person. Of particular concern is that the frequency of lock visitation at the ten locks is consistently greater than one would anticipate. Total visitation to the ten locks and dams averages 190,000 annually for the years 1983 to 1997. Double counting is also a problem. People fishing from boats are counted as both anglers and boaters. Further double counting occurs if the same boat uses more than one lock during a given day. Anyone that partakes in two different activities during the same trip may also be counted twice. However, this problem appears relatively minor since lockmasters only record users as far as they can see in either direction from the lock and some use in the pools is thereby omitted. Any

overvaluation due to double counting is probably offset by the use of recreation near the locks as a proxy for total recreation throughout the river.

In our examination of boaters using the locks it became clear that there has been a steady decrease in the number of boaters using the locks each year. The following figure (IIa) shows the total number of boaters using all locks from 1969 through 1997.

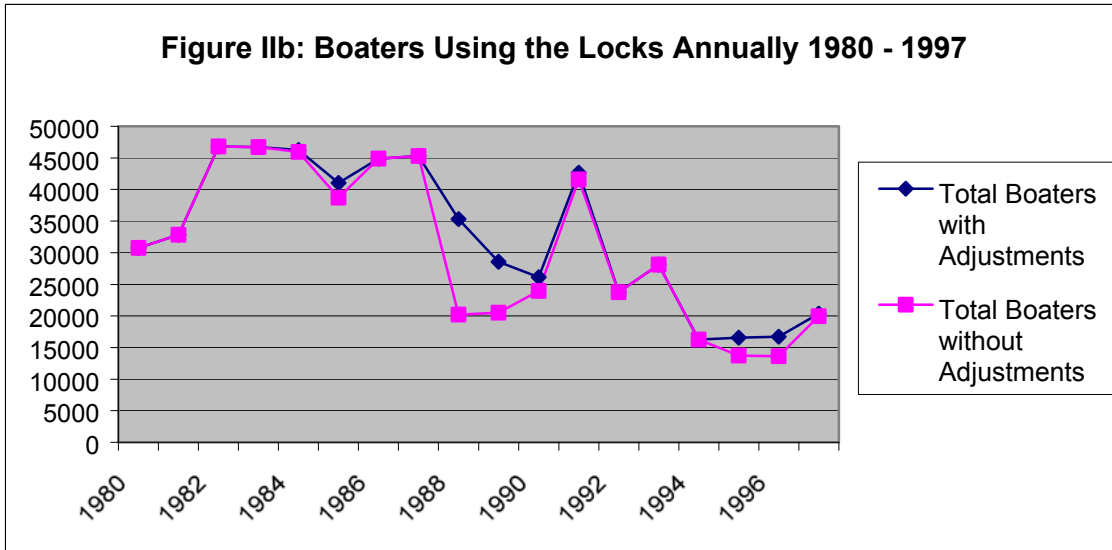


Upon noticing this trend, we were curious why such a marked decrease had occurred. One hypothesis was that the locks received a lot of use in the years just after their reopening, but after they had been functioning for some time their intrigue wore off resulting in less usage. Another possible explanation was that lock closings due to repair and maintenance of the locks significantly decreased the use of the locks.

In order to determine whether such closings significantly affected lock usage, we adjusted the actual usage amounts by the expected decrease in lock use for those months during which a lock was closed. That is, we looked at the monthly boater use of each lock individually. Whenever visitation to a lock was equal to zero during a given month we assumed that the lock had been closed for repairs during that month. We then

averaged the amount of usage of that lock during that month in the three years preceding the repair. This average provided an estimate of the loss in boaters using that lock in that month due to the lock being closed for repairs. The estimated loss was then added to the actual visitation value and a conservative adjustment was made showing what the lock usage levels would have been had locks not been closed for repair. This approach is, of course, not without fault. It does not capture any loss in visitation at adjacent locks. Further, had the lock repairs not been made it is conceivable that some locks would have deteriorated to the point where they could not even be used. However, this approach does give us an idea of whether or not we can attribute decreases in lock use to the closings alone.

Because most of the lock closings occurred after 1980, we decided to compare the recorded boater usage of the locks after 1980 with the boater usage of the locks after 1980 adjusted for closings. The adjustments have more of an impact on the shortened time period. However, the impact is not significant enough to offset the decrease in usage from 1980 – 1997. The boater usage of the locks adjusted for lock closings is shown below. Figure IIb indicates that once adjustments were made for lock closings, the trend was still a clear decrease in usage of the locks.



Unlike the decreasing boater usage of the locks, the number of visitors, anglers, picnickers and other boaters recorded by the lockmasters exhibit an increase over time. This is shown below in Figure IIc. However, the increases are relatively small and variable over time. Note that data on the number of picnickers and other boaters was only available as far back as 1983 and the observed number of anglers in 1994 is also missing.

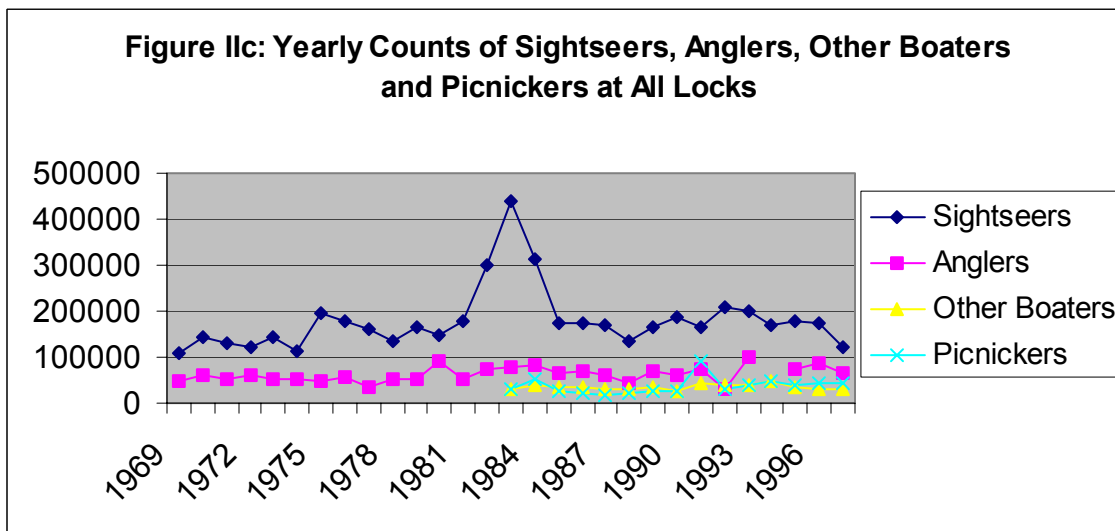
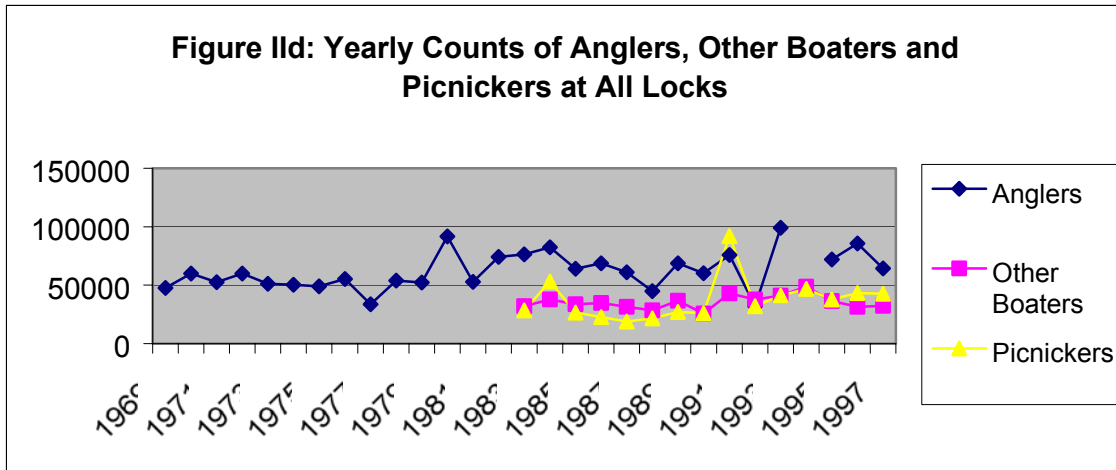
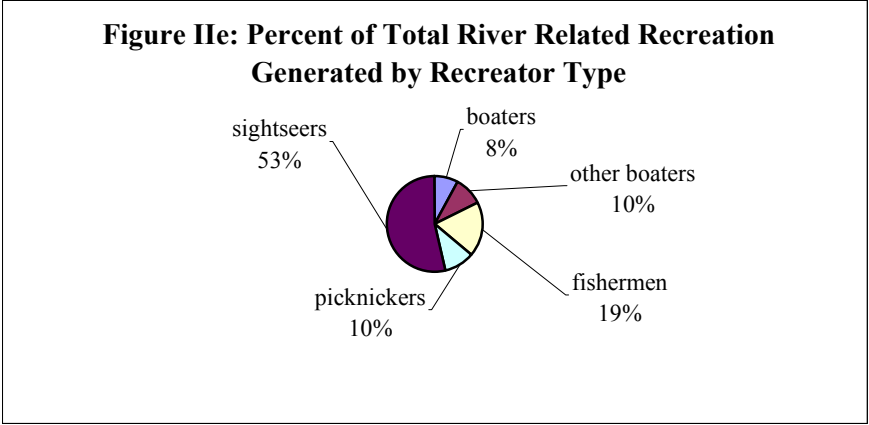


Figure IIc reveals that the number of sightseers recorded is far larger than the number of anglers, other boaters or picnickers. In order to appreciate the change in the level of fishing, boats using the locks, and picnicking at the locks it is helpful to look at these three types of recreation on a single graph. Figure IId below shows that these three types of recreation have indeed exhibited small increases over time.



The following pie chart shows the relative magnitude of each type of recreator in the corridor. Sightseers represent 53% of the total recreators at the locks. Anglers are the next most numerous group; they represent 19% of the annual recreators at the locks. Picnickers and other boaters each represent 10% of the recreators and boaters represent 8% of recreators.



In order to determine the effect of the increased and decreased use of the corridor on the revenues generated by river-related recreation we invoked a technique known as Benefit Transfer.

III. Benefit Transfer

Boyle and Bergstrom (1992) define benefit transfer as “the transfer of existing estimates of non-market values to a new study which is different from the study for which the values were originally estimated”. They refer to the area from which the values originated as the “study site” and the area to which the values will be transferred as the “policy site”. Several problems are inherent in the transfer process. In particular, the commodity, site and population characteristics of the study site must closely approximate those of the policy site. However, benefit transfer plays an important role in resource economics; it provides a rough estimate of benefits for sites where primary data collection is prohibitively expensive and/or time consuming.

The benefit transfer values used for this study were derived from a 1992 meta-analysis published by Walsh, Johnson and McKean. The authors reviewed 120 outdoor recreation studies from sites in the U.S. between 1968 and 1988. They estimated benefits resulting from various recreational activities including camping, fishing, boating,

hunting, picnicking, swimming and sightseeing. In their article, Walsh et al gave the activities and their median values per recreator day in 1987 dollars as follows.

Table IIIa: Average Consumer Surplus from Various Recreational Activities Found by the Walsh Study (1987 dollars)

Recreator Type	Average Expenditure	Recreator Type	Average Expenditure
Boater (motorized)	\$25.67	Picnicker	\$12.82
Boater (nonmotorized)	\$25.36	Visitor	\$19.72
Fisherman	\$22.50		

In Phase 1 the values from Walsh et al’s study were appreciated to 1999 dollars using a consumer price index (CPI). The resulting day use values were as follows.

Table IIIb: Average Recreational Surplus Used in Phase I of this Study

Recreator Type	Average Expenditure	Recreator Type	Average Expenditure
Boater	\$35.25	Picnicker	\$17.71
Fisherman	\$31.08	Visitor	\$13.62

For this Phase 2 analysis we deflated the day use values to reflect the median household income for the three county area which is lower than that of American households which are more relevant to the Walsh study. Because the proportion of motorized to nonmotorized boating on the river was unknown, the average of the two values was used to calculate the benefits. On average lock visitors probably do not spend more than an hour at a site and it is unknown whether or not they stop at more than one lock, or other river businesses. Furthermore, the magnitude of the average annual visitation to locks was suspiciously large. Therefore, a very conservative assumption was made and the value of visitation supplied by the Walsh study was divided by eight for use in this study. This resulted in a value of \$3.11 as opposed to the \$13.62 used in Phase 1. Table IIIc shows the day use values used in Phase II of our study.

Table IIIc: Average Recreational Surplus Adjusted for Use in Phase II of this Study

Recreator Type	Average Expenditure	Recreator Type	Average Expenditure
Boater	\$32.22	Picnicker	\$16.17
Fisherman	\$28.38	Visitor	\$3.11

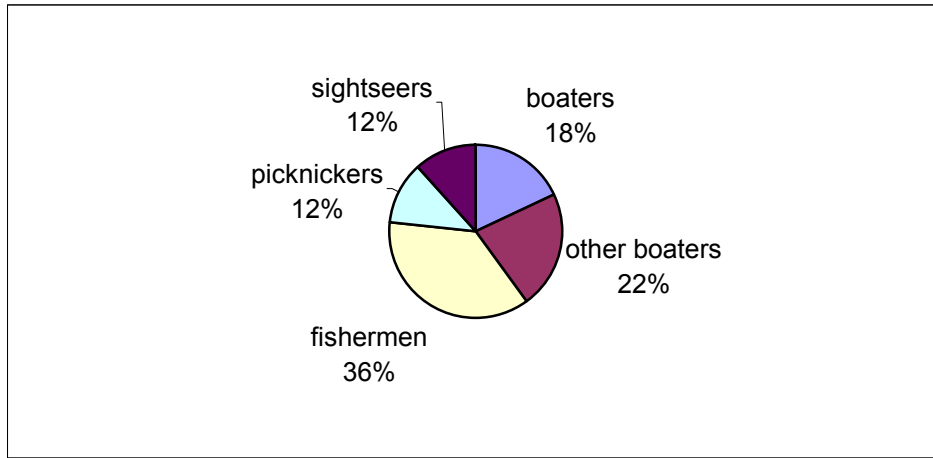
We then multiplied these values by the total number of recreational users to approximate the economic benefits of river-related recreation. The average annual results for each recreational category by lock are presented in Table III d.

Table III d: Benefit Transfer Results (rounded to the nearest thousands of dollars)

Type of Recreators	Total \$ Surplus Value According to Type of Recreation
Boaters	\$952,000
Other boaters	\$1,142,000
Anglers	\$1,936,000
Picnickers	\$604,000
Sightseers	\$615,000
Total Recreational Use Value	\$5,249,000

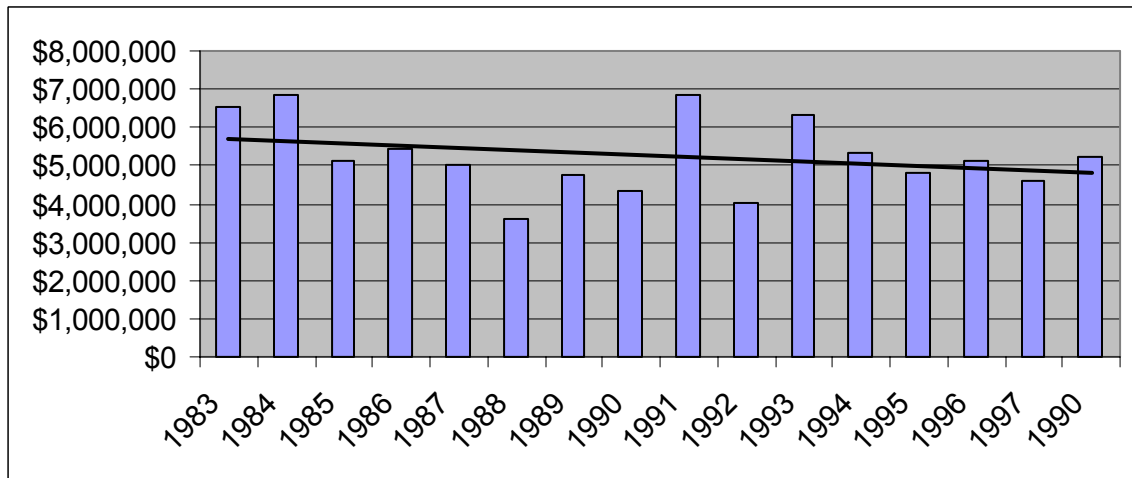
The average annual (1983-1997) consumer surplus from all types of river-related recreation in the corridor is approximately 5.2 million dollars. The following pie chart shows the relative importance of each type of recreator in terms of the percent of average annual river related surplus gained by that type of recreator. We see that anglers account for about 36% of such surplus. Other boaters (those boaters in the pools) gain 22% of total surplus and boaters using the locks receive 18%. Sightseers and Picnickers both gain 12% of the surplus. We must be careful to remember that these percentages are highly sensitive to any changes in the day use values.

Figure IIIa: Percent of Total River Related Recreation Generated by Recreator Type



By looking at the annual surplus generated from recreators between 1983 and 1997, we see a clear trend of decrease in surplus over time (see Figure IIIb below).

Figure IIIb: Annual Expenditures Made by Recreators from 1983 to 1997



We cannot say that all of the recreation recorded by ODNR results from the presence of the locks and dams. Much of it might occur whether or not the locks existed. In fact, some would argue that without the locks and dams the Muskingum River would become a more healthy ecosystem hosting a wider variety of aquatic life which would in turn increase the amount of anglers using the river. The absence of locks would also

likely increase the level of canoeing and kayaking in the river. However, without the dams, the water level of the river would very likely decrease and thereby prevent motorboating. The presence of the locks therefore makes it possible for motorboating to occur in the river. This uncertainty regarding the impact of the lock and dam system on recreation prevents us from estimating what portion of surplus resulting from recreation is attributable to the presence of the locks and dams. We can, however, say that the value includes expenditures made by the sightseers visiting the locks and boaters using the locks. The average annual revenue from lock users and sightseers is \$1,567,500. Since 1983 annual expenditures by these two groups has decreased. Given this decrease it seems that recreation may not justify lock repair. However, recreation related surplus or use values are not the only type of benefit generated by the locks and dams.

IV. Historic Value of Locks

In our discussion with various stakeholders it became clear that the locks, most of which were built in the 1840s, are of a great historical value to many people. In order to assess the historical value of the locks and dams we performed a Contingent Valuation (CV) of the general population of Ohio as well as special interest groups, which included Rivers Unlimited and The Canal Society. Appendix A contains a more detailed description of the Contingent Valuation Method as well as a comparison of the results from the survey of the general population and with the results from the two special interest groups.

The historic value of the locks can be measured as non-use value. People who have never even seen the locks before gain satisfaction by knowing that they exist and are being maintained in their original hand-operated condition (willingness to pay for such

reasons is known as existence value). Others who have spent time recreating along the corridor, feel that the locks should be preserved in their original condition and they are willing to contribute towards lock repair above and beyond the amount of money that they spend for recreation in the corridor. The survey question asked respondents:

Willingness to Pay for the Repair, Maintenance and Operation of the Muskingum River Locks and Dams

The Muskingum River Lock and Dam system requires costly repairs. Imagine you were asked to make a one-time donation to help with the maintenance, repair and operation of the Muskingum River lock and dam system. You would be contributing towards a maintenance and restoration effort that will do everything it can to preserve the locks in their original condition. Which of the following amounts most closely approximates the amount that you would contribute? *This amount does not include the amount of money that you currently spend or that you anticipate spending when touring or using the locks.*

- \$0.00
- \$10.00
- \$25.00
- \$50.00
- \$75.00
- \$100.00
- more than \$100.00 (please specify amount) _____.

Of the three valuation questions on our survey, this one received the most widespread and largest support from our sample of the general population of Ohio. Although 72% of respondents recorded zeros, 28% of those responding indicated that they would be willing to pay anywhere between \$10 and \$100 towards the repair of locks in the Muskingum River Corridor. The average of the responses to this question is \$8.99. In order to estimate the value that would be supplied by the entire adult population of Ohio, we decided to make a very conservative estimation. That is, we assumed that anyone who did not respond to the survey has a willingness to pay equal to zero. Under

this assumption the average Willingness to Pay (WTP) of our sample is \$2.07. If our sample of 473 Ohioans is representative of the population of Ohio above the ages of 16, (we have sound reason to believe that it is), our results represent a willingness to pay of adult Ohioans equal to \$17,511,000. This benefit (\$17,511,000) greatly outweighs the costs of repairing, maintaining and operating the locks for the next twenty years (\$11,635,000). Table IVa shows these costs and benefits.

Table IVa: Costs and Benefits Associated with the Locks and Dams

Attribute	Costs	Benefits
Dams and Locks	\$11,635,000	\$17,511,000

Our study of recreational opportunities throughout the corridor also identified the importance of a current proposal to extend a bike trail that is currently located in Zanesville.

V. Bike Trail Extension

Zane’s landing trail is a short bike path that measures 2.7 miles long and is located in Zanesville. An extension of this trail is currently underway and proposals to extend this trail North to Dresden are under negotiation. Because the existing trail is relatively new, and it takes at least five years for such improvements to be reflected in the hedonic model, we were unable to capture the impact of the trail on housing values. No data has been collected on this trail that shows the typical number of users. After interviewing users of the path and the owner of the Lorena Sternwheeler, which is docked at the head of the trail, we determined that it would be too costly and time consuming to estimate usage of the trail with primary data collection. Even if we had exact counts of the number of recreational users of Zane’s landing trail, they would not indicate the level

of usage that will occur once the trail is extended to 12.9 miles long. One would expect that the existing trail attracts less use than it will after the extension occurs due to its limited length (2.7 miles). We therefore used benefit transfer to forecast the expenditures that will be made by users of the trail once it is extended.

Using data gathered on visitation in a study of another similar trail allowed us to forecast expected expenditures by users of the extended Zanesville trail. In 1990 and 1991 the National Park Service and Penn State University conducted a study of three different bike trails. Of the three trails, the area surrounding the Heritage Trail in Dubuque, Iowa, is most comparable to Zanesville, Ohio. We reduced the number of expected visits to the Zanesville trail from the 135,000 found in the Dubuque study to 59,000 since the population of Dubuque is larger than the population of Zanesville (62,000 and 27,000 respectively). We then inflated the average expenditure during a visit to the Heritage trail (\$9.21 in 1991 dollars) using a consumer price index to determine the value in 1999 dollars (\$11.26 in 1999 dollars). We then deflated that expenditure amount to \$8.66 in order to reflect that the average income of a resident of Dubuque is 1.302 times that of a Zanesville resident. Multiplying forecasted visits by expected expenditure per visit we found that the expenditures would total \$510,940 per year. Over twenty five years these benefits, when expressed as a discounted present value (using a 10% discount rate) are \$6,065,000 in 1999 dollars. Based on the benefits from these expenditures alone, the bike trail will be a sound investment. However, such expenditures are not the only type of value the trail possesses.

In order to measure the non-use value of the trail we also surveyed the willingness of Ohioans to contribute to the trail extension. The relevant survey question was as follows.

Willingness to Pay for an Extension of the Zane’s Landing Bike Trail

There is currently a short bike path (2.7 miles long) located in northern Zanesville. An extension of this path has been proposed that will run North to Dresden. Imagine you are approached by someone who asks you to donate towards the extension of the Zanesville trail. How much would you pay (as a one time donation) towards funding the extension of the Zanesville bike trail along the Muskingum River?

- \$0.00
- \$10.00
- \$25.00
- \$50.00
- \$75.00
- \$100.00

more than \$100.00 (please specify amount) _____.

21% of the respondents reported that they would be willing to pay anywhere between \$10 and \$50 towards the extension of the trail. The average of the responses to this question is \$3.72. Once again, in estimating a value for the entire population of Ohio we assumed that anyone who did not respond to the survey has a willingness to pay equal to zero. Using this conservative assumption, the average willingness to pay of our sample is \$0.86. If our sample of 473 Ohioans is representative of the population of Ohio above the ages of 16, (we have no reason to believe that it is not), our results represent a willingness to pay of adult Ohioans equal to \$7,246,000.

The proposal entitled “Ohio Department of Transportation: Transportation Enhancement Program: Muskingum Recreational Pedestrian and Bicycle Trail” estimates total costs of building the trail to be \$1,782,000 in 1994 dollars. The average trail lasts twenty to thirty years before it has to be repaired or lifted. We therefore calculated the

cost of trail maintenance for the next twenty-five years. The total costs of trail planning, construction and maintenance when expressed in 1999 discounted net present value is \$2,050,000. Although \$7,246,000 (the total willingness of adult Ohioans to pay for the trail) is merely a lower bound estimate of the benefits of a bike trail extension, it alone clearly justifies the costs of constructing and maintaining the bike trail for twenty-five years, which are approximately \$2,050,000. In order to gain an all inclusive estimate of the value of the trail we can aggregate the forecasted expenditures made by trail users and the WTP of Ohioans. The resulting sum is \$13,311,000.

Table Va: Bike Trail Extension Costs and Benefits (CV and Forecasted Use) in 1999 dollars using a 10% discount rate

Attribute	Costs	Benefits
Bike Trail	\$2,050,000	\$13,311,000

VI. Other River Corridor Attributes: Impacts on Residential Property Values

Zoning and Septic Systems

In the Muskingum region, which is composed of both agricultural and urban communities, two types of zoning laws are present. The cities of Zanesville, McConelsville and Marietta have city zoning ordinances in practice while only two townships (Wayne and Devola) have implemented township zoning. The composition of administrative bodies, organization, appointments to the board, enforcement, and the zoning ordinances themselves differ considerably between the cities and the two townships. Besides, in our hedonic model, township zoning did not have any significant impact on the property values, and thus was dropped from the equation. We collected data on the functioning, administration and costs of variances in the three cities and compared them to the benefits derived from the hedonic model. The initial costs of

establishing zoning regulations in the area were not available, but we collected data on the costs only of maintaining, appealing, etc the ordinances. The time frame for zoning was assumed to be 50 years. Subsequent investigation determined that zoning was initially established in 1964 for the city of Zanesville and assumed the same for the other two cities for lack of data on these. We estimated a value (\$40,000) as the initial cost of establishing zoning.

Lack of sufficient water quality data in the Muskingum River Corridor unfortunately prevented us from doing any statistical analysis of the direct effect of water quality on recreational or residential values. Several attempts were made at incorporating water quality data, such as the Index of Biological Integrity (IBI) in the hedonic model as well as looking at its effect on recreation. Since the existing quantitative data was insufficient for the purposes of statistical analysis, proxy variables were explored. The hedonic method revealed that the existence of septic and sewer systems have a significant impact on housing values. We thought that the presence or absence of a well functioning septic system or connection to a sewage treatment facility would serve as the best available proxy for water quality. We interviewed public health officials and residents in the corridor. The health officials also identified “hotspots” as areas from which they received a higher number of complaints regarding odor from neighbors’ yard, street sewer, etc. Hot spots include areas with a large number of substandard dwellings that do not have adequate waste treatment. We learned that several segments otherwise termed as “hot spots” might contribute to significant deterioration of water quality in the Muskingum River.

Although it is required by the law that all residential parcels have a well functioning septic system, it is not strictly enforced. The only monitoring of the residential waste treatment facilities occurs when public health officials receive a complaint that a particular property is causing unpleasant odors, etc. Several houses in the corridor have a rudimentary septic system, which does not comply with the regulations. The only way to detect these is to perform a door-to-door inspection. Both monetary and time constraints prevented us from undertaking such a detailed survey. However, the parcel cards obtained from the auditor's offices indicate whether or not a property has a septic system or is connected to a sewer system. In fact, some parcel cards indicate that a residence has neither facility! Roughly 24 percent of our sample has no well functioning septic facility. Reasons these homeowners are not prosecuted for noncompliance with the law remain ambiguous.

The Hedonic Pricing Method

A well-developed method called hedonic pricing was chosen to measure the effect of corridor improvements such as zoning and septic systems on residential property values. Hedonic pricing is a method of statistically determining the amount paid for housing and community attributes as well as for environmental goods (see Appendix B for a detailed explanation). A basic concept of the hedonic model is that the value of an asset, in this case a home, is a function of a set of characteristics; this function is known as the hedonic price function. This can be expressed as: $P = f(S, C, Q)$, where P is the price or value of the house, S the housing characteristics, C the community characteristics and Q the environmental characteristics. Hedonic pricing involves decomposing property prices into their relevant components (as expressed above) to reveal the amount by which

consumers value the environmental amenities and disamenities being studied. Using the hedonic function, we can estimate the change in the asset value, in this case property value, as a result of a change in any characteristic, while holding all other characteristics constant. This change is measured by the coefficient by which that characteristic is multiplied.

In many hedonic studies structural characteristics of a house are described by the number of rooms, number of bathrooms, garage spaces, age, various utilities including water supply, sewer system, septic system and electricity. Other things equal, we expect that an additional bedroom or bathroom represent an extra amenity. The lifespan or durability of a house is associated with age and or type of construction. Since a majority of the houses were of the same type of construction, we did not include this variable.

Zoning regulations are included in the hedonic equation to represent one community characteristic. Jud concluded in his study on the effects of zoning on residential values in North Carolina, “purchasers of residential housing seek a uniformity in neighborhood land use... and are willing to pay a premium for it” (1980). An important purpose of zoning is to protect the neighborhood residents from externalities (such as decreased property value) arising from undesirable uses of land in the same area. Zoning increases the value of land in the neighborhood by preventing these uses. The purpose of zoning in any city or township is to promote the health, safety and welfare of the citizens of that region. It is considered to be an important factor in the allocation of property rights to the residents of the region. Further, zoning contributes to the tax base of the region and it is generally the case (e.g. Hite 1995) that property bidders include the higher tax rate when bidding for a property with such attributes. Another set of

community characteristics is represented by the cost and quality of the school system; 'high school graduation rate' was included as a proxy output. Expenditure per pupil was not included as an input variable, because the school districts in the corridor were of vastly different sizes. Distance to the three urban centers (Marietta, McConnelsville and Zanesville) is intended to provide a measure of relative locational advantage. A dummy variable specifying whether a property has direct river access or not, is intended to measure an environmental amenity, but lack of data made it difficult to include water quality in our model. Earlier work by Epp and Al-Ani (1979) found that river water quality has a positive impact on nearby non-farm residential property values.

Three samples were estimated: a sample containing three counties (Muskingum, Morgan and Washington counties), another with two counties (Muskingum and Washington counties) and a third with a single county (Morgan). The unique location of Morgan County and its economic characteristics, which are very different from the other two counties, makes it imperative to analyze all three samples. Three different models, using three different samples, were estimated. Due to the unique characteristics of Morgan County, the results of the least squares estimates of the sample containing pooled data of all three counties were suspected to be biased downwards. And hence, the two county and Morgan County models were also estimated.

Regression Results (pooled data of all three counties)

A significant portion of the variation, (64 percent) in the dependent variable is explained by the model. An adjusted R^2 value of 0.64 is considered to be robust when cross sectional data is being used as is the case in this model. All of the coefficients had the expected signs. The presence of well water was not significant even at the 20 percent level so it was dropped from the model. On the other hand, existence of municipal water supply was negative and significant at the 25 percent level. A negative coefficient on the public water supply indicates that the residents are not willing to pay for public provision of drinking water. It is important to note here, however, that detailed information on the other types of water supply, whether it comes from the municipal drinking water supply or otherwise is not available, and hence any specific conclusions are difficult to make based on the existing information.

The interpretation of the distance variables requires close assessment of the commuting patterns of the households in the region. All the coefficients were negative indicating that as the distance from the property to any of the three urban centers increases; it results in a decline in price. As none of these urban centers can be described as centers of economic activity and/or employment, conclusions based on commuting distance cannot be made. Further, the urban centers are of different sizes, economic activity, employment, income, density and other socio-economic indicators. The estimated coefficient of the income tax rate is significant, and the positive sign indicates that an increase in the tax rate results in an increase in assessed value. A possible explanation may be that higher income taxes mean higher income and individuals with higher income prefer residential properties of higher value.

Fifteen of the 20 estimated coefficients (other than the intercept term) are significantly different from zero at the 5% significance level. The estimated coefficient of the environmental amenity variable, river distance is significantly different from zero at 10% significance. Other variables, sewer, gas, and basement are significant at 20% level of confidence.

The coefficients for living area, acreage and age are elasticities, interpreted as percentage change in the value of a property due to a 1% change in the quantity of that characteristic, other things remaining the same. The other coefficients represent the change in the price due to a unit change in the respective variables. As the area of the property increases by one percent, the value of the property is expected to increase by approximately 0.102 percent. Similarly, as the total living area increases by one percent, the value of the property is expected to increase by 0.333 percent. As the age of the house increases by one year, the value of the house is expected to decrease by .036 percent. The value of the property is expected to increase by \$196 if the property is located in a zoned city (Marietta or Zanesville) area, an additional room will increase value by \$27, an additional bathroom by \$167 and river access by \$107. Provision of utilities like electricity, gas, sewer and septic system are expected to increase value by \$686, \$94, \$279 and \$74 respectively

The “focus” variables in this study are river distance, zoning, septic and sewer system. As hypothesized, the presence of these amenities is related positively to the price of the residential property. All of the focus variables, except for sewer, are highly significant with the expected signs. Table 6 illustrates the impact of these variables. These infrastructure and environmental factors in the corridor are valued at almost two

and half million dollars in increased residential property values. The aggregate values were calculated by multiplying the percent of parcels with the attribute times the coefficient estimate expressed in dollars. For example, the aggregate value for zoning is calculated as:

$$\$196 * 5950 * 0.6639 = \$774,240$$

where the coefficient estimate for zoning is \$196 (.196* 1000), 5950 is the total number of houses in the population, and 0.6639 is the proportion of houses located in the zoned area.

**Table VIa: Aggregate Hedonic Values For Select Variables
(Pooled data for three counties)**

Variable	Total Value (\$)
Zoning	\$774,240
Sewer	\$176,120
Septic	\$1,228,437
River Proximity	\$205,275
Total	\$2,384,072

Regression Results (pooled data of two counties)

A significant portion of the variation, (52 percent) in the dependent variable is explained by the model. However, it is much lower than the variation explained by the pooled data of the three counties. The coefficient estimates of the "focus" variables have changed in magnitude and in one case, sign of the coefficient. Zoning, which is technically urban zoning, has increased in magnitude to 269 dollars from 196 dollars. Septic estimates dropped from 279 to only 69, and the variable is significant at the 20

percent level. The sewer variable has changed both in magnitude and sign, it is negative and dropped to 128, indicating that existence of sewer system decreases the property value by 128 dollars. The coefficient of river distance dropped too, from 34 to 30, and is not significant even at 15 percent level of significance.

Estimation of Benefits to the Community

Zoning regulations and septic systems increase property values and imply higher tax revenues accruing to the community. The increase in taxes to the community may be expressed as the product of the tax millage rate² per thousand dollars of property value and the coefficient estimate. Ideally the expected increases in tax revenues to the zoned communities should be calculated using coefficients for each of these communities. Initially, we had pooled the data for all the counties and estimated the coefficients. Hence we shall take the aggregate or average coefficient estimate and assume it to have the same impact on all counties. However, after estimating separate regression equations for samples containing two counties and only Morgan County, we estimated the aggregates for these equations instead of using the results from the 3-county pooled data. Table VIb presents the implications of zoning on increased tax revenues for Muskingum and Washington Counties.

² The tax millage rate is the tax revenue accruing to the tax district per thousand dollars of property value.

Table VIb: Estimated Property Tax Revenues Generated by Zoning Regulation

City	Tax Millage	Coefficient Estimate	Number of Houses in the Area	Tax Revenue (\$)
Zanesville	41.37	\$269	1487	$(41.37 * \$269 * 1487) / 1000 = \$16,548.12$
Marietta	41.45	\$269	1190	$(41.45 * \$269 * 1190) / 1000 = \$13,268.56$
Total				\$29,816.68

The total increases in property tax revenue as a result of zoning regulation in the cities of Marietta and Zanesville is estimated to be \$29,816.68.

Similarly, Table VIc shows the increases in tax revenues accruing to the two cities as a result of increases in asset value due to septic and sewer systems.

Table VIc: Estimated Tax Revenues Generated by Septic System

City	Tax Millage	Coefficient Estimate	Number of Houses in the Area	Tax Revenue (\$)
Zanesville	41.37	\$67	1487	$(41.37 * \$67 * 1487) / 1000 = \$4,121.65$
Marietta	41.45	\$67	1190	$(41.45 * \$67 * 1190) / 1000 = \$3,304.81$
Total				\$7,426.46

Besides the increase in local government revenues generated due to the increase in asset value, the asset increase also contributes to the tax revenues that are received by the school district. Table VI d presents the increases in taxes accruing to the school districts. Both Muskingum and Washington counties have six school districts each, and every school district levies a different rate of tax on the residents of its district. The millage rate

for each county was weighted against the total value of the taxes and an average millage rate for each county was calculated.

Table VIId: Estimated Tax Revenues Generated by Septic System to School Districts

City	Tax Millage	Coefficient Estimate Zoning	Coefficient Estimate Septic	Number of Houses in the Area	Tax Revenue (\$)
Zanesville	24.61	\$269	67	1487	$\{(24.61 * \$67 * 1487) + (24.61 * \$269 * 1487)\} / 1000$ = \$12,295.94
Marietta	26.23	\$269	67	1190	$\{(26.23 * \$67 * 1190) + (26.23 * \$269 * 1190)\} / 1000$ = \$10,487.80
Total					\$22,783.74

Regression Results: Morgan County

Morgan County exhibits several features, which are less evident in the other two counties. The county has the highest rate of unemployment in the state. Most of the properties along the river in this county are in poor condition and there are more mobile homes. Also, the County Auditor has a more comprehensive set of data on the residential parcels. A separate exercise to assess property values in Morgan county was carried out in order to assess the property values in the county, observe differences, if any in the extent of variation explained by the independent variables and improve the robustness of the Hedonic Model with the help of additional variables and information.

A locational variable was introduced which describes whether the location of the parcel in any of the four townships, i.e., Morgan, Malta, Windsor or Bloom had any impact on housing values. The variables, Morgan, Malta and Windsor, capture this effect with

Bloom as the control variable. Topography is an important factor in determining property values, particularly in areas prone to flooding. To capture this effect, variables describing the topography of the parcel, (rolling, above street level, below street level and flat) are incorporated into the model. The properties in Morgan county were classified as agricultural and residential parcels with the total area divided between home site area in which property improvements are made, and area assigned for pasture, tillage, woodlands etc. In the earlier exercise involving all three counties, this differentiation was not available, which resulted in a larger average value of the home site. The other variables introduced in this model are boatdock, mobilehome, river distance1, which indicates whether the parcel is adjacent to the river and riverdistance2, which represents properties which have another parcel between the river and the parcel. Since these are discrete variables, the third measure, i.e., properties with more than two parcels between the river and itself is utilized as the control variable.

Most of the variables are significant and the adjusted R^2 is 68.09 percent, i.e., the model explains 68 percent of variation in the dependent variable. The variables Windsor, Rolling, Area, Homesite, Age, gfla, Room, Basement, Porch, Deck, Mobilehome, Septic, Well, Riverdistance1, and Subdivision are highly significant and the null hypothesis that any of these coefficients is zero at the 5 percent level of confidence can be rejected. Interestingly, basement had a negative effective in the analyses for three counties. It has a positive effect on property values in Morgan County, where the presence of basement is expected increase the value of the average property by 166 dollars. This inconsistency may be due to the fact that the properties adjacent to the river are mostly mobile homes without basement and the larger homes with basements are located away from the river,

and have a potential threat from flooding. A one percent increase in area, i.e., acres is expected to increase property value by .086 percent. On the other hand, a one percent increase in area of homesite is expected to decrease the value of the property by .075 percent. Topographic variables have a varied impact on the property value. Rolling topography is expected to have a negative effect of 21 dollars versus other types of topography. Properties above street level are expected to increase by 85 dollars and those below street level decrease by 84 dollars approximately. The control variable is flat topography.

Parcels classified as agricultural land are expected to add 52 dollars to the value of a property as compared to properties classified as residential in nature. Brick and stone construction adds to the value of property by 98 dollars versus other types of construction like frame, aluminum vinyl, etc. Age of the house has a negative effect on value as expected and decreases by .62 percent with a one percent increase in the age of the home. Structural characteristics such as gfla (square footage of house), number of bedrooms, bathrooms, porch, and deck have a positive effect on property value. A boat dock decreases the value of the property by about 4 dollars and a mobile home increases the value by 490 dollars. It was observed during visits to the corridor that Morgan County had a higher percentage of mobile homes than other counties and they may be a preferred form of housing in the area. Further investigation into the data needs to be carried out to determine whether the mobile homes in the sample are primary or secondary residences. A secondary residence may increase the value of the property if used as a guesthouse or rented. Septic systems increase the value of property by 361 dollars and a well decreases the value by 172 dollars.

The environmental variables, river distance 1 and 2, have negative coefficients. Since the region is prone to flooding, proximity to the river may have a negative effect on property values. The value of a property is expected to decrease by 188 dollars if it is located on the riverbanks and by 12 dollars if there is another property between the river and the residential property in question. Properties on the eastern side of the river are expected to be higher in value by 52 dollars compared to properties on the western side of the river. This is likely due to better highway access available to these parcels. Lastly, if the parcel is located in a subdivision, it is expected to decrease in value by 91 dollars. Although sub division regulations may not be as rigid as zoning regulations, they provide some uniformity and other amenities such as street light facilities to the residents. A possible explanation of the negative impact of sub division on property values may be due to undesired restrictions on properties resulting from subdivision regulations. Since most of the incidence of mobile homes and vacation homes is very high in the county, sub division regulation may be a deterrent to owners of properties who may want to use it as a site for mobile home. The marginal implicit values are presented in Table VIe.

Table VIe: Marginal Implicit Prices for Morgan County (in Dollars)

Area (acre)	\$8,001.96
Homesite (acre)	\$341.89
Home Size (gfla, Sq feet)	\$152.17
Age (years)	\$96.89

Table VI f presents the total benefits to the school districts as a result of increased asset value from the septic improvements.

Table VI f: Estimated Tax Revenues Generated by Septic System to School District

Tax Millage	Coefficient Estimate	Number of Houses in the Area	Tax Revenue (\$)
21.71	\$362	1290	$(21.71 * \$362 * 1290) / 1000 = \$10,138.14$

Table VI g presents the total increases in increased taxes due to increase in asset value from the septic improvements.

Table VI g: Estimated Tax Revenues for School Districts Generated by Septic

Tax Millage	Coefficient Estimate	Number of Houses in the Area	Tax Revenue (\$)
33.06	\$362	1290	$(33.06 * \$362 * 1290) / 1000 = \$15,438.35$

The average value of the properties is \$33,202 for the sample. A 10 percent sample was drawn, therefore the total population can be derived by multiplying the sample number by 10.

$$\text{Total Value } (213) * (10) * (33202) = 70,719,89.9 = \$7 \text{ million approx.}$$

These statistical results provide a starting point for determining the economic payoff that might be expected from various improvements proposed for the corridor. Other results of this Phase II study include further benefit (contingent valuation surveys) and cost estimates of specific Muskingum River corridor improvements to provide a more complete plan for economic development and methodology for river corridor valuation.

Comparison of results between the three models

The most significant difference between the models is the explanatory power of the models. Although Morgan County model has fewer observations its R^2 is the highest, at 68 percent, followed by the three county model at 64 percent and the lowest was for the two county model at 53 percent approximately. The magnitude, direction and significance of the coefficient estimates changed across the models indicating that the inclusion of data from Morgan County affects the coefficient estimates. Table VIh compares results across the three models.

Table VI h: Comparison of Results Across the Three Models

Indicator	One County (Morgan)	Two Counties (Muskingum And Washington)	Three Counties (Morgan, Muskingum and Washington)
R^2	68 %	53%	64%
Coeff For Zoning		0.2696	0.196
Coeff For Septic	0.362	0.0674	0.279
Coeff For Sewer		-0.1276	0.075
Coeff For River	-0.189 (proximity1)	0.0304	0.035
Proximity	-0.012(proximity2)		

A comparison of some of the indicators across the three models reveals that Morgan County in fact affects the results for the pooled data. The results from the models using three different samples revealed some expected pattern of behavior for some coefficients and behavior of other coefficients could not be explained by the hedonic process. For example, the coefficient of zoning was higher for a 2 county model than the three county

model. It posed a question whether zoning was perceived as a negative attribute by urban residents of Morgan County. The incidence of "no septic" in residential parcels is highest in Morgan County, yet the coefficient for septic was much higher and significant for the single county model than the 2 county model. Existence of a well functioning septic system carries a greater value for residents of Morgan County indicating that residents of the other two counties may take septic systems for granted or as a given amenity. One conclusion might be that the income elasticity for septic system is higher for a poorer community such as Morgan than the more affluent communities of Muskingum and Washington Counties.

Method for Comparing Estimated Benefits and Costs of Corridor Improvements

We developed cost estimates for the discussed corridor improvements and compared them to the residential property value, recreation benefit and existence value estimates. In this section, the benefits and costs of two corridor attributes, zoning and septic systems, will be discussed. When estimating the costs and benefits, we brought all values to discounted present value terms using a 10% rate of interest, or discount rate. In order to evaluate how rates of interest affected the ranking of the four major components under study (zoning, septic systems, bike trail and dam and lock repairs) we estimated costs and benefits at different rates of interest ranging from 4% to 15%. Between 8 and 10% and 10 and 12% there is a change in the ranking of the four corridor improvements or attributes. The initial expenditures, operation and maintenance costs, and the benefit streams for these four attributes differ. To estimate the aggregate benefits, we added up benefits derived from the hedonic model, the benefit transfer model (when appropriate) as well as results from the CV survey results. Double counting was avoided by focusing the CVM survey on non-use values.

Existence Value of Septic Systems

Lack of water quality data prevented our using any statistical method to estimate the benefits of well functioning waste treatment systems on increased recreation in the corridor. We therefore used the contingent valuation instrument to estimate the value of well functioning waste treatment systems to Ohioans. Local law enforcement's failure to provide homeowners with incentives to install and maintain well functioning septic systems along the corridor can be considered an institutional failure resulting from government's reach being larger than its grasp. Such institutional failure was the impetus for our asking the public's WTP for a program that is a radical departure from current laws. The proposed program puts the government in charge of the installation and twenty years of maintenance of household septic systems. The question was posed as follows:

Willingness to Pay for Installation and Maintenance of Household Septic Systems in the Muskingum River Corridor

Imagine you were asked to contribute towards an effort to improve the treatment of household waste produced by homes that are located on the banks of the Muskingum River. This effort would involve installation of treatment plants in areas where doing so is economically feasible (due to large enough household density). In areas where individual septic systems are necessary, the local health departments would service (replace baffles, repair motors, etc.) and pump out every household's septic system at no cost to the owner. How much would you pay (as a one time donation) to help install, upgrade and maintain household septic and sewage treatment along the Muskingum River?

- \$0.00
- \$10.00
- \$25.00
- \$50.00
- \$75.00
- \$100.00
- more than \$100.00 (please specify amount) _____.

Interestingly enough, many respondents seemed strongly opposed to this scenario; many surveys were returned with notes written in the margins to the effect that it is a homeowner's responsibility to pay for his own home's waste treatment system. Often in CV work, such responses are thrown out of the sample because they are considered "protest" responses. The researchers are, however, of the opinion that such responses are valuable information and since they are not outliers, they were included in the sample.

Despite this strong opposition, 23% responded that they would be willing to pay anywhere between \$10 and \$50 towards the installation, maintenance and repair of septic systems in residences along the corridor. The average of the responses to this question is \$5.73. Once again, in estimating a value for the entire population of Ohio we assumed that anyone who did not respond to the survey has a willingness to pay equal to zero. Under this assumption, the average willingness to pay of our sample is \$1.32. If our sample of 473 Ohioans is representative of the population of Ohio above the ages of 16, (we have no reason to believe that it is not), our results represent a willingness to pay of adult Ohioans equal to \$11,161,164.

In fact, such negative responses convey to the researchers that the survey respondents were often unaware of the lack of incentives homeowners have to maintain their own septic systems. This could be an indication of a need for public education regarding the effect of incentives on our decisions regarding the environment. Without such educational efforts (or perhaps even after educational outreach), many people believe that it is the homeowner's responsibility to install and maintain a septic system and do not recognize the institutional failure that arises when the government tries to enforce current laws regarding household septic systems. Because of this opposition it is

likely that a proposal to fully subsidize septic installation and maintenance would fail politically. For this reason, we compared the costs and benefits of two different programs.

The first is a program wherein new septic systems would be installed in those homes that currently have either no septic system or a failing septic system that needs replacement. After interviews with local health officials, we determined that roughly one fourth of the homes in the corridor likely need a new septic system. The costs of the program were estimated by calculating the sum of what it would cost to install new septic systems in one fourth of the 5950 homes in the corridor and what it would cost to maintain the septic systems of all of the 5950 homes in the corridor. The total cost of such a program would be roughly \$9,282,000. The total benefits from the program are the sum of the WTP and the increased property value; they total \$12,915,894. The second program addresses the opposition that would probably prevent the political success of the first program; it is a cost-sharing program in which homeowners would pay half of the cost of installation and maintenance while contributions would fund the other half. The benefits would remain the same as in the program with full subsidization (\$12,915,894) while the costs are simply cut in half to equal \$4,641,082. Table VIi shows the benefit cost ratios of zoning and septic systems. The benefits of both zoning and septic installation are well above the costs and have a benefit cost ratio greater than one.

Table VI: Benefits (CVM and Hedonic) and Costs of Zoning and Septic at a 10% Discount Rate

Attribute	Benefits	Costs	Benefits- Costs	Benefit/Cost
Zoning	\$912,000	\$144,000	\$769,000	6.35
Septic (Fully Subsidized)	\$12,915,894	\$9,282,000	\$3,633,894	1.39
Septic (Cost Sharing)	\$12,915,894	\$4,641,082	\$8,274,812	2.78

VII. Summary and Conclusions

A. Overview

This is the second phase of a two-phase economic evaluation of the Muskingum River corridor in Southeast Ohio. The intent of the overall study has been to develop estimates of the benefits and costs of various river corridor improvements or changes as a guide to public policy on river restoration and improvement. When the various corridor benefits or values are expressed in a common economic metric and compared to their economic costs, one has a basis for viewing river corridors and their improvements in an economic development context.

In fact, the genesis of this study was from community leaders in the Muskingum River corridor who were concerned about the depressed economic situation of their communities. They contacted Rivers Unlimited for help and Rivers Unlimited in turn contacted our resource economics group in the Department of Agricultural, Environmental and Development Economics at The Ohio State University. Jointly we explored what types of improvements in the river corridor might directly result in or are catalysts for improved economic well-being and developed methods for measuring them. We have drawn heavily on the methodological literature in resource economics known as non-market valuation and from the benefit cost analysis and benefit transfer literature.

This two-phase study has focused on one river corridor and its relevant improvements including the repair of historic dams and locks, extension of an existing bike trail, improvement of household septic systems and the past establishment of municipal zoning. However, our future intent is to explore other improvements in other

selected rivers in order to develop a template and the capability to simulate benefit cost outcomes for a wide range of river scenarios.

The methods applied for estimating costs in this study are market-based opportunity cost concepts. Benefits are more difficult to observe in market transactions for each of the corridor improvements, so benefit transfer, hedonic pricing and contingent valuation survey methods are utilized. In all cases conservative assumptions are chosen to provide lower bound estimates of net benefits and to avoid overstating the economic merits of the selected corridor improvements. In order to easily compare benefits and costs that are occurring over time, we express both the benefits and costs in 1999 dollar values. This is known in the economic jargon as using a discounted present value. Simply stated, when we faced a benefit (or cost) that would be incurred in the future, we used a discount rate to express it in present day terms.

B. Infrastructure Results

Earlier US Army Corps of Engineers analysis projected large increases in Muskingum River corridor recreation; the corps maintained that these values justified large future investments in lock and dam improvements. Our analysis shows that recreational use values do not offset the costs of lock and dam repair/upgrades. We demonstrated this with evidence that repairs and upgrades made in recent years have not resulted in any measurable increases in recreation use. Decreases in lock use have in fact been the norm. This evidence was combined with benefit transfer techniques and day use values for various types of recreation (e.g. boating, fishing, picnicking and visiting) common in the Muskingum Corridor.

Since use values are inadequate, we explored non-use (existence, historic preservation) values through the use of a contingent valuation survey of willingness to pay for lock and dam repair by a sample of the adult residents of Ohio. These results suggest benefits large enough to exceed the discounted present value costs of lock and dam repair. The benefit cost ratio is 1.51 and the net present value \$5,876,000.

The proposed extension of the Zane's Landing bike trail was evaluated with a similar approach. Construction cost estimates were available for the proposed trail and it was possible to get information on annual operating and maintenance costs from other trails in Ohio. The benefits were estimated by aggregating the results from the aforementioned contingent valuation survey and the forecasted trail use. Once again the findings are supportive; the benefit cost ratio is 6.49 and the net present value \$11,261,000.³

C. Zoning and Septic System Results

The costs of zoning and improved household septic systems were determined from interviewing those involved in the provision of each. The analysis of the benefits was more complex. Both zoning and household septic systems are expected to impact residential property values, so we chose a hedonic pricing method to estimate this effect. Hedonic pricing statistically decomposes the housing/property values into house, community, and environmental attributes and estimates the relative values of each of these attributes. In the case of household septic systems we felt it appropriate to assess benefits accruing to other stream users besides river corridor residents. Thus, the

³ To avoid possible confusion, it is important to point out that the trail usage values taken from the study of the trail in Dubuque, Iowa are measures of the expenditures made by the users of the trail. This is a different measure than the day use values used for boaters, fishermen, etc. taken from the Walsh study which are a measure of economic surplus. Thus, the aggregation of the trail usage values and the CV results does not pose a problem of double counting.

contingent valuation survey was utilized to approximate these values and the results were combined with the hedonic estimates.

From the hedonic model it was possible to determine the effect of the presence of zoning, central sewer system, individual household septic system and river proximity on residential property values in the corridor. The aggregate values are as follows: zoning \$912,497; central sewer \$678,300; household septic systems \$1,469,650; and river proximity \$636,650. The hedonic benefits for zoning when compared with costs show a benefit cost ratio of 6.35 and NPV of \$768,793. The combined hedonic and CVM results for household septic systems (with a local government 50% cost share of installation and full coverage of repair and cleaning) showed a benefit cost ratio of 2.78 and NPV of \$8,274,812. The results of a program of full governmental subsidization were a benefit cost ratio of 1.39 and NPV of \$3,633,894

D. Sensitivity Analysis and Aggregation of Results

Tables VIIa and VIIb present the results of performing sensitivity analysis by using discount rates ranging from 6 to 15 percent. This allows us to determine how robust or stable the results are as the opportunity cost of capital increases. This refers both to whether or not the various corridor attributes/ improvements continue to be economically viable as well as to whether the ranking of the attributes changes.

Even at 15% all of the corridor improvements have benefit cost ratios greater than 1; in other words, they remain economically viable. Stated alternatively, the internal economic rates of return for all of the corridor improvements are greater than 15% (see Table VIIc). However, the ranking of the alternative improvements does change with

increases in the discount rate (between 8 and 10 and between 10 and 12%) as shown in Table VIIb.

Table VIIa: Benefit Cost Ratios at Alternative Rates of Interest

Attribute	Benefits over Costs					
	4%	6%	8%	10%	12%	15%
Zoning	4.70	5.27	5.82	6.35	6.86	7.58
Septic (Fully Subsidized)	1.39	1.39	1.39	1.39	1.39	1.39
Septic (Cost Sharing)	2.78	2.78	2.78	2.78	2.78	2.78
Bike Trail	8.01	7.35	6.86	6.49	6.22	5.94
Dam & Lock	0.88	1.06	1.27	1.51	1.75	2.16

Table VIIb: Ranking of the Attributes (on the Basis of Benefit Cost Ratio) at Different Rates of Interest

Attribute	4%	6%	8%	10%	12%	15%
Zoning	2	2	2	2	1	1
Septic (Fully Subsidized)	4	4	4	5	5	5
Septic (Cost Sharing)	3	3	3	3	3	3
Bike Trail	1	1	1	1	2	2
Dam & Lock	5	5	5	4	4	4

At a 10% discount rate (a discount rate commonly used in this type of analysis) it is instructive to compare and aggregate the net present value and benefit cost ratio results for the corridor improvements. Table VIIc presents these results.

Table VIIc: Summary of Aggregate Benefit Cost Results in 1999 Dollars
(Using a 10% Discount Rate)

Improvement	Present Value of Benefits	Present Value of Costs	Net Present Value (B-C)	Benefits/ Costs (Ratio)
Zoning	\$912,000	\$144,000	\$769,000	6.35
Septic (Fully Subsidized)	\$12,916,000	\$9,282,000	\$3,634,000	1.39
Septic (Cost Sharing)	\$12,916,000	\$4,641,000	\$8,275,000	2.78
Bike Trail	\$13,311,000	\$2,050,000	\$11,261,000	6.49
Lock & Dam	\$17,511,000	\$11,635,000	\$5,876,000	1.51
Total (Fully Subsidized)	\$44,650,000	\$23,111,000	\$21,539,000	1.93
Total (Cost Sharing)	\$44,650,000	\$18,470,000	\$26,180,000	2.42

When using the benefit cost ratio efficiency criterion and a 10% discount rate, the bike trail extension and zoning rank first and second followed by cost sharing of upgraded household septic systems and lock and dam operation and repairs. Full subsidization of septic systems ranks last but does have a benefit cost ratio greater than one. With the net present value criterion, which is influenced by the scale or size of investments, the bike trail ranks first, followed by the cost sharing of upgraded household septic systems, the locks and dams, the full subsidization of household septic systems and zoning respectively. In total, the four improvements have a net present value of \$26.2 million and a B/C ratio of 2.42.

E. Limitations and Further Research

Any research endeavor has limitations and this study of the Muskingum River is no exception. In an ideal world, better water quality data and higher response rates on the CVM survey would have been preferred. More evidence on establishment costs for zoning, and the economic and environmental value of river water for AEP's cooling

needs in electric power generation would all improve the study results. More detailed second stage estimates of actual demand functions in the hedonic price analysis, estimation of economic internal rate of return and development of bid functions for the CVM survey results would improve the accuracy, generalization and explanation of results. Several of these issues will be addressed in the thesis research of Sarah Lowder and Radha Ayalasomayajula.

F. Policy Implications

These research results have some important policy implications in spite of the limitations highlighted in the previous section and the need for further research. First, the methods and results demonstrate that it is possible to develop economic metrics for the costs and benefits of selected river corridor attributes. In addition, these results provide evidence for ranking corridor improvements based on the benefit cost ratio and net present value of each attribute. However, if magnitude or scale of the attribute improvements varies considerably, the ranking of attributes according to benefit cost ratio and net present value may be different.

Benefit cost ratios greater than one and positive net present values were evident for all Muskingum River Corridor attributes and improvements even though fully subsidized household septic systems were not considered politically viable. So, in general, the economic rationale for river improvement and restoration is supported. As an investment strategy one might propose to proceed by implementing corridor improvements on the basis of their relative economic efficiency based on their benefit cost ratios. Some caution must be exercised. One might expect improved septic systems, lock and dam restoration and the bike trail extension to result in increased

economic well being in the Muskingum River Corridor. However, limited opportunity may exist for additional municipal zoning and hence it is unlikely that additional benefits from zoning will occur in the future.

One potential benefit of these economic methods and results is to reduce conflict and transaction costs in the policy process. For example, applying a common economic metric to river corridors and other natural systems may make it possible for state departments of natural resources and economic development to find more common ground in improving the well being for state citizens. Business and environmental interest groups may also be able to build more consensus and lower decision making (e.g. litigation) costs.

The future challenge is to build more public support for additional resource economic analysis of rivers and other natural systems. Our intent is to expand the river economic analysis to other corridors where we can study water quality variations, toxics and dam removal and restoration of channelized streams. We feel confident that as additional economic evidence is generated, we will be able to develop templates that allow us to simulate results for other issues and river corridors.

VIII: Appendices

Appendix A: The Contingent Valuation Method

We were unable to estimate the value of certain corridor attributes and improvements using market data. Such values are either not captured by the market or secondary data is unavailable. We therefore chose to perform a contingent valuation of these attributes. Contingent valuation is performed by surveying individuals. The survey instrument establishes a hypothetical or simulated market and asks respondents to state their willingness to pay for a particular good, service or environmental amenity. Contingent valuation is a somewhat controversial method. Its largest criticism comes from the hypothetical nature of the markets it establishes. However, it is in many cases the only method available for the purposes of valuing non-market items and it is capable of a more holistic valuation of environmental attributes.

Our strategy in this study was to glean as much information as possible from available market data collected for the corridor. We then identified the values we were unable to estimate and designed a CV survey that we mailed to a sample of the general population of Ohio as well as two special interest groups.

In limiting our survey population to adult Ohioans we have effectively underrepresented the users of the river corridor. It may have been more accurate to sample a population defined as those residents of Ohio, West Virginia, Kentucky and Pennsylvania who live within a certain distance to the corridor. However, time and resource constraints prevented such an undertaking. By limiting our population to adult Ohioans we were consistent with the conservative estimation we used throughout the study.

Our sample of the adult population of Ohio was provided by the Ohio Bureau of Motor Vehicles Department of License Registration. The bureau supplied a randomly drawn sample of the population of Ohio that has drivers' licenses. Because our sample consists only of those Ohioans who have a driver's license, it contains some bias. We did not survey Ohioans under age 16. Our original intent was to survey the adult population of Ohio because we find it unlikely that anyone who is not an adult would have a positive willingness to pay. Therefore, the lack of anyone under the age of 16 in our sample does not appear to pose a serious problem regarding bias. A minor problem exists in that our sample excludes Ohioans who do not own a drivers license. This may include those people whose incomes are too low to have the opportunity to drive. We anticipate that such omission from our sample causes our results to have a slight upward bias. However, the assumptions that we made when calculating the average willingness to pay of the population of Ohio would appear to easily offset this upward bias and make our final value a lower bound estimate of the value of the amenities in question.

In designing our survey we ran several pretests in order to determine how best to phrase our questions, which questions to include, etc. Most of the pre-testing was performed in the corridor on people using Zane's Landing bike trail or fishing along the river. The survey also went through a process of peer review by several graduate students and faculty members within the Department of Agricultural, Environmental and Development Economics. The final draft of the survey was sent to 500 Ohioans randomly selected from a list of over 4000 Ohioans generated by the Bureau of Motor Vehicles. Twenty-seven of the 500 surveys were returned unopened because the address used was no longer valid. Because those 27 surveys never reached a potential respondent

our effective sample size was reduced from 500 to 473 Ohioans. Since the response rate to our first survey was low, (about 8%) we sent the survey out a second time and in so doing increased the response rate to 23%. We are pleased with the 23% response rate; we did not expect our survey to elicit a response rate of 35% or higher as often obtained in successful CV studies. We rather expected our survey response rate to be much lower because we were not surveying people about an issue that affects them locally. However, we recognize that our respondents are not fully representative of the adult population of Ohio. The average age of respondents is higher than that of the average for the adult population aged 16 and over. We estimate that the average age of the adult population of Ohio is approximately 46 years old. The average age of our respondents is approximately 61 years old. Such results are not surprising as senior citizens are more likely to respond to surveys than other groups.

As earlier stated, we used the survey instrument to value those amenities for which we lacked benefit information. These amenities include the historic value of the locks and dams, the benefit to Ohioans of the extension of the Zane's landing bike trail and the value of establishing a governmental program to oversee the maintenance and installation of well functioning septic systems to households throughout the corridor. The results of the survey revealed that the strongest and widest support was for lock and dam repairs, maintenance and operation. Not only was the average willingness to pay highest for the lock and dams, it was also the question to which the largest percent of respondents supplied a non-zero willingness to pay. The household waste treatment program and bike trail extension were the least widely supported with only 22% and 21% responding with a non zero willingness to pay. The average willingness to pay for the

waste treatment program was \$5.73. The bike trail elicited the lowest willingness to pay; it averaged \$3.72 for survey respondents.

These responses only represent approximately 23% of the 473 Ohioans that we randomly sampled. In order to get an idea of the total amount that the entire adult population of Ohio would be willing to pay for these amenities we had to make assumptions regarding the responses of the other 77% of our sample. Throughout the study we have made the most conservative assumptions whenever possible; this was no exception. We calculated the average Ohioan's willingness to pay assuming that all non-respondents have a zero willingness to pay. We must be careful to emphasize that these results are merely a lower bound. It is expected that they would increase if we were able to get a response from everyone. Furthermore, if we knew every individual's response, the ranking of the three amenities could possibly change. The responses we received suggest that adult Ohioans value the operation and maintenance of the locks and dams the most. They consider the proposed household waste treatment program to be less valuable and the extension of the bike trail the least valuable of the three options. Regardless of the ranking of these amenities it seems clear that they are all important to the general population of Ohio.

Appendix A Table 1: General Population Survey Results

	Lock and Dam Repairs, Maintenance and Operation	Household Waste Treatment	Extension of Zane’s Landing Bike Trail
Percent of Respondents with non-zero WTP	28%	22%	21%
Average Willingness to Pay of Survey Respondents	\$8.99	\$5.73	\$3.72
Average Willingness to Pay of Ohioans (age 16 and above)	\$2.07	\$1.32	\$0.86
Average Willingness to Pay of the Total Adult Population of Ohio	\$17,511,145	\$11,161,164	\$7,245,991

Although Contingent Valuation is a powerful research tool, it like any other methodology, has its weaknesses. One major criticism of Contingent Valuation is that although it measures values of environmental services it does not capture them. That is, the consumer surplus provided by the locks and dams and other amenities can be estimated using CV, however, no money is ever collected. The transaction costs associated with a fundraising campaign that solicits contributions from the entire population of Ohio towards the Muskingum River locks and dams could be so large that the resulting net present value would be quite small. Instead of undertaking such a futile exercise, the results of our study could be used to identify certain groups whose willingness to pay is large enough to justify the transaction costs associated with soliciting their contributions. Further work estimating bid functions which help identify

the traits of people who would contribute significantly is underway in Sarah Lowder's MS thesis.

By surveying the membership of two special interest groups we were able to assure ourselves that the members of at least those two organizations have significantly higher willingness to pay than that of the general population of Ohio. One obvious limitation to the ability to raise money by soliciting groups such as Rivers Unlimited and the Canal Society is the small size of their membership. Future research will include identification of similar groups based in Ohio, Kentucky, Pennsylvania and West Virginia and the extrapolation of our results to these groups in order to estimate the size of funds that could be raised by contacting such groups. The results from our survey of Rivers Unlimited and the Canal Society are shown in Table VIIIb below. These results suggest that by contacting the members of environmentally and historically conscious river organizations, fund raising efforts might be better remunerated than they would be by contacting the general population of Ohio.

Table VIIIa: Canal Society Survey Results

	Lock and Dam Repairs, Maintenance and Operation	Household Waste Treatment	Extension of Zane's Landing Bike Trail
Percent of Canal Society Respondents with non-zero WTP	82%	38%	60%
Average Willingness to Pay of Canal Society Survey Respondents	\$60.50	\$16.08	\$22.25
Average Willingness to Pay of Canal Society Members	\$26.30	\$6.99	\$9.67
Willingness to Pay of the Total Membership of the Canal Society	\$7180	\$1908	\$2640

Table VIIIa: Rivers Unlimited Survey Results

	Lock and Dam Repairs, Maintenance and Operation	Household Waste Treatment	Extension of Zane's Landing Bike Trail
Percent of Rivers Unlimited Respondents with non-zero WTP	67%	44%	62%
Average Willingness to Pay of Rivers Unlimited Survey Respondents	\$32.00	\$27.89	\$20.78
Average Willingness to Pay of Rivers Unlimited Members	\$8.52	\$7.42	\$5.53
Willingness to Pay of the Total Membership of Rivers Unlimited	\$2922	\$2545	\$1897

Interestingly, the Rivers Unlimited group ranked each of the three amenities in the same order as the general population did (in terms of the average amount respondents were

willing to pay). The average WTP of a member of Rivers Unlimited for lock and dam repairs was \$8.52, WTP for waste treatment was \$7.42, and WTP for the extension of the bike trail was \$5.53.⁴ The average WTP of a member of the Canal Society for lock and dam repairs was \$26.30, WTP for waste treatment was \$6.99 and WTP for the extension of the bike trail was \$9.67. The Canal Society had a much higher willingness to pay for lock and dam improvement, as might be expected.

On average, a member of the Canal Society has a WTP for lock and dam restoration that is almost thirteen times that of an adult Ohioan and a member of Rivers Unlimited has a WTP for lock and dam restoration that is over four times that of an adult Ohioan. A member of the Canal Society or Rivers Unlimited has an expected WTP for the septic program over five times that of an adult Ohioan. On average, a member of the Canal Society has a WTP for the bike trail that is over eleven times that of an adult Ohioan and a member of Rivers Unlimited has a WTP for the bike trail that is over six times that of an adult Ohioan.

Our main concerns with the survey are that the way in which we constructed the WTP questions may have affected the amount respondents claimed they would contribute. That is, we asked people if they would be willing to pay 0, 10, 25, 50, 75, 100 or more than 100 dollars towards certain programs. Had we instead asked respondents if they would be willing to pay 0, 50, 100, 200, 400, 800 or more dollars for the same programs, our results might have been different. However, our initial pre-testing focused on limiting such bias by determining what increments would be appropriate. During the pre-test phase we asked respondents an open-ended WTP question. That is, we did not supply respondents with any amounts to guide them in their statement of willingness to

⁴ Again, these averages assume that all non-respondents have zero willingness to pay.

pay. Consequently, we had a lot of people that responded that they were unsure. However, we analyzed the responses that we did receive and used them to determine the increments to use in our actual survey. Furthermore, we were careful to use conservative values once again in order to avoid overestimation of our results.

Another problem with the survey is that the program for the treatment of household waste seems to have been misunderstood by many respondents. A different scenario may have led to different results. Increased enforcement coupled with a program whereby the government manages septic system installation and maintenance may be a more effective approach to resolving the problem of inadequate household waste treatment. However, it seems that much of the public does not feel that this is reasonable. In hindsight it seems that it may have been more appropriate to ask the public what they would be willing to pay for a program of cost sharing and/or enhanced monitoring and enforcement of the current law.

There are, of course, concerns related to the nature of the contingent valuation method. Whether or not one believes that contingent valuation is a reliable method, it is important to recognize that it is the only method we have for measuring the non-use value of the locks and dams as well as the value of a program for the treatment of household waste. For those who are skeptical, we remind them that very conservative assumptions were used in estimating lower bound values of the total benefit of these attributes. A copy of the survey that was sent to the adult population of Ohio follows; the survey that was sent to the membership of Rivers Unlimited and the Canal Society was the same with the exception that it did not include the first two questions.

1. Are you a member of any environmental organizations that are particularly concerned with protecting and/or restoring river corridors? Examples of such groups include but are not limited to Rivers Unlimited, the Issac Walton League, and Friends of the Olentangy River. If so, **please list** the group(s) to which you belong. If you are unsure whether or not a group to which you belong fits this description, please list it.

2. Do you belong to any historical group(s) whose mission is to preserve the historical aspects of river corridors and canals? The Canal Society is an example of such a group. If so, **please list** any such group(s) to which you belong. Once again, if you are unsure whether or not a group to which you belong fits this description, please list it.

3. Have you ever visited the Ohio River Museum in Marietta, Ohio?

4. Do you live along the river corridor?

5. Do you spend or have you spent time in the Muskingum River Corridor? If so then skip question 6.

6. Do you expect to spend time in the Muskingum River Corridor?

7. If you answered yes to either question 2 or 3, which of the following recreational activities **have you done in the past** in the Muskingum River Corridor or do you **plan to do in the future** in the Muskingum River Corridor? Put a cross in the appropriate column and row of all responses that apply to you.

Activity:	I have done this in the past in or along the Muskingum	I plan to do this in the future in or along the Muskingum
Fishing on the river bank		
Using bike trails that run alongside the river		
Boating		
Motor boating		
Jet skiing		
Canoeing, kayaking or rowboating		
Using the locks to navigate the river		
Touring historical sites (e.g. Covered bridges, locks, etc.)		
Picnicking		
Fishing from a boat		
Swimming in the River		
Other(s) Please specify: _____		

8. Does poor water quality in the Muskingum River discourage you from doing any of the following at any specific point along or in the river? Check all that apply.

- Fishing on the river bank
- Using bike trails that run alongside the river
- Boating
- Motor boating
- Jet skiing
- Canoeing, kayaking or rowboating
- Using the locks to navigate the river
- Touring historical sites (e.g. covered bridges, locks, etc.)
- Picnicking
- Fishing from a boat
- Swimming in the River
- Other(s) Please specify: _____

9. The Muskingum River Lock and Dam system requires costly repairs. Imagine you were asked to make a one-time donation to help with the maintenance, repair and operation of the Muskingum River lock and dam system. You would be contributing towards maintenance and restoration effort that will do everything it can to preserve the locks in their original condition. Which of the following amounts most closely approximates the amount that you would contribute? *This amount does not include the amount of money that you currently spend or that you anticipate spending when touring or using the locks.*

\$0.00

\$10.00

\$25.00

\$50.00

\$75.00

\$100.00

more than \$100.00 (please specify amount) _____.

10. Given what you know about locks and dams (however much or little) for what reasons do you consider well maintained locks and dams important to the Muskingum River corridor? Check all that apply

Entertainment (they are fun to use)

Practical reasons (to move watercraft from
one point along the river to another)

Enjoyment of them as historic landmarks

Their maintenance of water levels necessary for motorboats

Commerce

They are not important

Other(s) Please specify: _____

11. There is currently a short bike path (2.7 miles long) located in northern Zanesville. An extension of this path has been proposed that will run North to Dresden. Imagine you are approached by someone who asks you to donate towards the extension of the Zanesville trail. How much would you pay (as a one time donation) towards funding the extension of the Zanesville bike trail along the Muskingum River?

- \$0.00
- \$10.00
- \$25.00
- \$50.00
- \$75.00
- \$100.00
- more than \$100.00 (please specify amount)

_____.

The effectiveness and existence of household waste treatment systems varies across households in the Muskingum River. That is, some households have septic systems that are in good working order, others have septic systems that are not functioning well and still others do not have septic systems and are not connected to a sewage treatment plant. Because household waste is emptied directly into the river after it has or has not been treated, it is regarded as a threat to the water quality of the Muskingum River.

12. Imagine you were asked to contribute towards an effort to improve the treatment of household waste produced by homes that are located on the banks of the Muskingum River. This effort would involve installation of treatment plants in areas where doing so is economically feasible (due to large enough household density). In areas where individual septic systems are necessary, the local health departments would service (replace baffles, repair motors, etc.) and pump out every household's septic system at no cost to the owner. How much would you pay (as a one time donation) to help install, upgrade and maintain household septic and sewage treatment along the Muskingum River?

- \$0.00
- \$10.00
- \$25.00
- \$50.00
- \$75.00
- \$100.00
- more than \$100.00 (please specify amount)

_____.

13. Which of the following river-related recreational activities do you enjoy in rivers *other than* the Muskingum River? Check all that apply.

- Fishing on the river bank
- Using bike trails that run alongside the river
- Boating
 - Motor boating
 - Jet skiing
 - Canoeing, kayaking or rowboating
- Using the locks to navigate the river
- Touring historical sites (e.g. covered bridges, locks, etc.)
- Picnicking
- Fishing from a boat
- Swimming in the River
- Other(s) Please specify: _____

14. Does the poor water quality of any river (other than the Muskingum) prevent you from doing any of the following in its waters or along its banks? Check all that apply.

- Fishing on the river bank
- Using bike trails that run alongside the river
- Boating
 - Motor boating
 - Jet skiing
 - Canoeing, kayaking or rowboating
- Using the locks to navigate the river
- Touring historical sites (e.g. covered bridges, locks, etc.)
- Picnicking
- Fishing from a boat
- Swimming in the River
- Other(s) Please specify: _____

Demographics

15. Are you:

Male Female

16. In what year were you born? _____

17. How many people, including yourself, live in your household?

One Four
Two Five
Three Six or more

18. What is your level of formal education?

- Professional or Graduate degree
- College Graduate
- Some College
- High School Graduate
- Some High School
- Grade School or less
- Other. Please specify _____

19. Indicate the number of people living in your household who fall into each age and sex category.

Age Group	Female	Male
Under 1 year		
1 to 3 years		
4 to 12 years		
13 to 25 years		
26 to 45 years		
46 to 65 years		
65 or older		

20. What is your current employment status? Check all that apply.

Full-time Unemployed
Part-time Student
Seasonally Employed Homemaker
Self Employed Retired

21. If you work please give a brief description of your position.

22. Please indicate your approximate household income (the total of the yearly incomes of each of the members of your household).

- \$100,000 or over
- \$80,000 - \$99,999
- \$60,000 - \$79,999
- \$40,000 - \$59,999
- \$20,000 - \$39,999
- Under \$20,000

23. In recent years discussion has occurred regarding whether or not it would be possible to install low head hydropower plants at various dam sites. Please check whichever of the following statements best describes your attitude regarding this issue.

- I am opposed to the construction of hydroelectric power plants because I feel that they are a threat to the natural environment
- I support the construction of hydroelectric power plants because they create industrial and economic growth.
- I support the construction of hydroelectric power plants because they generate pollution free, sustainable power.
- I am concerned about this issue but unsure what position to take.
- I do not care whether or not hydroelectric facilities are constructed.
- Other (please specify)_____.

24. Indicate whether you consider the following services and issues very valuable, somewhat valuable, neither valuable nor invaluable, not very valuable or not at all valuable.

	Very valuable	Somewhat valuable	Neither valuable nor invaluable	Not very valuable	Not at all valuable
Conservation of wildlife and natural habitats					
Government provision of well-maintained outdoor recreational facilities					
Preservation of all locks in their original state (as they were in the 1840s)					
Maintaining all locks in a functional state regardless of whether or not they are preserved in their original state					

Appendix B: Hedonic Pricing Method for Residential Values: Three County Sample

“The hedonic technique is a method for estimating the implicit prices of the characteristics which differentiate closely related products in a product class” (Freeman, 1971). It is the basic method used in the analysis of environmental amenities and disamenities related to property values. Hedonic prices are defined as “implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them”(Rosen, 1974). The econometric estimation of the hedonic pricing function consists of property value as the dependent variable and all other characteristics as independent variables. Freeman developed a two-stage model of individual choice. In the first stage, he assumes that the housing market is in equilibrium and each individual’s utility is a function of his/her consumption of a composite commodity, X , which is a vector of some characteristics, and the price of the i th residential location, P_i . The hedonic function is given by: $P_i = P(S_i, C_i, Q_i)$ where S_i represents the structural characteristics, C_i represents the community characteristics and Q_i represents the environmental characteristics.

The functional form that performed the best in our study was a log-linear mixed form. The assessed value of property (the dependent variable), total acreage of the parcel, total living area, and age of the house were specified in log form. Log-linear mixed form incorporates diminishing marginal utility. A linear model would not have been desirable because it assumes that implicit price is constant regardless of the quantity of the attribute.

Sampling And Data Collection

The analysis of the effect of river access on the land values within the corridor required accumulating an adequate data set. Data requirements were chosen from a literature-based approach as well as from a hands-on approach by interviewing local officials. Relevant theoretical and applied literature was reviewed, and a set of explanatory variables that would explain the property values of river front properties was identified and specified. Theoretically, it is best to take sale values as the dependent variable. However, the study area is very small and the number of arm's length sales occurring in a period of one year were not sufficient to make an adequate sample size. In addition, there were concerns about some values being "deals" between friends or relatives. The assessed market property values as estimated by the county auditor's office are taken as a proxy for sale values. The county auditor's office assesses the value of the house by measuring the structural and locational characteristics of the house using a pre-determined scale and recent sales in the area. All the sales within the sample were regressed against the market assessed values and it was found that the sale values were an average of 5 percent higher than the assessed values. The research used cross sectional data from the county auditors' offices. The data relating to the independent as well as dependent variables was gathered from parcel cards obtained from the auditors. The values of the river distance variable, were obtained by matching each individual observation of parcels with the corresponding maps provided by the county engineers' offices. The sample was selected from the townships adjoining both sides of the Muskingum River. Townships not touching the river were left out of the sample. Particular attention was given to include townships that incorporated zoning. The sample

consists of 476 observations. A simple sampling procedure of picking every tenth parcel was adopted. The hedonic price function for the model is expressed as

$$\text{LnValue} = \alpha + \text{B1zoning} + \text{B2 elec} + \text{B3Water} + \text{B4gas} + \text{B5 sewer} + \text{B6septic} + \text{B7basement} + \text{B8lnacreage} + \text{B9lnlivingarea} + \text{B10rooms} + \text{B11bathrooms} + \text{B12 heating} + \text{B13airconditioning} + \text{B14riverdistance} + \text{B16garage} + \text{B17lnage} + \text{B19 Martdist} + \text{B20Mcdist} + \text{B21zanedist} + \text{B22taxrate} + \text{B23gradrate} + e$$

The model explains 64% (adjusted R^2) of the variation in the data. Fifteen of the 21 estimated coefficients are significantly different from zero at the 5% significance level as illustrated in Table VIIIc. The estimated coefficient of water is different from its expected sign and is significantly different from zero at the 5% confidence level. Existence of community drinking water supply to a house is expected to have a positive effect on property value. The environmental amenity variable, river distance is significantly different from zero at the 10% level of significance. The variables measuring locational advantage are significantly different from zero at the 10% significance.

Table VIIIc: Hedonic Price Gradient Estimates
Dependent Variable = Natural Logarithm of Home Assessed Value

Variable	Coefficient Estimate	t-value	Variable	Coefficient Estimate	t-value
Electricity	.686	5.3	Age	-.036	-2.8
Water	-.254	-2.6	Sewer	.114	1.6
Gas	.094	1.6	Septic	.247	3.5
Basement	.067	1.0	River Distance	.107	1.9
Acreage	.102	6.3	Zoning	.231	2.81
Living Area	.333	6.0	Distance to Marietta	-.018	-1.9
Rooms	.027	1.9	Distance to McConnelsville	-.008	-2.0
Bathrooms	.167	.335	Distance to Zanesville	-.018	-2.6
Air Conditioning	.416	6.8	Income Tax Rate	.019	-2.6
Garage	.171	3.9	High school Graduation Rate	.001	.4

The coefficients for living area, acreage and age are elasticities, interpreted as percentage change in the value of a property due to a 1% change in the quantity of that characteristic, other things remaining the same, since they are expressed in the natural logarithmic form. Variables used in regression analyses generally take values over a continuous range. As the area of the property increases by one percent, the value of the property is expected to increase by approximately 0.102 percent. Similarly, as the total living area increases by one percent, the value of the property is expected to increase by 0.333 percent. As the age of the house increases by one year, the value of the house is expected to decrease by .036 percent. However, if the variable takes only two values, the value of 1 or 0, then a dummy variable is created. Since most of our data is qualitative in nature, dummy variables were used to specify a number of variables. Coefficients estimated for the dummy variables represent the change in the value of property due to

the presence or absence of the respective variable holding all other variables constant. The value of the property is expected to increase by \$231 if the property is located in a zoned area, an additional room will increase value by \$27, an additional bathroom by \$167 and river access by \$107. Provision of utilities like electricity, gas, sewer and septic system are expected to increase value by \$686, \$94, \$114 and \$247 respectively.

In the first stage, adopting a log-linear mixed model specification, derivatives of the estimated coefficients were taken with respect to each of the characteristics specified in its logarithmic form. The derivatives yield estimates of the marginal implicit price of these characteristics described as $P/Z_i = -P/Z * \beta_i(\ln Z_i)$ where i is the characteristic of which the derivative is taken. The average assessed market value was estimated at \$45,820 and marginal implicit prices were calculated for the average house. Table VIIIId illustrates the marginal implicit prices for the three continuous variables, parcel area in acres, square footage of the living area and age of the structure.

Table VIIIId: Marginal Implicit Prices (in Dollars)

Area (acre)	1,640
Living Area (sq feet)	12.5
Age (years)	94.5

The total value to the homeowners can be estimated by adding the marginal implicit price for each incremental increase in the characteristic until the effect is negligible for the total population of homes in the study area. The aggregate values for the river attributes are presented in the main text.

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