

May 1, 2018

Research Report

The Economic Impact
of the
Environmental Protection Agency
on
Minnesota's Arrowhead region and
Douglas County, Wisconsin

For the
Environmental Protection Agency (EPA)
Office of Research and Development's
Mid-Continent Ecology Division

Bureau of Business and
Economic Research

Labovitz School
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Driven to Discover

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The EPA provided the majority of inputs for this report. Where data was not available from the EPA, the BBER utilized IMPLAN and other secondary data sources. The report is conditional upon the completeness, accuracy, and fair presentation of that data and information. The BBER does not promise or guarantee the outcome of these results but rather is providing projections based upon inputs and outputs using IMPLAN software.

The BBER was asked to supply an economic impact analysis only, and this report should not be viewed as a cost benefit analysis or environmental impact assessment.

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Executive Summary

The Environmental Protection Agency (EPA) Office of Research and Development's Mid-Continent Ecology Division (MED) plays a vital role in the integrity of global watersheds and freshwater ecosystems. By conducting innovative research and predictive modeling, it is able to document and forecast the effects of pollutants on a vital resource.

Located in Duluth, Minnesota, the EPA MED uses the fresh water of Lake Superior to conduct its research in over 90,000



square feet of laboratories. Its work supports numerous federal, legislative, and science-based regulatory acts.

Approximately 130 employees, which include national and international experts, contractors, grantees, and postdoctoral researchers, utilize an annual budget of approximately \$15 million to conduct this highly significant research that affects the quality of life worldwide.

The EPA contacted the Bureau of Business and Economic Research (BBER) at the University of Minnesota Duluth's Labovitz School of Business and Economics to study the economic benefits that the agency has on the Arrowhead region of Minnesota and Douglas County, Wisconsin, through its operations and initiatives.

Of the EPA's \$15 million budget, roughly \$12.9 million is paid to local employees and businesses. This includes \$8.2 million in wages and benefits for the agency's 60 local federal employees, \$3.4 million in wages and benefits for its 68 local contracted employees, and \$1.27 million in local operational spending.

In addition to the EPA's 128 workers (both federal and contracted), the agency also supports 69 jobs in the study area through indirect and induced effects, contributing nearly 200 total jobs to the region's economy.

Altogether, the agency has an economic impact totaling \$14.3 million in wages and benefits for the region's workers (labor income), \$16.3 million in GDP (value added), and \$23.9 million in overall spending (output) throughout the study area. These impacts are the combined effects of the agency's spending as well as the indirect and induced effects generated in other parts of the economy.

In other words, for every dollar in wages, benefits, and payroll taxes paid to EPA employees, another \$0.23 is paid to employees in other industries. Likewise, for every dollar the agency spends in the region (output) another \$0.61 is spent in supporting industries as a result.

The supporting industries that benefit the most from the EPA's operations in Duluth are owner-occupied dwellings, hospitals, offices of physicians, real estate, and wholesale trade. Most of these industries benefit primarily from the agency's induced impacts, the result of EPA employee spending, as such a large portion of the agency's annual budget goes to wages and benefits.

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The Economic Impact of the Environmental Protection Agency on Minnesota's Arrowhead region and Douglas County, Wisconsin

I. Project Description

The Environmental Protection Agency (EPA) Office of Research and Development's Mid-Continent Ecology Division (MED) plays a vital role in the integrity of global watersheds and freshwater ecosystems. By conducting innovative research and predictive modeling, it is able to document and forecast the effects of pollutants on a vital resource.

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Approximately 130 employees, which include national and international experts, contractors, grantees, and postdoctoral researchers, utilize an annual budget of approximately \$15 million to conduct this highly significant research that affects the quality of life worldwide.

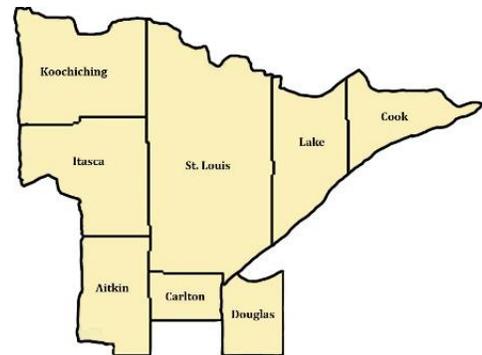
The EPA contacted the Bureau of Business and Economic Research (BBER) at the University of Minnesota Duluth's Labovitz School of Business and Economics to study the economic benefits that it has on the Arrowhead region of Minnesota and Douglas County, Wisconsin, through its operations and initiatives.

Study Area

The geographic scope for this economic impact analysis is the Arrowhead region of Northeastern Minnesota, which includes the counties of Aitkin, Carlton, Cook, Itasca, Koochiching, Lake, and St. Louis, along with Douglas County, Wisconsin.

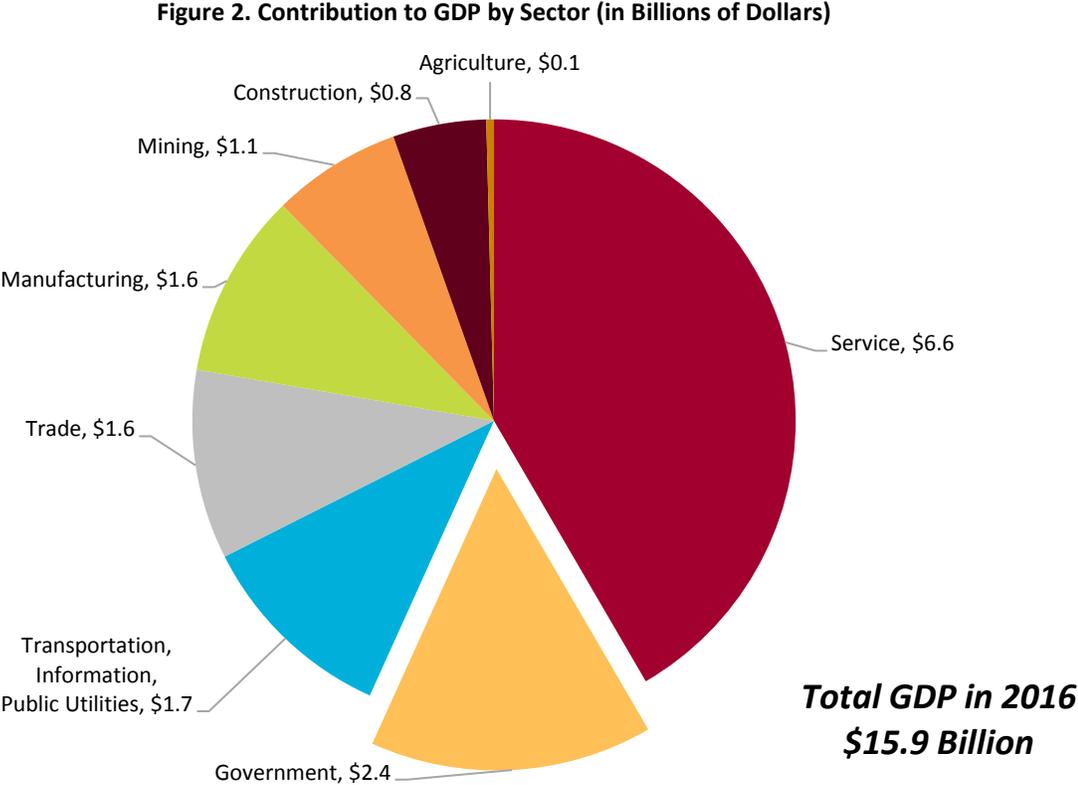
All estimates and figures shown in this report reflect the eight-county study area. The study area data used was the most recent IMPLAN data available, which is for the year 2016. Results are shown in 2018 dollars.

Figure 1. Study Area Counties



SOURCE: WIKIPEDIA, BBER

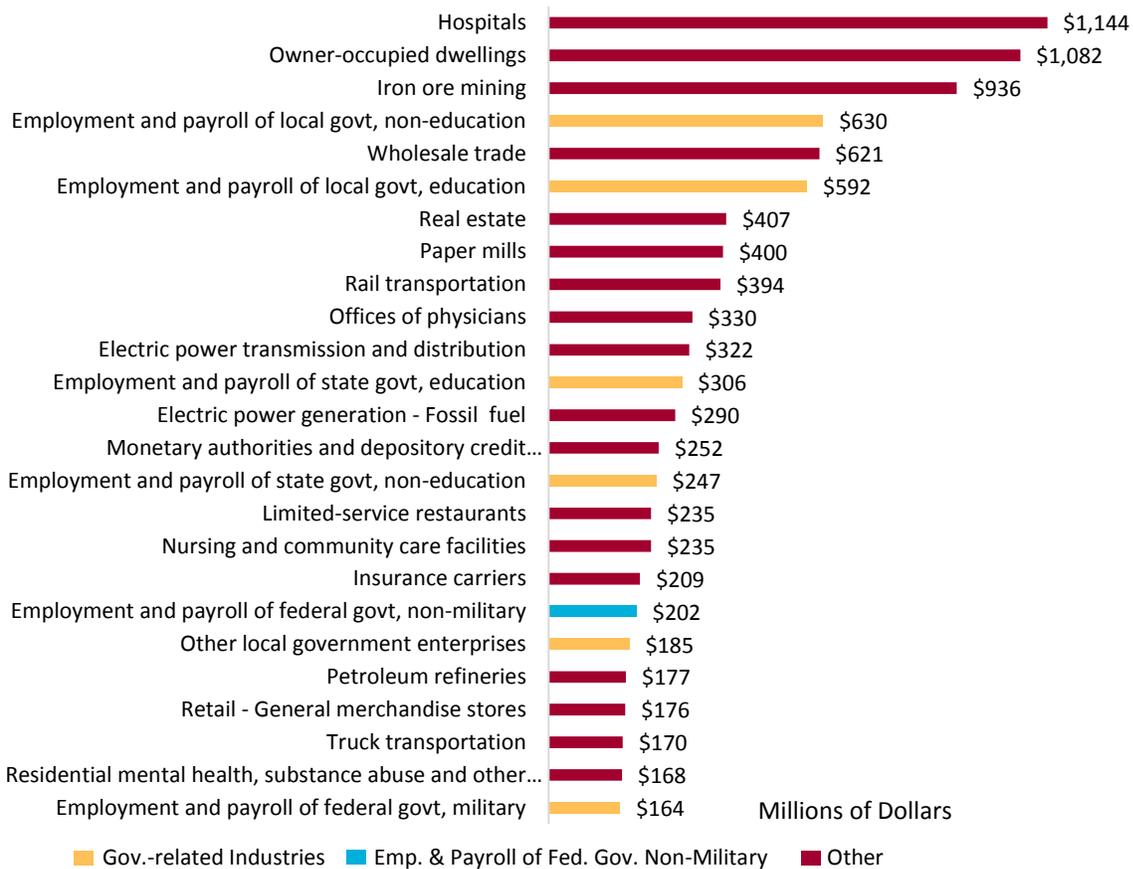
The following figures provide insight into the economy of the study area as context for the results of the report.



SOURCE: IMPLAN

Figure 2 shows the study area’s total GDP, nearly \$16 billion in 2016, broken out by major industry sector. The service sector, which includes all health care, education, retail, and hospitality industries, contributed the greatest portion to the study area’s GDP, at \$6.6 billion. The government sector (of particular interest for this analysis) was the second largest sector, representing roughly 15% (\$2.4 billion) of the \$15.9 billion total GDP in 2016.

Figure 3. Top 25 Industries by Contribution to GDP (in Millions of Dollars)



SOURCE: IMPLAN

Further detail on the region’s GDP in 2016 can be seen in Figure 3. Here, the 25 industries with the largest contributions to GDP are shown in descending order. Combined, these 25 industries contribute roughly \$9.9 billion to the region’s GDP, approximately 60% of the \$15.9 billion total shown in Figure 2.

All government-related industries in the figure are highlighted in gold, with the exception of employment and payroll of federal, non-military government (into which the EPA would be categorized), which is shown in blue. All other industries are shown in red. Of the government industries shown in the figure, local government entities provide the largest contribution to the region’s economy, followed by state and then federal. Notably, seven of IMPLAN’s ten government-related industries are in the top twenty-five list of largest contributors to the area’s GDP, highlighting the importance of government to the study area’s economy.

There are a few interesting points to note about this figure. First, it is significant that 2016 represents the first time in many years where hospitals overtook iron ore mining as the region’s greatest contributor to GDP. This is likely due to the iron mining downturn that occurred between 2015 and 2017.

It is also helpful to explain the significance of the second category shown in the figure, owner-occupied dwellings. This category, which is unique to IMPLAN’s accounting model, essentially creates an industry out

of owning a home.¹ Estimates are based on what homeowners would pay in rent if they rented rather than owned their homes. The industry is included in the database to ensure consistency in the flow of funds. It captures the expenses of home ownership such, as repair and maintenance construction, various closing costs, and other expenditures related to the upkeep of the space in the same way expenses are captured for rental properties.

Table 1 provides some additional details on the government-related industries in the study area, including employment numbers, value added, labor income, and labor income per worker.

Table 1. Characteristics of Government-Related Industries in Study Area

<i>Description</i>	<i>Employment</i>	<i>Total Labor Income, in Millions</i>	<i>Total Value Added, in Millions</i>	<i>Average Labor Income Per Worker</i>
Local government, non-education	9,617	\$544.9	\$629.6	\$56,667
Local government, education	8,920	\$513.1	\$592.5	\$57,522
State government, education	5,076	\$266.4	\$305.9	\$52,469
State government, non-education	2,945	\$214.6	\$247.4	\$72,876
Other local government enterprises	2,678	\$114.2	\$185.2	\$42,640
Federal government, military	1,462	\$51.8	\$164.0	\$35,466
Federal government, non-military	1,363	\$140.4	\$201.5	\$102,993
Postal service	744	\$55.4	\$56.8	\$74,491
Local government passenger transit	229	\$9.5	(\$0.2)	\$41,577
Local government electric utilities	175	\$12.6	\$22.6	\$71,775
Total ²	33,210	\$1,923.0	\$2,405.4	\$57,905

SOURCE: IMPLAN

As shown in Table 1, there are more than 33,000 government employees in the eight-county study area, and their combined labor income equals roughly \$1.9 billion. Local government agencies employ the greatest numbers and contribute the most to the GDP of the study area. However, federal (non-military) employees, such as those employed by the EPA, tend to have the highest labor income³ per worker (\$102,993). The average government salary in the study area is roughly \$58,000 per year.

There are a number of possible explanations for the wide range in labor income by industry. Some of the variation is due to the number of part-time versus full-time employees in each industry. For example, federal government military employees are more likely to be temporary or part-time, which is why labor income per worker in that industry (\$35,466) is so much lower than the other categories. Education level and training play a major factor in compensation as well. Some of the federal agencies in the non-military sector include the Federal Aviation Administration, the Internal Revenue Service, the U.S. Forest Service, Immigration and Customs Enforcement, and, of course, the EPA. Employees in these agencies tend to have highly specialized training and high levels of educational attainment. Finally, while federal government workers tend to earn more than other industries, labor income per worker in the eight-county study area is quite a bit lower than

¹ IMPLAN

² Totals may not sum to due rounding

³ Note that labor income includes employee wages, benefits, and proprietor income.

the averages for the Twin Cities Metro Area, the State of Minnesota, and the United States.⁴

II. Inputs

The following section describes the inputs required for modeling the impacts of the operations of the EPA facility. Operational inputs required included estimates of employment, annual purchases, and local spending. Data were provided by EPA representatives. The research team worked under the assumption that the agency provided estimates in good faith. In instances where data was not provided by the EPA, the research team relied on IMPLAN estimates and secondary data sources as inputs.

Operations Inputs

Operations inputs required for modeling include all annual expenditures for the EPA facility. For this analysis, EPA representatives provided spending estimates for a typical year of operations (2017), a breakdown of major operational expenditures, the percentage of expenditures purchased from within the study area, employment numbers, and payroll estimates.

Table 2. EPA Spending by Category (in Millions of Dollars), Typical Year

	<i>2017 Spending</i>	<i>Percent Spent in Study Area</i>	<i>Amount Spent in Study Area</i>
Wages and benefits, all employees (n=128)	\$12.91	90.2%	\$11.64
<i>Wages and benefits, federal employees (n=60)</i>	<i>\$8.56</i>	<i>96.0%</i>	<i>\$8.22</i>
<i>Wages and benefits, contracted employees (n=68)</i>	<i>\$4.35</i>	<i>78.6%</i>	<i>\$3.42</i>
Operations spending	\$2.06	53.8%	\$1.11
Total	\$14.97	85.0%	\$12.75

SOURCE: EPA

The total estimated spending for a typical year of operations for the EPA facility equals approximately \$15.0 million. Of that amount, almost \$13 million is spent in the study area. This includes just over \$8.2 million in wages and benefits for the agency’s 60 local federal employees, just over \$3.4 million in wages and benefits for their 68 local contracted employees,⁵ and \$1.1 million in local operational spending.

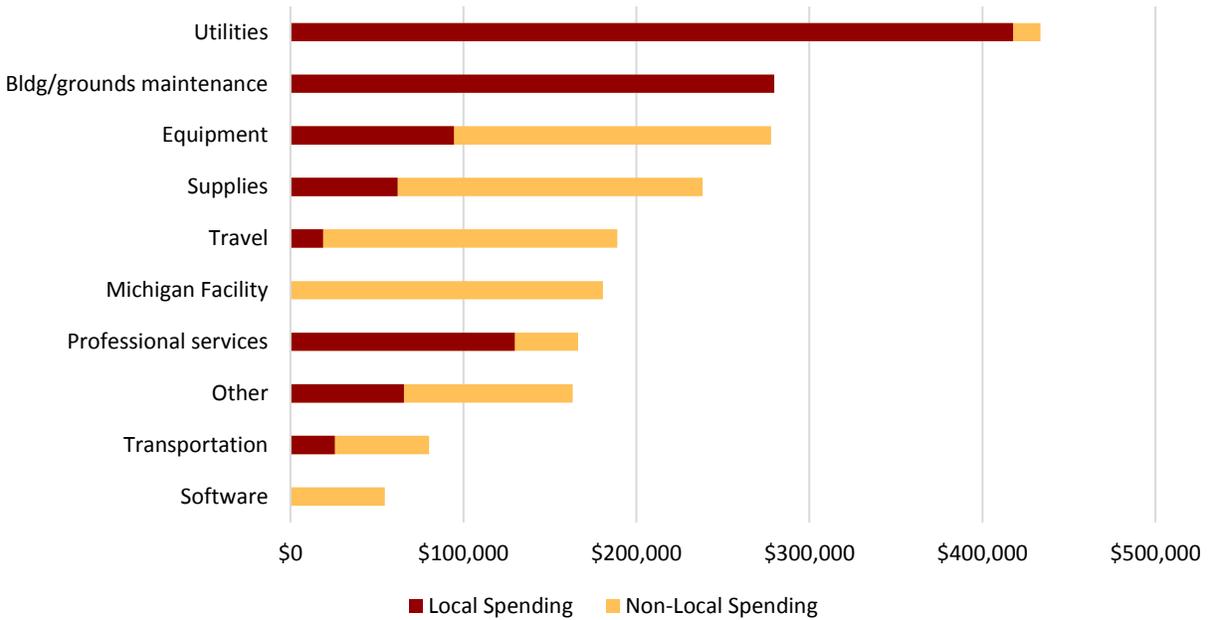
It is important to note the economic significance of having a federal agency located in the study area. As shown in Table 2, the agency spends a large portion of its operating budget on wages and benefits for its local employees (\$11.6 million in 2017). The agency pays, on average, almost \$91,000 in labor income (local wages and benefits) per worker⁶ to the agency’s highly educated, specialized workers. The agency’s 60 federal employees are primarily Ph.D.-trained scientists, and the contracted employees include post-doctoral students and experts in areas such as science, engineering, and transportation. Many of these workers would not otherwise reside in the area if it weren’t for the agency’s location there.

⁴ Average labor income per worker for federal non-military employees was \$122,531 for the U.S., \$161,719 for the State of Minnesota, \$122,112 for the Twin Cities Metro, and \$102,993 for the study area.

⁵ The EPA’s Mid-Continent Ecology Division (MED) includes both the Duluth facility and a smaller location in Grosse Ile, Michigan. All spending at the Michigan location, including wages and benefits paid to employees, was excluded from the modeling.

⁶ Calculated by dividing the total wages and benefits paid within the study area (\$11.64 million) by the number of employees (128)

Figure 4. EPA Operations Spending Detail



SOURCE: EPA

Further detail on the operations portion of the EPA’s budget is shown in Figure 4. For each item, local spending is shown in maroon and non-local spending (leakages outside the eight-county region) is shown in gold. Utility payments represent the agency’s greatest annual expense (\$433,000), followed by building and grounds maintenance (\$280,000). The next largest category is equipment. The equipment category includes scientific equipment with a life expectancy of greater than 12 months but still under the capital threshold level. Supplies include those with a life expectancy of less than 12 months. The category labeled other includes chemicals, permits and licenses, employee training, and academic and professional subscriptions.

Analysis by Parts

EPA representatives provided fairly detailed budget information for the operations of the facility. Therefore, the BBER modeled all impacts using a technique called Analysis by Parts. Analysis by Parts is the process of splitting or parsing an impact analysis issue into smaller and more specific parts, and it allows the analyst to create a customized industry based on an existing budgetary spending pattern. This technique also gives the analyst the flexibility to specify the amount of commodity inputs, the proportion of local labor income, and the proportion of local purchases. Table 3 on the following page shows all IMPLAN commodities used in developing the EPA’s customized industry.

Table 3. IMPLAN Commodities Used in Modeling EPA Impacts

<i>Commodity number</i>	<i>Commodity Description</i>
3049	Electricity transmission and distribution
3050	Natural gas distribution
3051	Water, sewage and other systems
3062	Maintained and repaired nonresidential structures
3156	Refined petroleum products
3395	Wholesale trade distribution services*
3396	Retail services - Motor vehicle and parts dealers*
3398	Retail services - Electronics and appliance stores*
3399	Retail services - Building material and garden equipment and supplies stores*
3400	Retail services - Food and beverage stores*
3401	Retail services - Health and personal care stores*
3402	Retail services - Gasoline stores*
3405	Retail services - General merchandise stores*
3406	Retail services - Miscellaneous store retailers*
3407	Retail services - Nonstore retailers*
3408	Air transportation services
3415	Couriers and messengers services
3418	Periodicals
3428	Wireless telecommunications (except satellite)
3431	News syndicates, libraries, archives and all other information services
3442	Automotive equipment rental and leasing services
3443	General and consumer goods rental services except video tapes and discs
3469	Landscape and horticultural services
3471	Waste management and remediation services
3496	Other amusement and recreation
3499	Hotels and motel services, including casino hotels
3501	Full-service restaurant services
3502	Limited-service restaurant services
3503	All other food and drinking place services
3506	Electronic and precision equipment repair and maintenance
3518	US Postal delivery services
5001	Employee Compensation

*Spending on equipment and supplies was distributed between the retail and wholesale commodities identified with asterisks, and margins were applied to all retail and wholesale commodities.

SOURCE: IMPLAN

III. Findings

This section provides the direct, indirect, and induced economic impacts of a typical year of operations for the EPA facility. To estimate the on-going impact of economic activity of the agency’s presence in the region, the BBER used the term “Typical Year” to represent the impact for each year of operations. However, inputs were modeled using 2017-dollar inputs, to align with operational data provided by the EPA. Results of modeling are shown in Table 4 in millions of 2018 dollars.

As shown in the table, total effects are broken into three components: direct, indirect, and induced. Direct effects represent the employment and spending coming from the EPA itself on wages, equipment, and supplies. Indirect effects measure increased inter-industry spending on the part of regional businesses and

suppliers as a result of their direct spending. Induced effects reflect an increase in household spending by the EPA’s employees as well as the employees of businesses that support the agency.

Table 4. Economic Impact of a Typical Year of EPA Operations, in Millions of Dollars

<i>Impact Type</i>	<i>Employment</i>	<i>Labor Income</i>	<i>Value Added</i>	<i>Output</i>
Direct Effect	128	\$11.6	\$11.6	\$14.9
Indirect Effect	6	\$0.3	\$0.5	\$1.2
Induced Effect	63	\$2.4	\$4.2	\$7.8
Total Effect	198	\$14.3	\$16.3	\$23.9
Multipliers	1.55	1.23	1.41	1.61

SOURCE: BBER

In addition to the three effect components, results are also shown in terms of employment, labor income, value added, and output. The column labeled employment in Table 4 shows the number of jobs⁷ that the agency supports directly and through induced and indirect effects. In a typical year of operations, the EPA employs 128 workers (both federal and contracted). In addition, the EPA supports another 69 jobs in the eight-county study area through indirect and induced effects. In total, the agency contributes nearly 200 jobs to the region’s economy.

The column labeled labor income is the total of all employee compensation. This includes wages, benefits, and payroll taxes. In a typical year of operations, the federal government agency directly spends \$11.6 million on wages and benefits to the EPA employees in Duluth (including federal and contract employees). Additionally, the EPA facility supports over \$2.7 million in indirect and induced labor income during a typical year, for a total of \$14.3 annually.

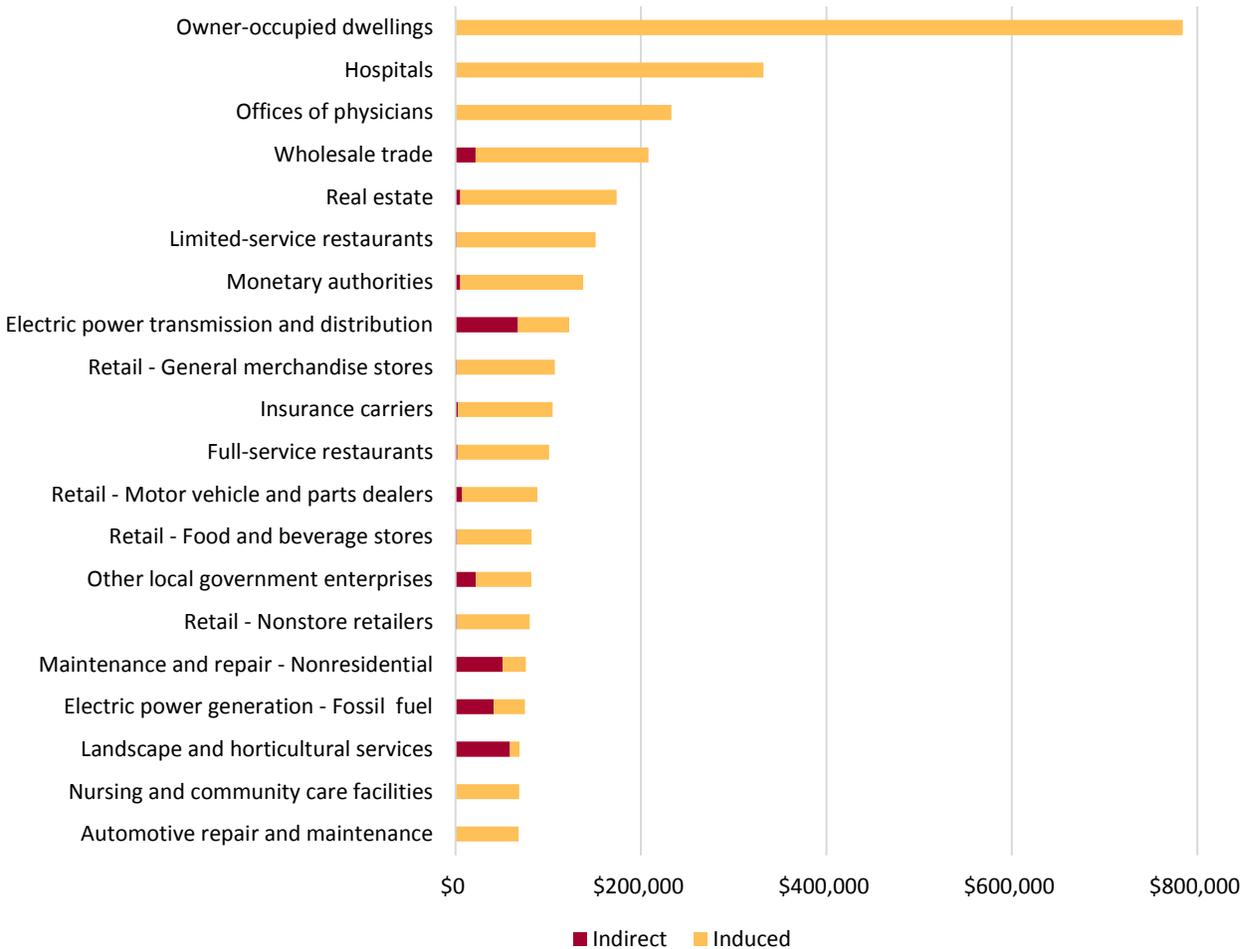
The column labeled value added refers to the contribution to the GDP made by an individual producer, industry, or sector. It includes employee compensation, proprietor income, and other property income and taxes. Government entities, like the EPA, would only pay employee compensation (not proprietor income or other property income and taxes), which explains why value added equals labor income in the first row, direct effects. The EPA contributes \$11.6 million to the region’s GDP each year, and it supports \$4.7 million in additional value added (the sum of the induced and indirect effects) in other supporting industries, for a total value added effect of \$16.3 million.

Output, the last column in the table, is the total value of all local production required to sustain activities. In a typical year of operations, the Duluth EPA creates nearly \$15 million annually in direct output. Along with \$9.0 million in induced and indirect output, the agency creates just under \$24 million in total output each year.

The last row in the table shows the multipliers associated with each component. A multiplier indicates how much additional spending is added to the regional economy for each dollar in new spending. For example, for every dollar in wages, benefits, and payroll taxes paid to EPA employees, another \$0.23 is paid to employees in other industries, through indirect and induced spending effects. Likewise, for every dollar the agency spends in the region (output) another \$0.61 is spent in supporting industries as a result.

⁷ IMPLAN reports jobs in terms of workers, both full- and part-time, not in terms of FTE. However, EPA representatives provided employment numbers for their contracted workers in FTEs. Therefore, the direct employment numbers shown in Table 4 may slightly underestimate the true employee headcount depending on the number of part-time contracted employees.

Figure 5. Top 20 Industries Impacted by EPA Operations Spending



SOURCE: BBER

Figure 5 provides more detail into the industries that are most significantly impacted by the EPA’s operations. Indirect impacts (the result of inter-industry spending) are shown in maroon, and induced impacts (the result of employee spending) are shown in gold. The graph clearly shows how much more significant the EPA’s induced impacts are as compared to its indirect impacts. This is due to the very large portion of the agency’s budget that goes to wages, benefits, and payroll taxes. In fact, 86% of the EPA’s \$15 million operating budget goes to its federal and contracted staff’s wages (see Table 2, page 5). A much smaller portion is spent by the agency on items such as utilities, supplies, equipment, and maintenance.

The industry that sees the greatest impacts as a result of the EPA’s operations in Duluth is the IMPLAN sector of owner-occupied dwellings. As mentioned previously, owner-occupied dwellings is a sector that is unique to IMPLAN’s accounting model and represents the amount homeowners would pay if they rented rather than owned their homes. Some of the other categories shown in Figure 5 include the most common items found in the typical household spending pattern: hospitals, offices of physicians, real estate, wholesale trade, restaurants, monetary authorities, electric power, and insurance companies.

IV. Conclusions

The Environmental Protection Agency (EPA) Office of Research and Development's Mid-Continent Ecology Division (MED) plays a vital role in the integrity of global watersheds and freshwater ecosystems. By conducting innovative research and predictive modeling, it is able to document and forecast the effects of pollutants on a vital resource. This analysis shows that the agency also has a significant economic impact on the region's economy.

The estimated budget for a typical year of operations at the EPA facility is approximately \$15.0 million, \$12.9 million of which is paid to local employees and businesses. This includes \$8.2 million in wages and benefits for the agency's 60 local federal employees, \$3.4 million in wages and benefits for their 68 local contracted employees, and \$1.1 million in local operational spending.

It is important to note the economic significance of having a federal agency located in the study area. The agency spends a large portion of its operating budget on wages and benefits for its highly educated, specialized workers. These employees include Ph.D.-trained scientists, post-doctoral students, and experts in areas such as science, engineering, and transportation. If it weren't for the agency's location in the study area, many of these workers would not reside in the area and the economic benefits from their household spending would not exist.

In total, the agency creates nearly 200 jobs for the region's economy (employment), \$14.3 million in wages and benefits for the region's workers (labor income), \$16.3 million in additional GDP (value added), and \$23.9 million in overall spending (output) in the study area, through its combined direct, indirect, and induced effects.

The supporting industries that benefit the most from the EPA's operations in Duluth are owner-occupied dwellings, hospitals, offices of physicians, real estate, and wholesale trade. Most of these industries benefit primarily from the agency's induced impacts, the result of EPA employee spending, as such a large portion of the agency's annual budget goes to wages and benefits.

NOTE - Readers are also encouraged to remember the UMD Labovitz School's BBER was asked to supply an economic impact analysis only. Any subsequent policy recommendations should be based on the "big picture" of total impact.

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Appendix A. Detailed Inputs and Assumptions

Table 5. Detailed EPA Operations Expenses Used in Modeling

<i>EXPENSE CATEGORY</i>	<i>TOTAL ANNUAL COST</i>	<i>% SPENT IN STUDY AREA</i>	<i>AMOUNT SPENT IN STUDY AREA</i>
Utilities	\$433,096	96%	\$417,737
Travel	\$188,951	10%	\$18,895
Transportation	\$80,177	32%	\$25,656
Training	\$35,309	0%	\$0
Supplies	\$238,301	26%	\$61,958
Subscriptions	\$40,262	0%	\$0
Software	\$54,511	0%	\$0
Shipping	\$12,539	100%	\$12,539
Rentals	\$2,507	100%	\$2,507
Publications	\$7,865	0%	\$0
Professional services	\$166,309	78%	\$129,721
Permits	\$7,634	100%	\$7,634
License/fees	\$17,440	70%	\$12,208
Equipment	\$277,816	34%	\$94,457
Chemicals	\$39,658	77%	\$30,707
Michigan Facility	\$180,716	0%	\$0
Bldg/grounds maintenance	\$279,676	100%	\$279,676
Contracted local wages**	\$4,248,874	80%	\$3,418,850
Wages for federal employees	\$8,556,080	96%	\$8,219,426
Total	\$14,867,722	86%	\$12,731,970

*Utility subcategory

**Contract for Labor and Services

Appendix B. Economic Impact Procedures and Data Sources

Input-Output Modeling

This study uses the IMPLAN Group's input-output modeling data and software (IMPLAN version 3.1). The IMPLAN database contains county, state, zip code, and federal economic statistics, which are specialized by region, not estimated from national averages. Using classic input-output analysis in combination with region-specific Social Accounting Matrices and Multiplier Models, IMPLAN provides a highly accurate and adaptable model for its users. IMPLAN data files use the following federal government data sources:

- U.S. Bureau of Economic Analysis Benchmark Input-Output Accounts of the U.S.
- U.S. Bureau of Economic Analysis Output Estimates
- U.S. Bureau of Economic Analysis Regional Economic Information Systems (REIS) Program
- U.S. Bureau of Labor Statistics Covered Employment and Wages (CEW) Program
- U.S. Bureau of Labor Statistics Consumer Expenditure Survey
- U.S. Census Bureau County Business Patterns
- U.S. Census Bureau Decennial Census and Population Surveys
- U.S. Census Bureau Economic Censuses and Surveys
- U.S. Department of Agriculture Census

IMPLAN data files consist of the following components: employment, industry output, value added, institutional demands, national structural matrices, and inter-institutional transfers. Economic impacts are made up of direct, indirect, and induced impacts.

The following are suggested assumptions for accepting the impact model: IMPLAN input/output is a production-based model, and employment numbers (from U.S. Department of Commerce secondary data) treat both full- and part-time individuals as being employed.

Regional data for the impact models for value added, employment, and output are supplied by IMPLAN for this impact. Employment assumptions were provided to the model to enable construction of the impact model. From these data, social accounts, production, absorption, and byproducts information were generated from the national level data and was incorporated into the model. All region study definitions and impact model assumptions were agreed on before work with the models began.

Modeling Issues

There are some IMPLAN modeling issues that should be considered when interpreting the results of this study. First, a small area, like the one included in this analysis, can have a high level of leakage. Leakages are any payments made to imports or value added sectors which do not in turn re-spend the dollars within the region. What's more, a study area that is actually part of a larger functional economic region will likely miss some important backward linkages. For example, linkages with the labor force may be missing. Workers who live and spend outside the study area may actually hold local jobs.

Regional indirect and induced effects are driven by assumptions in the model. With some models, one problem is that the assumptions can mask the true multiplier. This is especially true of the assumption of constant returns to scale. This assumption most affects induced effects and says that, for example, if I drink coffee, and my income increases, I will drink proportionally more coffee than before. The amount of weight placed on the induced effects (the percentage of the total induced effect you would want to use) can be

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further analyzed with an in-depth impact study, involving much more specific data collection and more detailed analysis, but that is beyond the scope of this analysis.

Appendix C. IMPLAN Assumptions

The following are suggested assumptions for accepting the impact model:⁸

Backward-Linkages: IMPLAN is a backward-linkage model, meaning that it measures the increased demand on industries that produce intermediate inputs as a result of increases in production. However, if an industry increases production, there will also be an increased supply of output for other industries to use in their production. Models that measure this type of relationship are called forward-linkage models. To highlight this concept, consider the example of a new sawmill beginning its operations in a state. The increased production as a result of the sawmill's operations will increase the demand for lumber, creating an increase in activity in the logging industry, as well as other supporting industries such as electric transmission and distribution. IMPLAN's results will include those impacts, but will exclude effects on any wood product manufacturers located nearby that might be impacted by the newly available supply of lumber.

Employment: IMPLAN input-output is a production-based model, and employment numbers (from U.S. Department of Commerce secondary data) treat both full- and part-time individuals as being employed.

Fixed prices and no supply constraints: IMPLAN is a fixed-price model. This means that the modeling software assumes no price adjustment in response to supply constraints or other factors. In other words, the model assumes that firms can increase their production as needed and are not limited by availability of labor or inputs and that firms in the local economy are not operating at full capacity.

Fixed production patterns: Input-output (I-O) models assume inputs are used in fixed proportion, without any substitution of inputs, across a wide range of production levels. This assumption assumes that an industry must double its inputs (including both purchases and employment) to double its output. In many instances, an industry will increase output by offering overtime, improving productivity, or improvements in technology.

Industry homogeneity: I-O models typically assume that all firms within an industry have similar production processes. Any industries that fall outside the typical spending pattern for an industry should be adjusted using IMPLAN's Analysis-by-Parts technique.

Leakages: A small area can have a high level of leakage. Leakages are any payments made to imports or value added sectors, which do not in turn re-spend the dollars within the region. What's more, a study area that is actually part of a larger functional economic region will likely miss some important linkages. For example, workers who live and spend outside the study area may actually hold local jobs.

⁸ Bureau of Economic Analysis https://www.bea.gov/papers/pdf/WP_IOMIA_RIMSII_020612.pdf

Appendix D. Definitions Used in This Report

Analysis by parts: The process of splitting or parsing an impact analysis issue into smaller and more specific parts. This technique allows the user to specify the amount of commodity inputs, the proportion of local labor income, and the proportion of local purchases.

Backward linkages: The interconnection of an industry to other industries from which it purchases its inputs in order to produce its output. It is measured as the proportion of intermediate consumption to the total output of the sector (direct backward linkage) or to the total output multiplier (total backward linkage). An industry has significant backward linkages when its production of output requires substantial intermediate inputs from many other industries.⁹

Direct effect: Initial new spending in the study area resulting from the project.

Employment: Estimates (from U.S. Department of Commerce secondary data) are in terms of jobs, not in terms of full-time equivalent employees. Therefore, these jobs may be temporary, part-time, or short-term.

Indirect effect: The additional inter-industry spending from the direct impact.

Induced effect: The impact of additional household expenditures resulting from the direct and indirect impact.

Labor income: All forms of employment income, including employee compensation (wages and benefits) and proprietor income.

Leakages: Any payments made to imports or value added sectors that do not in turn re-spend the dollars within the region.

Margins: The value of wholesale and retail trade services provided in delivering commodities from producers' establishments to purchasers. Margin is calculated as sales receipts less the cost of the goods sold. It consists of the trade margin plus sales taxes and excise taxes that are collected by the trade establishment. (BEA)

Multipliers: Total production requirements within the Study Area for every unit of production sold to Final Demand. Total production will vary depending on whether Induced Effects are included and the method of inclusion. Multipliers may be constructed for output, employment, and every component of value added.

Output: The value of local production required to sustain activities.

Value added: A measure of the impacting industry's contribution to the local community; it includes wages, rents, interest, and profits.

⁹ IMPLAN