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Economic Impact of Green Infrastructure Maintenance

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ECONOMIC IMPACT OF GREEN INFRASTRUCTURE MAINTENANCE

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EXECUTIVE SUMMARY

The Center for Economic Development (the Center) at the Levin College of Urban Affairs at Cleveland State University prepared this report for LAND studio. The objective of this report is to present an economic impact of the green infrastructure maintenance of the green infrastructure projects that the Northeast Ohio Regional Sewer District (NEORSD) will undertake as a part of the Consent Decree NEORSD has entered into with the U.S. Environmental Protection Agency (US EPA) and the State of Ohio. This report will guide LAND studio as it engages in a broader study of best practices of green infrastructure maintenance, the needs of the sector, and to develop a foundation for the creation of a green infrastructure maintenance education and training program.

Since the exact expenditures of green infrastructure maintenance could not be provided, the Center used the Water Environment Research Foundation (WERF) User's Guide to the Best Management Practices (BMP) and Low Impact Development (LID) Whole Life Cost Models 2.0[1] as a framework to calculate the green infrastructure maintenance for the NEORSD projects. These calculations were based upon water quality volume and drainage area of the future NEORSD green infrastructure projects. The Center made modifications to the model in order to derive a more accurate economic impact model. To do this, the research team separated labor expenditures from machinery and equipment expenditures. Moreover, since the model was calculated using a national survey, other adjustments were made to the model to better fit the Cleveland-Elyria-Mentor Metropolitan Statistical Area (MSA).[2]

Using the data derived from the adjusted WERF model, the economic impact conducted by the Center was done in two phases. First the economic impact of the green infrastructure maintenance, and then the economic impact of green infrastructure storm water pipe maintenance. The total impact represents the summation of these two impacts.

The economic impact of green infrastructure maintenance in the Cleveland-Elyria-Mentor MSA (including Cuyahoga County) for the combined years 2020 to 2024 is as follows:

- Total Employment Impact: 69 jobs
- Total Labor Income Impact: $3.1 million
- Total Value Added Impact: $4.1 million
- Total Output Impact: $7.5 million
- Tax Impact: $849,000

The economic impact of green infrastructure storm water pipe maintenance in the Cleveland-Elyria-Mentor MSA (including Cuyahoga County) for the combined years 2020 to 2024 is as follows:

- Total Employment Impact: 150 jobs
- Total Labor Income Impact: $7.9 million
- Total Value Added Impact: $9.8 million
- Total Output Impact: $16.4 million
- Tax Impact: $2.0 million

[1] Water Environment Research Foundation. (2009) *User's Guide to the BMP and LID Whole Life Cost Models 2.0* Alexandria, VA: Water Environment Research Foundation.
[2] The Cleveland-Elyria-Mentor MSA consists of Cuyahoga, Geauga, Lake, Lorain, and Medina counties

The total economic impact of green infrastructure projects in the Cleveland-Elyria-Mentor MSA (including Cuyahoga County) for the combined years 2020 to 2024 is as follows:

- Total Employment Impact: 219 jobs
- Total Labor Income Impact: $11.0 million
- Total Value Added Impact: $13.8 million
- Total Output Impact: $23.9 million
- Tax Impact: $2.8 million

INTRODUCTION

The Center for Economic Development (the Center) at the Levin College of Urban Affairs at Cleveland State University prepared this report for LAND studio. The objective of this report is to present an economic impact of the green infrastructure maintenance of the future green infrastructure investments that the Northeast Ohio Regional Sewer District (NEORSD) will undertake. LAND studio will use this study as a component to a broader study of best practices in green infrastructure maintenance, the needs of the sector, and to develop a foundation for the creation of a green infrastructure maintenance education and workforce training program.

The report contains two sections: the first section includes the creation of the green infrastructure maintenance estimates, and the second details the economic impact of the green infrastructure maintenance estimates. The Center's estimates of the green infrastructure maintenance are of a five year period (2020-2024) for the Cleveland-Elyria-Mentor Metropolitan Statistical Area (MSA).[3] In the next section, the Center estimates the economic impact of this industry using the IMPLAN software.

Traditional storm water management, also known as grey infrastructure, uses a network of sewers and pipes to collect and treat sewage and storm water so that it may be returned as clean water. Green infrastructure, on the other hand, is an environmentally friendly waste water cleaning technique that uses vegetation and soil to manage rainwater.[4] Green infrastructure, also known as Best Management Practices (BMP) and Low Impact Development (LID), can take many forms. The green infrastructure that this report examines is that of bioretention ponds, defined as vegetated areas that are planted with native plants to collect and treat water runoff.[5]

It is not only the implementation and construction of green infrastructure that is important to consider, but it is also key to examine the maintenance and upkeep of these areas. It has been suggested that green infrastructure maintenance can create jobs in many cities since the maintenance of green infrastructure requires more manual labor and less heavy equipment than traditional storm water facilities.[6]

[3] The Cleveland-Elyria-Mentor MSA consists of Cuyahoga, Geauga, Lake, Lorain, and Medina counties

[4] Environmental Protection Agency. (2013, April 23). *Water: Green Infrastructure* . Retrieved May 2, 2013, from Green Infrastructure: http://water.epa.gov/infrastructure/greeninfrastructure/

[5] The City of Lancaster. (April 2011). *Green Infrstructure Plan.* Lancaster, PA: The City of Lancaster.

[6] Environmental Protection Agency. (14 December 2012) *How Can I Overcome the Barriers to Green Infrastructure?*, from Water: Green Infrastructure: http://water.epa.gov/infrastructure/greeninfrastructure/gi_barrier.cfm

GREEN INFRASTRUCTURE MAINTENANCE

OVERALL METHODOLOGY

Since the exact expenditures on the amount of green infrastructure maintenance could not be provided, the Center used the Water Environment Research Foundation (WERF) User's Guide to the BMP and LID Whole Life Cost Models 2.0[7] to calculate the green infrastructure maintenance for the NEORSD projects. The WERF User's Guide to the BMP and LID Whole Life Cost Models 2.0 is an Excel based cost estimator that facilitates the estimation of the costs of implementing and maintaining green infrastructure projects. The retention pond model was used in calculating green infrastructure maintenance for this economic impact, which was derived from the first edition of the whole life cost model in 2005.

Information obtained from LAND studio on the size and quantity of the NEORSD green infrastructure projects indicated that NEORSD would implement 14 bioretention ponds, with a total water quality volume of 132,000 cubic feet per pond. These estimates were provided by NEORSD based on where they were in the design of the green infrastructure practices in the first quarter of 2013. Water quality volume is an important factor because according to the Ohio Environmental Protection Agency (EPA), "Water quality volume is generally used to define the amount of storm water runoff from any given storm that should be captured and treated in order to remove a majority of storm water pollutants on an average annual basis."[8] Using this information the Center was able to use the WERF model to calculate the total drainage area for each project (72.73 acres).

Using the above information, the green infrastructure maintenance calculations were run using the traditional WERF model, but the research team made a few adjustments for several reasons:

1) In order to run a more detailed economic impact, labor and machinery/materials estimates needed to be broken out into two separate line items. The unadjusted WERF model created one dollar amount for maintenance schedules.

2) The maintenance schedule created by the WERF model seemed limited based upon other documentation on bioretention ponds. The WERF model provided a high, medium, and low maintenance schedule to calculate maintenance costs; the medium maintenance schedule was selected, but this was deemed too simplistic. The Center modified the medium maintenance schedule based upon current literature of bioretention maintenance. The research team adjusted the maintenance to occur twice a year (up from once a year), and inspections and vector control would stay at one site visit per year. The WERF base model for medium maintenance was 2 individuals for 4 hours per visit. However, based upon the literature,[9] this was adjusted up to 6 hours per visit. All other maintenance schedules were maintained from the WERF model.

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[7] Water Environment Research Foundation. (2009) *User's Guide to the BMP and LID Whole Life Cost Models 2.0* Alexandria, VA: Water Environment Research Foundation.

[8] Ohio EPA (20 March 2007) *RE: Guidance Regarding Post-Construction Storm Water Management Requirements of Ohio EPA's Storm Water Construction General Permit #OHC000002* from: Storm Water Post-Construction Questions & Answers http://www.epa.ohio.gov/dsw/storm/CGPPCQA.aspx

[9] Russell, Doug (2012) "Willows Special Improvement District" *City of Kalispell, Office of the City Manager*. Memo to Mayor Fisher and Kalispell City Council, September 19, 2012 http://kalispell.com/mayor_and_city_council/documents/SID345.pdf

3) Since the WERF model used a national survey to gather its data, the Center used the WERF model as a framework and made workforce adjustments based upon the Cleveland MSA. Each maintenance duty was matched to an occupational category based upon the Standard Occupational Classification (SOC) code. Based upon the matches by SOC code, hourly median wage rates were used for the Cleveland MSA from the Bureau of Labor Statistics Occupational Employment Statistics data.

Labor Maintenance Estimates

Table 1 and 2 describe the labor estimates for the green infrastructure maintenance for one NEORSD project (there are 14 in total). Table 1 multiplies the hourly wage by the hours per visit, crew size per visit, number of visits per year to establish the total cost of labor maintenance estimates for each occupation. This information was derived from the WERF model. Moreover, the WERF model accounts for the sediment dewatering and removal maintenance that will occur within the bioretention basins. The WERF model estimates that this will occur every 20 years. Based upon other literature the research team reviewed, we thought this was too infrequent and adjusted the sediment removal to every 5 years.[10] Total costs for all visits in Table 1 are inflated to 2020 and 2024 dollars in Table 2 using a projected Cleveland MSA consumer price index (CPI) for 2020 to 2024.

Table 1. Labor Maintenance Costs for One Green Infrastructure Project, 2005

SOC Code	SOC Name	WERF Model Name	Hourly Wage ($2005)	Hours Per Visit	Crew Size, per visit	Number of Visits, per year	Total Cost, all visits, per year ($2005)
17-2051	Civil engineers	Inspection, reporting & information mgmt	$31	2	1	1	$62
37-3011	Landscaping and groundskeeping	Vegetation mgmt with trash & minor debris removal	$10	6	2	2	$251
37-2021	Pest control	Vector control	$15	1	1	1	$15
47-2073	Operating engineers and other construction equipment operators	Sediment Dewatering & Removal: Main Pool	$21	16	2.5	Only in 2023	$858

Source: Bureau of Labor Statistics; Water Environment Research Foundation

Table 2. Total Labor Maintenance Costs, All Visits Per Year for One Green Infrastructure Project, 2020-2024

SOC Code	SOC Name	WERF Model Name	2020	2021	2022	2023	2024
17-2051	Civil engineers	Inspection, reporting & information mgmt	$84	$86	$88	$90	$92
37-3011	Landscaping and groundskeeping	Vegetation mgmt with trash & minor debris removal	$339	$347	$354	$362	$370
37-2021	Pest control	Vector control	$21	$21	$21	$22	$22
47-2073	Operating engineers and other construction equipment operators	Sediment Dewatering & Removal: Main Pool				$1,240	

[10] The City of Lancaster. (April 2011). *Green Infrstructure Plan.* Lancaster, PA: The City of Lancaster.

Source: Table 1

Machinery and Equipment Estimates

Table 3 and 4 display the calculations for machinery and equipment estimates for one green infrastructure project; these formulations were derived from the WERF model. Table 3 calculates machinery costs for each occupation based upon machinery and equipment costs, hours per visit, number of visits per year, and any incidental costs. As noted earlier, the model accounts for the sediment removal based upon a given quantity from the total drainage area of the project (each NEORSD bioretention pond has a sediment quantity of 1,222 yd^3). The materials and machinery costs were derived from the WERF model and were calculated by the cubic yard. Table 4 estimates the total costs for all visits for each green infrastructure project (there are 14) shown in Table 3, and inflates it to 2020 and 2024 dollars using a projected Cleveland MSA CPI.

Table 3. Machinery and Equipment Costs for One Green Infrastructure Project, 2005

SOC Code	SOC Name	WERF Model Name	Machinery & Equipment Cost ($2005)	Hours Per Visit	Number of Visits, Per Year	Incidentals ($2005)	Total Machinery & Equipment Cost ($2005)
17-2051	Civil engineers	Inspection, reporting & information mgmt	$30/hour	2	1	$0	$60
37-3011	Landscaping and groundskeeping	Vegetation mgmt with trash & minor debris removal	$60 /hour	6	2	$1,000	$1,720
37-2021	Pest control	Vector control	$400 /hour	1	1	$0	$400
47-2073	Operating engineers and other construction equipment operators	Sediment Dewatering & Removal: Main Pool	$50 materials / ($yd^3$) $150 machinery / ($yd^3$)	-	Only in 2023	$0	$244,400

Note: Machinery costs for sediment removal the product of the sediment quantity (1,222 yd^3) * material cost per yd^3 plus the product of the sediment quantity (1,222 yd^3) * machinery cost yd^3.
Source: Bureau of Labor Statistics; Water Environment Research Foundation

Table 4. Total Machinery and Equipment Costs, All Visits Per Year for One Green Infrastructure Project, 2020-2024

SOC Code	SOC Name	WERF Model Name	2020	2021	2022	2023	2024
17-2051	Civil engineers	Inspection, reporting & information mgmt	$81	$83	$85	$87	$89
37-3011	Landscaping and groundskeeping	Vegetation mgmt with trash & minor debris removal	$2,330	$2,381	$2,432	$2,485	$2,538
37-2021	Pest control	Vector control	$542	$554	$566	$578	$590
47-2073	Operating engineers and other construction equipment operators	Sediment Dewatering & Removal: Main Pool				$353,115	

Source: Table 3

STORM WATER PIPE MAINTENANCE

In addition to the green infrastructure maintenance calculated in Tables 1 to 4, storm water pipes that will deliver storm water runoff to the bioretention ponds should be included in the calculations. Based upon the assumption that 50% of storm water pipes will be replaced over 20 years,[11] we amortized the pipe replacement and maintenance from the beginning of the project to year 20. According to the Southeast Storm Water Association it costs $325 per linear foot to replace a pipe in 2011.[12] According to NEORSD, each bioretention pond will require 8,500 linear feet of storm water pipe. Using the above information, approximately 213 linear feet of pipe will be replaced each year. Moreover, according to the EPA, labor accounts for 85 to 95 percent of the maintenance costs of storm water pipes.[13] It is from this information that we can determine the amount of storm water pipe maintenance costs and inflate it to 2020 and 2024 dollars using a projected Cleveland MSA CPI. Then using the EPA guidance estimate that 90% of this amount will be used toward labor costs and 10% to materials (Table 5).

Table 5. Storm Water Pipe Maintenance Cost Estimations, 2020-2024

Year	Total Costs in future dollars	Labor (90% of total)	Materials (10% of total)
2020	$1,166,404	$1,049,764	$116,640
2021	$1,191,591	$1,072,432	$119,159
2022	$1,217,322	$1,095,590	$121,732
2023	$1,243,613	$1,119,251	$124,361
2024	$1,270,467	$1,143,420	$127,047

Source: Southeast Storm water Association Conference; Environmental Protection Agency

[11] Central Oregon Intergovernmental Council. (August 2010) *Central Oregon Storm Water Manual* http://www.lcog.org/documents/sub_action/CentralOR_StormwaterManual_201008.pdf

[12] Southeast Storm Water Association (11 October 2011) *Estimating Storm Water System Annual Maintenance and Repair Costs - A GIS Approach*. 2011 SESWA Annual Conference

[13] Environmental Protection Agency. (2000) *Wastewater Technology Fact Sheet: Sewers, Force Main*. EPA 832-F-00-071 http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_force_main_sewers.pdf

ECONOMIC IMPACT METHODOLOGY

Economic impact modeling assumes that the green infrastructure projects whose impact is estimated in this report came into existence one day and the appearance of these projects stimulates the local economy through increased demand for goods and services. The value of this stimulus is defined as the purchase of labor and goods and services by NEORSD for final consumption. The effect of this change is then traced through the Northeast Ohio economy using the IMPLAN model.

IMPLAN is an input-output (I/O) model that captures the buy-sell relationships among all industries, government, and the household sector. These relationships largely determine how an economy responds to changes in economic activity. I/O models estimate inter-industry relationships in a county, region, state, or country by measuring the industrial distribution of inputs purchased and outputs sold by each industry and the household sector. Thus, by using I-O models, it is possible to estimate how the impact of one dollar or one job ripples through the local economy, creating additional expenditures and jobs. The economic multiplier measures the ripple effect that an initial expenditure has on the local economy.[14]

NEORSD buys goods and services in order to have the green infrastructure projects, which, in turn, leads into the three components of economic impact: direct, indirect, and induced effects. *Direct impact* is the initial value of goods and services that NEORSD purchases in the region. *Indirect impact* measures the jobs and production needed to manufacture goods and services required by NEORSD through the local supply chain. *Induced impact* is the increase in spending of local households because of income received through their work at NEORSD and with its suppliers. Since the analysis only looks at the impact on the five county region of the Cleveland MSA, any purchases made outside each region were excluded from that respective model.

This report measures five impacts for the region: employment, labor income, output, value added, and taxes. *Employment* measures the number of jobs that exist due to NEORSD spending. *Labor income* is payroll paid to employees, plus proprietors' income. *Output* measures the total value of goods and services produced in the region as a result of the spending. *Value added* measures the value of goods and services less the intermediary goods and represents a portion of output. *Taxes* include federal as well as state and local tax revenues.

EMPLOYMENT IMPACT

The activities of NEORSD affect job creation in Northeast Ohio through the goods and services that it purchases, beyond the hiring of its own employees. The total employment impact equals the sum of NEORSD employment involved in green infrastructure (the direct impact), the indirect impact (employment in industries from which NEORSD purchases goods and services and that sell inputs for the goods and services), and the induced impact (jobs created through the purchases of the employees of NEORSD and its suppliers).

[14] For example, suppose that Company A reports sales of $10 million to NEORSD. From the revenues of the company, they pay suppliers and workers, cover production costs, and take a profit. Once the suppliers and employees receive their payments, they will spend a portion of their money in the local economy purchasing goods and services, while another portion of the money will be spent outside the local economy (known as leakage). By evaluating the chain of local purchases that result from the initial infusion of $10 million, it is possible to estimate a regional economic multiplier.

LABOR INCOME IMPACT

Labor income impact, or earnings impact, is the estimated total change in money paid to local households due to NEORSD spending on goods and services from businesses and other entities in the region for the purpose of green infrastructure projects. In the economic impact, the direct impact represents the total amount of NEORSD spending on the maintenance of green infrastructure in either payroll and benefits or contract labor spending. The indirect impact is estimated by summing the money paid to persons who work for companies from which NEORSD makes purchases and those that provide inputs to the producers of the goods and services ultimately consumed by NEORSD. The induced impact represents money paid to workers in all industries who are employed as a result of purchases by households whose income is affected by NEORSD's demand for products and services.

OUTPUT IMPACT

In order to calculate the output impact, the spending of NEORSD on the green infrastructure maintenance projects in the region were categorized into industry classifications based on the IMPLAN 3.0 model. The direct impact here represents the total spending of NEORSD (excluding payroll and benefits). The indirect effect is the summation of local purchases by individual industries from which NEORSD makes purchases and that provide inputs to the producers of the goods and services ultimately consumed by NEORSD. The induced effect is estimated by measuring the spending of workers who are employed as a result of NEORSD's demand for products and services.

VALUE ADDED IMPACT

Value added measures the value of goods and services less the intermediary goods, such as utilities, and represents a portion of output. NEORSD may directly hire workers for green infrastructure maintenance or outsource the duties through contracts. The direct effect here (equal to that of labor income) represents NEORSD's total payroll and benefits or contract labor spending.

TAX IMPACT

The tax impact is a sum of the state and local taxes and the federal taxes paid from the green infrastructure projects.

ECONOMIC IMPACT OF GREEN INFRASTRUCTURE MAINTENANCE

ECONOMIC IMPACT OF GREEN INFRASTRUCTURE MAINTENANCE, 2020-2024

Using the expenditures outlined in the previous section of this report, this section outlines the economic impact of the maintenance of the green infrastructure projects of NEORSD on the Cleveland MSA between 2020 and 2024. The maintenance will create an estimated 69 jobs, $3.1 million in labor income, $4.1 million in value added impact, $7.5 million in output, and generate $849,000 in taxes (Table 6).

The majority of the jobs created are in *Maintenance and repair construction of nonresidential structures,* (42), while the remaining jobs are in various industries that support the industry and the individuals that work on the projects. Other top industries affected included *Services to buildings and dwellings*, *Food services and drinking places*, *Architectural, engineering, and related services*, and *Real estate establishments*.

Table 6. Economic Impact of Green Infrastructure Maintenance Impact, 2020-2024

Impact Type	Employment	Labor Income	Value Added	Output	Tax
Direct Effect	45	$1,984,013	$2,159,604	$4,422,456	$437,665
Indirect Effect	9	$480,826	$711,150	$1,191,007	$149,220
Induced Effect	15	$670,153	$1,181,665	$1,902,024	$262,207
Total Effect	69	$3,134,992	$4,052,419	$7,515,487	$849,092

Note: Data displayed in 2013 dollars

ECONOMIC IMPACT OF GREEN INFRASTRUCTURE STORM WATER PIPE MAINTENANCE, 2020-2024

This section outlines the economic impact of the maintenance of the storm water pipes associated with green infrastructure projects of the NEORSD on the Cleveland MSA between 2020 and 2024. The maintenance of the storm water pipers will create an estimated 150 jobs, $7.9 million in labor income, $9.8 million in value added impact, $16.4 million in output, and generate $2.0 million in taxes over the five years (Table 7).

As with the green infrastructure maintenance, the largest number of jobs created are in *Maintenance and repair construction of nonresidential structures,* (107). The other jobs are again spread across various industries that support the projects and the individuals that they employ. Other top industries affected included *Food services and drinking places*, *Private hospitals*, *Real estate establishments*, and *Offices of physicians, dentists, and other health practitioners*; mostly through the induced effect.

Table 7. Green Infrastructure Storm water Pipe Maintenance Impact, 2020-2024

Impact Type	Employment	Labor Income	Value Added	Output	Tax
Direct Effect	101	$5,648,845	$6,036,354	$10,306,495	$1,150,229
Indirect Effect	6	$299,407	$347,299	$678,497	$71,021
Induced Effect	43	$1,911,195	$3,369,338	$5,423,947	$745,640
Total Effect	150	$7,859,447	$9,752,991	$16,408,939	$1,966,890

Note: Data displayed in 2013 dollars

TOTAL ECONOMIC IMPACT, 2020-2024

Overall, the maintenance projects will create an estimated 219 jobs, $11.0 million in labor income, $13.8 million in value added impact, $23.9 million in output, and generate $2.8 million in taxes over the five years (Table 8).

Table 8. Total Green Infrastructure Maintenance Impact, 2020-2024

Impact Type	Employment	Labor Income	Value Added	Output	Tax
Direct Effect	146	$7,632,858	$8,195,958	$14,728,951	$1,587,894
Indirect Effect	15	$780,233	$1,058,449	$1,869,504	$220,241
Induced Effect	58	$2,581,348	$4,551,003	$7,325,971	$1,007,847
Total Effect	219	$10,994,439	$13,805,410	$23,924,426	$2,815,982

Note: Data displayed in 2013 dollars

In the employment impact, 66% of the impact is in the direct effect (146 jobs). Seven percent is in the indirect effect (15 jobs) and 27% is in the induced effect due to household spending (58 jobs). In the labor income impact, 69% of the total effect comes from the direct impact ($7.6 million). The indirect effect accounts for 7% ($780,233) and the induced effect accounts for 24% of the total ($2.6 million).

The value added impact comes from $8.2 million in the direct effect (59%), $1.1 million in the indirect effect (8%), and $4.6 million in the induced effect (33%). The output impact comes from $14.7 million in the direct effect (62%), $1.9 million in the indirect effect (8%), and $7.3 million in the induced effect (30%).

Fifty six percent (56%) of the tax impact is in the direct effect ($1.6 million). Eight percent (8%) is in the indirect effect ($220,241) and 36% is in the induced effect ($1.0 million). Figure 1 shows the percentage of each project that represents the total impact in each type of impact. The maintenance of the pipes represents the clear majority of each type of impact, between 69% and 71% of the total impact.

Figure 1. Total Economic Impact by Green Infrastructure Maintenance and Green Infrastructure Pipe Maintenance, 2020-2024