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**An Economic Impact Analysis of the  
Nursery and Landscaping Industry  
in Washington State**

By

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# **AN ECONOMIC IMPACT ANALYSIS OF THE NURSERY AND LANDSCAPING INDUSTRY IN WASHINGTON STATE**

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## **ABSTRACT**

This study shows the economic impact of the Washington State Nursery, Plant Materials and Landscaping industries on the Washington State economy. The analysis in this paper is based on 2002 Census of Agriculture and Census of Industry data, up-dated to 2005 and integrated into an IMPLAN based input-output (IO) model. The economic impact measured in this study relates only to Green Industry production and distribution sourced in the State of Washington. That is, the source of the product or service is firms located in Washington. Measured in 2002 dollars, the economic (direct and indirect) impact of the Green Industry in Washington is estimated to be \$2.48 billion in sales and over 43,000 jobs. This report is organized as follows: In section 1, we give a brief overview of the study. In section 2, we present a brief literature review of other state studies made on Green Industry and their estimated economic impact. In section 3, we summarize the overall structure of Green Industry. In section 4 we discuss the research methodology. In section 5 we review the economic impact of Green Industry on the Washington economy as measured in our study, and section 6 concludes.

Keywords: Green Industry, Regional economic impact, Input-output analysis

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\* David Holland is a Professor and Sanjoy Bhattacharjee is a recent Ph.D. graduate from the School of Economic Sciences, Washington State University, Pullman, WA. This research was sponsored by Grant Number 3025-3384 from the Washington State Nursery and Landscape Association.

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## **1: INTRODUCTION**

The main purpose of this study is to estimate the economic impact of the Washington State Nursery, Plant Materials and Landscaping industry on the Washington State economy. The analysis in this paper is based on 2002 Census of Agriculture and Census of Industry data updated to 2005 and integrated into an IMPLAN based input-output (IO) model by personnel at Washington State University (IMPLAN, 2004). The Washington “Green Industry” for this study is defined as consisting of the following industry groups/sectors (NAICS): Nursery and Greenhouse (1114), Landscaping Services (56173), Landscape Architecture (54132), plus Wholesale Marketing Intermediaries (42293) such as brokers and horticultural distribution centers and finally retailers like Lawn and Garden Centers (4442), Building Material Supply Stores (4441) Food and Beverage Stores (445) and Mass Merchandisers (452), such as Wal-Mart, all of whom retail the Nursery and Greenhouse product produced in Washington.

The economic impact measured in this study relates only to Green Industry production and distribution sourced in the State of Washington. That is, the source of the product or service is firms located in Washington. This means that the economic impact of imported Green Industry product is not measured in this study even though such imports do generate jobs and income in Washington-based wholesale, retail and transportation industries. From that perspective the economic impact figures (jobs and income) in this report are conservative.

This report is organized as follows: In section 1, we give a brief overview of the study. In section 2, we present a brief literature review of other studies made on Green Industry and their estimated economic impact. In section 3, we summarize the overall structure of Green Industry. In section 4 we review the economic impact of Green Industry on the Washington economy as measured in our study, and section 5 concludes.

## 2: OTHER ECONOMIC IMPACT STUDIES OF THE GREEN INDUSTRY

The only previous study of Washington's Green Industry was an extensive survey of the industry in 1966-1967 (Carkner and Moore, 1998). Based on their survey Carkner and Moore estimated output (sales) by the various sectors of the Green industry. According to the Carkner and Moore study, the industry generated \$842 million sales at retail during 1996-1997. Table 1 shows a breakdown of gross sales by product category.

**Table 1: Gross Sales by Product Mix**

Sector	Percentage	Total (\$)
A. Nursery/live Goods	0.14	117,910,565
B. Bedding	0.26	218,976,764
C. Fruit Trees	0.11	92,644,016
D. Flowers	0.10	84,221,832
E. Other	0.09	75,799,649
F. Grass Seed	0.02	16,844,366
G. Hard Goods	0.09	75,799,649
H. Services (Landscape Design, Maintenance)	0.11	92,644,016
I. Bulbs	0.08	67,377,466
<b>Total</b>	1.00	842,218,323

Source: Carkner and Moore

It should be noted that estimates summarized in Table 1 do not include estimates of ripple effects on the rest of the economy and in the language of economic impact analysis, include only direct effects of the Green Industry.

Besides the previously noted Washington study, a number of other state level studies on the economic impact of Nursery and Landscape industries are available. For a comprehensive overview of previous studies evaluating the economic impact of the Green Industry in specific

states, see “Economic Impacts of the Green Industry in the United States,” Charles Hall et al., 2005.

Among state level Green Industries, the big three are California, Texas and Florida. According to Hall et al. California ranked first with estimated total state economic impact of \$10.33 billion. Texas was second with \$9.76 billion of economic impact and Florida was third with an estimated impact of \$9.16 billion (Table 2.) After Florida, a number of states such Illinois, Ohio, Tennessee, Minnesota, and Wisconsin are roughly in the same size range - \$2-4 billion total state economic impact.

### **3: THE STRUCTURE OF GREEN INDUSTRY<sup>1</sup>**

The entirety of “Green Industry” includes its input suppliers; the production of nursery, greenhouse, and sod followed by consumption (Figure 1). Other services are associated with the movement of product to consumption: wholesale distribution firms, including importers, brokers, re-wholesalers, and transporters; firms providing landscape and urban forestry services such as design, installation, and maintenance; and retail operations, including independent garden centers, florists, home improvement centers, and mass merchandisers or other chain stores.

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<sup>1</sup> The description of the Green Industry” is from Hall et al., 2005

**Table2: Overview of Selected Previous Studies Evaluating the Economic Impact of the Green Industry in Specific States<sup>2</sup>**

State	Year	Output Impact (\$ Millions)	Number of Jobs	Adjusted Impact per Capita	Sectors Included
Arizona	2002	\$1,200	24,100	\$229.60	P,L
California	2001	\$10,337	168,867	\$321.21	P,R
Colorado	2002	\$1,500	45,000	\$347.04	P,L,G,F,BG,R
Connecticut	2003	\$949	41,000	\$278.14	P,L,R
Florida	2000	\$9,164	187,859	\$617.84	P,L,R,T
Idaho	1999	\$662	12,911	\$566.24	P,L,F,A,R
Illinois	1999	\$3,950	160,000	\$352.03	P,L,R
Louisiana	2001	\$2,215	56,686	\$523.98	P,G,L,R,RHA
Maine	2003	\$286	10,000	\$223.26	P,L,R
Maryland	2000	\$1,152	14,800	\$235.34	P,L,R
Massachusetts	2003	\$1,860	52,000	\$296.07	P,L,R
Minnesota	2002	\$2,110	28,200	\$436.97	P,L,R
Nevada	2002	\$751	15,736	\$360.65	P,RW,L,G
New Hampshire	2003	\$438	12,100	\$347.35	P,L,R
Ohio	2001	\$3,950	96,600	\$367.60	P,L,RW,R
Pennsylvania	2000	\$3,300	107,000	\$290.62	P,L,R
Rhode Island	2003	\$329	10,000	\$312.46	P,L,R
South Carolina	1999	\$1,380	24,710	\$380.71	P,L,F,R
Tennessee	2000	\$2,782	73,000	\$527.91	P,L,R
Texas	2000	\$9,760	222,000	\$504.10	P,L,R
Utah	2000	\$800	15,000	\$385.89	P,L,R
Vermont	2003	\$186	5,400	\$306.92	P,L,R
Wisconsin	2002	\$2,706	43,000	\$517.62	P,HH,PG,G

Source: Hall et al. Study, page 20

<sup>2</sup> a Population data by state: U.S. Census Bureau, State and County Quickfacts, <http://quickfacts.census.gov/qfd/index.html>

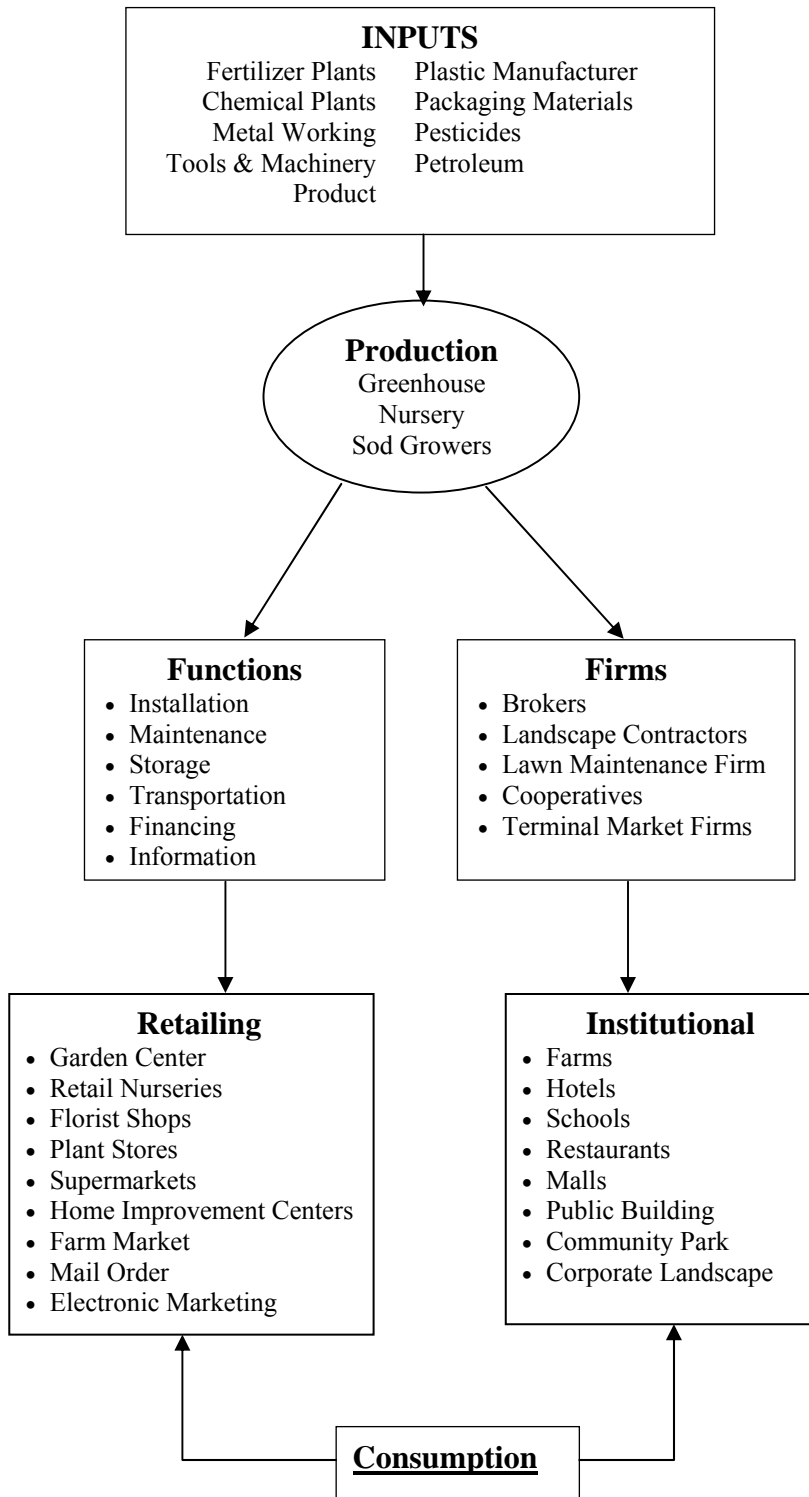
b Impact per capita = Total Green Industry output impact divided by Total Population.

c Deflator = GDP Implicit price inflator for each respective year; Sales Per Capita are adjusted to 2004 dollars.

d Sector codes = [P] Producer; [L] Landscape-related; [R] retail; [RW] Re-wholesale; [F] Florist; [G] Golf; [BG] Botanical gardens; [HH] Households; [A] Arborists; [T] Trade; [RHA] Related horticultural activities; [PG] Public government.



**Figure 1: Structure of the Green Industry**



## **Input Supply Firms**

These firms, often referred to as allied trade firms, are businesses that provide various inputs for Ornamental plant production, landscape services, and retail sales. These inputs commonly include agrichemicals, fertilizers, containers, packaging, farm machinery, tools and equipment, propagative materials, and consulting services. These products often originate from extractive and manufacturing industries such as mining, petroleum, and forestry.

## **Production Firms**

Participants engaged in producing Green Industry products include growers of nursery, sod, and floriculture crops. *Floriculture crops* include bedding plants, potted flowering plants, foliage plants, cut cultivated greens, and cut flowers. Bedding and garden plants consist of young flowering plants (annuals and perennials) and vegetable plants.

Flowering plants are largely sold in pots for indoor use. The market outlets for floriculture crops are florists, garden centers, mass merchandisers, supermarkets, chain stores, discount stores, home improvement centers, hardware stores, landscape contractors, and re-wholesalers. Other retail outlets are farmers markets, flea markets, and street vendors.

*Nursery crops* are woody perennial plants that are usually grown in containers or in-ground. The Census of Agriculture defines nursery crops as ornamental trees and shrubs, fruit and nut trees (for noncommercial use), vines, and ground covers. They are primarily used for landscaping, not for producing edible products on a commercial scale. Trees and shrubs are classified as deciduous or evergreen. Deciduous includes shade, flowering, ornamental, fruit, and nut trees and shrubs. Evergreens include broadleaf and coniferous trees, and Christmas trees. Christmas tree farms are counted as part of nursery crops.

Sales of most nursery crops, except Christmas trees, are more local or regional than floriculture crops, which are less costly to ship to farther markets. While homeowners are the typical consumers of trees, shrubs, and woody ornamental plants, markets also include developers, public utilities, golf courses, resorts, commercial parks, malls, as well as government agencies in charge of public parks, street and highway vegetation, and forests. Like many floral crops, demand for nursery crops (except Christmas trees) tends to coincide with normal planting seasons in the spring and fall.

Wholesale sales of nursery products are usually handled by salespersons who have established relations with large buyers. Marketing programs include numerous trade shows, advertising in trade publications, catalogs, and direct mail. Close planning with large buyers (referred to as partnering) is required to secure long-term markets and to ensure that the right product mix is produced; however, demand for different products can still vary substantially from year to year. Sales and many variable expenses (costs-of-goods-sold) are highly seasonal, with up to 50 percent of sales in the second quarter of a typical year. Cash flow is uneven throughout the year so cash management is important. Technical knowledge of plants and pests is important for nursery management, although many of the everyday tasks (cultural practices) are routine and do not require specialized labor. However, automation has proven to be difficult, aside from the widespread use of irrigation and fertilization systems. Greenhouse operations can be very sophisticated, with automatic irrigation and fertilization (sometimes referred to as fertigation), and air and lighting systems driven by a variety of sensors. Innovations demanded by big-box retailers (such as custom labeling, bar codes, scanners, and electronic data interchange between suppliers and buyers) are now used by many producers.

In recent years, there has been considerable consolidation among large growers, largely in response to consolidation occurring at the retail level. The rise of large, nationwide plant retailers like Home Depot, Lowe's, Wal-Mart, etc. has created a marketing opportunity for large growers who can supply the large volumes these customers require. Companies like Hines and Color Spot have grown rapidly through acquisition during the past decade, largely to service these big customers. Geared to serve big customers by handling large volumes, large growers actively discourage small-volume buyers. While large nurseries are supplying mainly big-box retailers and large landscape installation companies, smaller growers are the main suppliers of independent garden centers, retail nurseries, and smaller landscape firms. Proximity and high product quality are more important to these buyers than low price because the end consumer is most interested in quality and the breadth of retail selection. Keeping plants alive and healthy is a challenge for many consumers, and small retail operations often have more technically knowledgeable staff than mass retailers to assist customers with plant care advice.

To even out the seasonal nature of demand throughout the year, many nurseries produce plants like Easter lilies and poinsettias that have demand at times other than late spring or fall. Large producers may also sell related products like soil, sod, and Christmas trees. Some growers may produce a range of soil mixtures made from peat moss, sand, bark, sawdust, lime, perlite, vermiculite, and other materials (including mulched product waste) to sell to other growers on a contract basis.

### **Wholesale Distribution Firms**

Wholesale distributors are an integral part of the Green Industry supply chain. Intermediaries such as brokers and importers facilitate the transactions of domestic and

international (importing/exporting) growers and retailers. Re-wholesalers (often referred to as horticultural distribution centers or HDCs) are also market facilitators that offer regionally specific mixes of landscape supplies for immediate pickup or delivery to landscape professionals and have emerged throughout the United States in a variety of forms. There are self-contained HDCs and HDCs that serve as independent profit centers within vertically-integrated grower, landscape contracting, and retail garden center operations.

### **Retailers**

Retail firms are another point of contact with end consumers of horticultural products, such as independent garden centers, florists, home centers, mass merchants, and other chain stores. Garden centers are establishments primarily engaged in selling trees, shrubs, other plants, seeds, bulbs, mulches, soil conditioners, fertilizers, pesticides, garden tools, and other garden supplies to the general public. These establishments primarily sell products purchased from others, but may sell some plants which they grow themselves. Garden center consumer studies indicate customer loyalty and repeat business result from a convenient store location, plant quality, customer service, and plant selection.

### **End Users**

Final consumers of Green Industry products and services are referred to as end users. While the vast majority of nursery and turf grass products used by end users are purchased from Green Industry businesses, this is not the case for services. The end users themselves perform a significant amount of lawn and landscape services. However, these services are only for internal consumption; that is, end users do not maintain or care for any landscape plants or green space

other than their own. The list of end users includes airports, cemeteries, churches, commercial general business areas, golf courses and driving ranges, homeowners, municipalities, private recreation areas, public roadways, schools and universities, utilities and construction<sup>3</sup>. “Commercial areas” are comprised of restaurants, banks, credit unions, commercial building operators, shopping centers, real estate managers, apartment buildings, other dwelling operators, mobile home sites, hotels and motels, medical centers, nursing care centers, intermediate care facilities, general and specialty hospitals, residential care facilities, retirement communities, community centers, and adult and child day-care centers.

#### **4: RESEARCH METHODOLOGY AND INFORMATION SOURCES**

The economic impact analysis in this paper begins with the most recent figures from the Agriculture and Economic Census for the State of Washington data for 2002 and IMPLAN 2002 data for Washington. Information from the Census was considered the most reliable data available, because the Census has well-established statistical methodologies and adjustment for non-responding business as well as published confidence parameters. According to Census 2002 data, the Washington Green Industry was estimated to generate \$1.17 billion worth of sales, which is the value of sales at factory gate during 2001-2002. Table 3 shows a breakdown of gross sales by industry.

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<sup>3</sup> In Table A1.3, new residential construction and highway construction are shown as important buyers of Landscape Services.

**Table 3: (Sales in Washington for the Green Industry, 2002)**

Sector (NAICS no.)	Percentage	Total (\$M)
Nursery & Greenhouse (1114)	33.372	391.9
Lawn & Garden Equipment Mfg (333112) <sup>4</sup>	0.828	9.72
Landscaping Services (56173)	59.602	699.94
Landscape Architectural Services (54132)	6.198	72.79
<b>Total</b>	100.000	1174.35

Source: 2002 Agricultural & Economic Census

In Table 3 “Landscaping Services (56173)” and “Landscape Architectural Service (54132)” sales are presented individually, but in the subsequent economic impact analysis they are combined into a single “Landscape Industry”. Landscaping Services is the dominant Green Industry in Washington with 2002 sales of approximately \$700 million (Table 3). Out of 3.54 million total Washington state jobs, roughly 26,000 jobs are in this industry.

The year for which we are going to measure total economic impact of Green Industry is 2005. Using the industry annual average growth rate between 1997 and 2002, we project industry sales for the year 2005 by assuming that the Green Industry grew between 2002 and 2005 at the same annual rate that characterized 1997-2002. We use 1997 Census data for the Nursery and Greenhouse sector. Landscaping Services and Landscape Architectural Services are newly added sectors in the 2002 census. For growth projection in these two sectors we use IMPLAN 1997 data from the Landscape Industry. We also use IMPLAN 1997 data for the projected value of Lawn & Garden Equipment Manufacturing. The following table (Table 4) summarizes the basic time series data for each industry as well as estimated 2005 sales for each industry. In total, Green Industry sales in 2005 are estimated to be \$1.527 billion.

<sup>4</sup> Figure taken from IMPLAN data

**Table 4: (Projected Gross Sales, Year 2005)**

Sector (NAICS no.)	1997 (\$M)	2002 (\$M)	Growth Rate per Year	2005 Projected (\$M)
Nursery & Greenhouse (1114)	271.58	391.9	7.6%	488.216
Lawn & Garden Equipment Mfg (333112)	3.30	9.72	24.1%	18.577
Landscape Industry <sup>5</sup>	485.75	772.73	9.73%	1020.95
Total				1527.742

Source: Authors' Estimates

While Tables 3 and 4 provide useful information regarding the basic structure and size of the industry, they do not provide information regarding the size of the Green Industry relative to other industries in Washington. Table 5 shows the relative size of Green Industry relative to selected other industries in Washington. We arrange all industries in ascending order, based on their respective share in total industry output. In the 2002 IMPLAN sectoring scheme (NAICS), the largest industry was Software Publishers (Microsoft) with sales of roughly \$20 billion. Second was Aircraft Manufacturing (Boeing). There is no surprise in these figures.

The Landscape Industry ranked 105 out of 458 industries represented in IMPLAN with 2002 sales of \$773 million, while Nursery and Greenhouse was the 153<sup>rd</sup> largest industry with sales of \$392 million (Table 5). The size of the Green Industry may be compared with more traditional horticulture industries such as fruit and vegetables. Fruit farming ranked 60<sup>th</sup> among all Washington industries with sales of almost \$1.45 billion and the Vegetables and Melons industry ranked 102, slightly ahead of Landscaping, with sales of \$790 million. With the high annual growth rate of the Green Industry it is in a position to overtake fruit and vegetable production as the most important horticultural related industry in Washington.

<sup>5</sup> Landscape Architectural Services (54132) and Landscaping Services (56173) combined



**Table 5: Relative Size of Washington Industries**

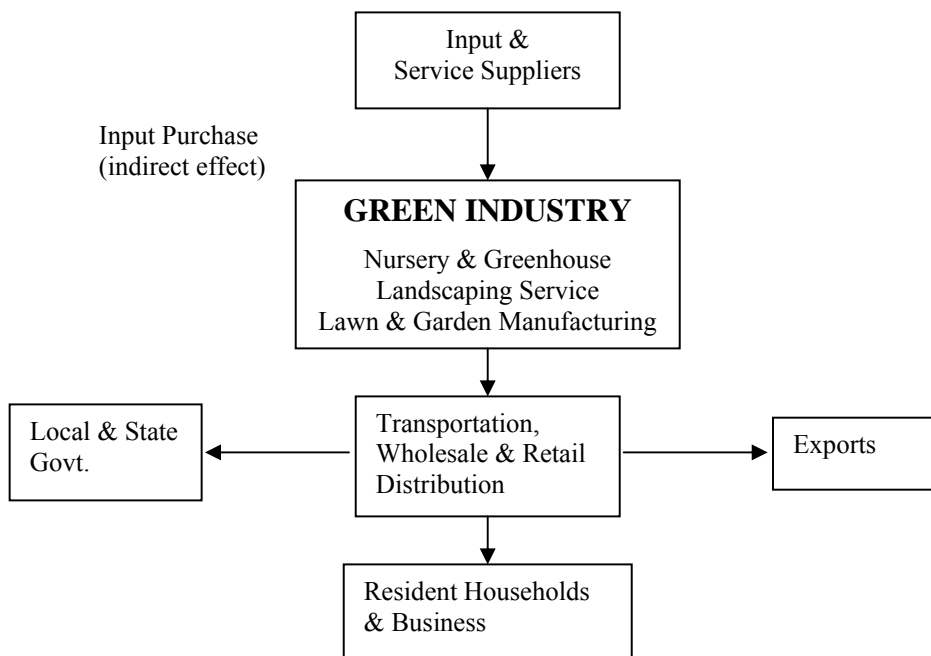
Rank (Output)	Sector	Total Output (\$M)	% Total Output	Employment	% Employment	Employee Compensation (\$M)	Employee Compensation Per Job (\$)
1	Software Publishers	20,185.4	5.08	36,184	1.02	7,322.173	202,358
2	Aircraft Manufacturing	19,177.1	4.83	65,087	1.84	6,373.561	97,924
3	Wholesale Trade	17,650.3	4.44	122,329	3.46	6,694.910	54,729
4	Real Estate	17,533.9	4.41	112,067	3.17	1,246.656	11,124
8	Food Services and Drinking Places	8,687.0	2.19	211,287	5.97	3,339.932	15,808
15	Hospitals	6,159.9	1.55	59,482	1.68	3,046.388	51,215
16	Insurance Carriers	6,001.4	1.51	29,863	0.84	1,591.506	53,293
17	Petroleum Refineries	5,513.8	1.39	2,125	0.06	231.663	109,001
25	Food and Beverage Stores	4,152.0	1.04	65,514	1.85	1,773.815	27,075
28	Truck Transportation	3,562.7	0.90	31,171	0.88	1,040.074	33,366
44	Logging	2,131.8	0.54	9,309	0.26	315.550	33,897
51	Sawmills	1,631.1	0.41	8,207	0.23	382.445	46,602
60	Fruit Farming	1,451.8	0.365	21,603	0.611	442.724	20,494
74	Postal Service	1,138.4	0.29	15,171	0.43	954.338	62,906
79	Couriers and Messengers	1,058.5	0.27	14,007	0.40	458.401	32,726
81	Fishing	1,053.8	0.27	9,183	0.26	248.654	27,076
91	Household Goods Repair and Maintenance	876.3	0.22	6,349	0.18	141.272	22,252
95	Child Day Care Services	842.2	0.21	24,198	0.68	306.648	12,673
102	Vegetable and Melon Farming	790.1	0.20	6,702	0.19	145.464	21,705
<b>105</b>	<b>Landscape Industry</b>	<b>772.7</b>	<b>0.19</b>	<b>20,497</b>	<b>0.58</b>	<b>226.992</b>	<b>11,074</b>
110	Services to Buildings and Dwellings	695.8	0.18	18,640	0.53	317.257	17,020
117	Grain Farming	651.4	0.16	15,227	0.43	24.720	1,623
<b>153</b>	<b>Greenhouse and Nursery Production</b>	<b>391.9</b>	<b>0.10</b>	<b>5,003</b>	<b>0.14</b>	<b>173.079</b>	<b>34,592</b>
156	Fluid Milk Manufacturing	355.0	0.09	834	0.02	46.598	55,899
164	Dry Cleaning and Laundry Services	339.6	0.09	7,697	0.22	151.619	19,698
170	Breweries	301.1	0.08	821	0.02	41.070	50,012
171	Wineries	293.4	0.07	1,000	0.03	35.801	35,785
188	Poultry Processing	229.4	0.06	1,508	0.04	41.147	27,287
228	Poultry and Egg Production	142.2	0.04	405	0.01	14.862	36,661
258	Prefabricated Metal Buildings and Components	87.1	0.02	519	0.01	24.705	47,647
294	Nitrogenous Fertilizer Manufacturing	59.9	0.02	166	0.00	15.378	92,461
392	Cheese Manufacturing	14.2	0.00	25	0.00	0.879	34,584
<b>409</b>	<b>Lawn and Garden Equipment Manufacturing</b>	<b>9.7</b>	<b>0.00</b>	<b>31</b>	<b>0.00</b>	<b>1.331</b>	<b>42,916</b>
Total		397,346.9		3,536,550		136,845.521	38,695

Source: IMPLAN 2002

## 5: ECONOMIC IMPACT ANALYSIS

In order to provide additional information on ripple (indirect) effects and other associated economic perspectives of Green Industry on the Washington economy, we conducted an economic impact analysis using an IMPLAN based input-output economic model of Washington State. Figure 2 illustrates direct and indirect economic impacts of the Green Industry. Direct effects are represented by sales of Green Industry products to final demand such as households, government and exports. Indirect effects stem from the input purchase by Green Industry firms from their suppliers.

**Figure 2: Economic Impact of the Green Industry**



The IMPLAN based economic model is from the year 2002 (the most recent year available) and will be accurate in terms of estimated impact as long as the production functions represented in the economic model accurately reflect the existing production structure (recipe) of

Washington's industries. Usually industry structure changes slowly so that an economic model that captures the structure in 2002 should be reasonably representative for the next 5 to 6 years. For more information on input-output models and economic impact analysis see Appendix 3.

As previously noted, the data in Table 4 refer to sales at producer prices. However, for economic impact purposes we need to include the business activity that occurs as the product moves from the nursery gate to the final consumer. For example, if a consumer pays \$1 at a retail shop in order to purchase a unit of "Nursery and Greenhouse products", then we assume (from the IMPLAN data), \$.45 go to the growers of the product, \$.08 to the wholesaler, roughly \$.45 to the retailer and \$.02 for different transport services to move the product from the grower through to the retailer (Table 6). In other words, \$1 dollar of Nursery and Greenhouse products at the nursery gate become roughly \$2.15 of product at retail once the transportation and marketing margins are added to the producer price. Similarly, if a customer pays \$1 to buy Lawn & Garden Equipment, \$.45 is going to the Lawn & Garden Equipment supplier, with \$.08 to the Wholesaler, and \$.46 for Retail services<sup>6</sup>.

By using the relevant IMPLAN margin data, we are able to obtain the total value of retail payments for a given commodity unbundled into its component parts, consisting of producer value, wholesale margin, transportation margin and retail margin. These price mark-ups for any commodity retail sale are also known as "event margins". These event margin figures are required because all regional input-output economic models are specified in terms of producer prices. This is why retail sales of a given commodity must be broken into their component parts reflecting underlying producer values.

The following table shows the relevant IMPLAN breakouts for Green Industry products.

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<sup>6</sup> Sales margins are taken from IMPLAN

**Table 6: Event Margins for Green Industry Products**

Name of the Industry (IMPLAN Sectoring no.)	Event Margin (%)	Nursery & Greenhouse (\$M)	Event Margin (%)	Prefabricated Metal Building (\$M)	Event Margin (%)	Lawn & Garden Equipment Manufacturing (\$M)	Total (\$M)
Nursery & Greenhouse (6)	0.451212	488.216	0.535	1.755	0.445732	18.577	
Wholesale Trade (390)	0.080492	87.093	0.0373	0.121445	0.082338	3.432	90.65
Air Transportation (391)	0	0	0	0	0	0	0
Rail Transportation (392)	0.000246	0.266	0	0	0.000216	0.009	0.27
Water Transportation (393)	0	0	0	0	0	0	0
Truck Transportation (394)	0.016035	17.35	0.00145	0.0047625	0.006262	0.261	17.62
Pipeline Transportation (396)	0	0	0	0	0	0	0
Retail Trade (401)	0.452015	489.084	0.4271	1.4025713	0.465453	19.399	509.88
	1		1.00		1.00		

Sales Margin Source: IMPLAN 2002<sup>7</sup>

After accounting all event margins and adding Landscape we get the final figure on which we run our economic impact analysis. Table 7 shows the final product mix. The values corresponding to each sector are estimated values for the year 2005.

**Table 7: Final Direct Effects for the Year 2005**

	Values (\$M)
Nursery & Greenhouse	488.22
Landscape	1020.95
Prefabricated Metal Buildings	1.76
Lawn & garden Equipment Manu	18.58
Wholesale Trade	90.65
Rail transportation	0.27
Truck transportation	17.62
Retail Trade	509.88
Total	2147.92

Source: Authors' estimates based on Census and IMPLAN data

<sup>7</sup> The estimate for "prefabricated metal buildings" was based upon the Hall et al. findings.

Almost \$2.15 billion worth of direct sales are associated with the Washington Green Industry. This includes almost \$510 million worth of retail markup, \$18.5 million worth of transportation and \$90 million worth of wholesale markup. This is the Marketing and Transportation business associated with bringing Washington produced Green Industry product to end consumers.

We assumed that all Nursery and Greenhouse product is eventually sold at retail. This probably overestimates the retail margins for this industry in Washington. We have used a Type-I input-output (IO) model to enumerate the total economic impact of Green Industry. The Type-I multiplier measures the direct and indirect effects of the Green Industry. It captures the inter-industry effects only; i.e., industries buying from local industries and does not include payroll-household consumption impact (induced effect). As a result, the indirect effects of the Green Industry are conservatively estimated in this study. Since household consumption of Green Industry production is treated as exogenous it was not possible to estimate induced economic impacts.

### **Impact Analysis:**

We used the Washington IO model to estimate direct and secondary effects of Green Industry final demand. After adjusting for 2002-year prices, total output impacts are shown in Table 8. The estimated direct impact is around \$2.043 billion, while the total (direct + indirect) economic impact is \$2.482 billion. The difference between the total and direct impact reflects the secondary or indirect impact, which in turn represents the total ripple effects. For example, Landscape Industry sales create a demand for Greenhouse Nursery business and other inputs into

Landscaping (Table A1.2, appendix). This is reflected in the indirect impacts of the Green Industry in Table 8.

Table 9 shows total employment driven by final demand of the Green Industry in the state of Washington. An estimated 39,000 jobs in Washington are directly associated with the Green Industry. The ripple effect generates an additional 4,000 jobs for a total of 43,000 jobs in Washington. The Value-added impact is summarized in Table 10. Green Industry adds almost \$1.7 billion to the Washington economy, out of which \$1.4 billion is direct impact. Value-added impact comprises employee compensation, proprietor's income, other property type income and indirect business tax. Employee compensation and indirect business tax share the highest and lowest proportion of value-added income among all four categories respectively (Table11). Retail trade generates the highest indirect business tax (almost \$73 million) among all sectors in Green Industry (Table 12).

The impact on taxes from changes in Green Industry economic activities is reported in more detail in Table13. Based on the IMPLAN tax information (simple ratio estimates) and output (sales), Table 13 shows the taxes generated directly and indirectly by the Green Industry. The economic impact of Green Industry increases Federal tax revenues by \$215 million. State and local tax revenues are estimated at \$152 million. The sales tax, which is also part of total indirect business taxes, is the largest of all state-tax impact. The estimated value of the state sales tax is almost \$78 million per year. Other important state and local taxes are the property tax and the B&O tax (Table 13).

**Table 8: Output (Sales) Impact of the Green Industry, WA State, 2005**

Industry	Direct Impact (\$)	Indirect Impact (\$)	Total (\$)
Ag, Forestry, Fishing	0	11,280,250	11,280,250
Greenhouse and Nursery Production	470,865,152	56,286,656	527,151,808
Landscape Service	984,666,048	342,976	985,009,024
Mining	0	653,202	653,202
Utilities	0	2,675,235	2,675,235
Construction	0	13,398,938	13,398,938
Manufacturing	0	42,027,080	42,027,080
Prefabricated Metal Buildings and Components	1,653,372	6,082	1,659,455
Lawn and Garden Equipment Manufacturing	17,203,506	126,258	17,329,764
Wholesale Trade	84,552,184	54,286,376	138,838,560
Transportation & Warehousing	0	26,940,640	26,940,640
Rail Transportation	248,568	842,543	1,091,111
Truck Transportation	16,860,518	14,085,228	30,945,746
Retail Trade	467,451,754	6,164,707	473,616,461
Information	0	21,247,466	21,247,466
Finance & Insurance	0	34,436,648	34,436,648
Real Estate & Rental	0	46,903,320	46,903,320
Professional- Scientific & Tech Services	0	43,941,752	43,941,752
Management Of Companies	0	13,033,777	13,033,777
Administrative & Waste Services	0	14,104,911	14,104,911
Educational Services	0	170,541	170,541
Health & Social Services	0	28,419	28,419
Arts- Entertainment & Recreation	0	1,414,353	1,414,353
Accommodation & Food Services	0	6,575,358	6,575,358
Other Services	0	7,022,106	7,022,106
Government & Non Naics	0	20,884,846	20,884,846
<b>Total</b>	<b>2,043,501,103</b>	<b>438,879,667</b>	<b>2,482,380,770</b>

Source: Authors' estimate based on IMPLAN IO model (2002 prices)

**Table 9: Employment Impact of Green Industry, WA State, for 2005**

Industry	Direct Impact	Indirect Impact	Total
Ag, Forestry, Fish & Hunting	0	382	382
Greenhouse and Nursery Production	6,012	719	6,730
Landscape Service	26,119	9	26,128
Mining	0	5	5
Utilities	0	5	5
Construction	0	103	103
Manufacturing	0	104	104
Prefabricated Metal Buildings and Components	10	0	10
Lawn and Garden Equipment Manufacturing	55	0	55
Wholesale Trade	586	376	962
Transportation & Warehousing	0	246	246
Rail Transportation	1	4	5
Truck Transportation	148	123	271
Retail Trade	6255	99	6354
Information	0	114	114
Finance & Insurance	0	201	201
Real Estate & Rental	0	298	298
Professional- Scientific & Tech Services	0	516	516
Management Of Companies	0	79	79
Administrative & Waste Services	0	263	263
Educational Services	0	3	3
Health & Social Services	0	0	0
Arts- Entertainment & Recreation	0	39	39
Accommodation & Food Services	0	134	134
Other Services	0	89	89
Government & Non Naics	0	52	52
Total	39,184	3,965	43,149

Source: Authors' estimate based on IMPLAN IO model



**Table10: Value-Added Impact of Green Industry for 2005**

Industry	Direct Impact (\$)	Indirect Impact (\$)	Total (\$)
Ag, Forestry, Fish & Hunting	0	6,905,357	6,905,357
Greenhouse and Nursery Production	403,205,312	48,198,680	451,404,000
Landscape Service	614,429,696	214,016	614,643,712
Mining	0	370,107	370,107
Utilities	0	1,627,372	1,627,372
Construction	0	5,694,907	5,694,907
Manufacturing	0	8,759,052	8,759,052
Prefabricated Metal Buildings and Components	542,650	1,996	544,647
Lawn and Garden Equipment Manufacturing	4,605,918	33,803	4,639,721
Wholesale Trade	61,215,456	39,303,128	100,518,584
Transportation & Warehousing	0	14,629,003	14,629,003
Rail Transportation	156,094	529,094	685,188
Truck Transportation	7,918,224	6,614,861	14,533,084
Retail Trade	365,880,219	4,630,562	370,510,766
Information	0	11,545,980	11,545,980
Finance & Insurance	0	20,830,432	20,830,432
Real Estate & Rental	0	29,484,808	29,484,808
Professional- Scientific & Tech Services	0	33,002,056	33,002,056
Management Of Companies	0	9,156,450	9,156,450
Administrative & Waste Services	0	8,837,362	8,837,362
Educational Services	0	84,623	84,623
Health & Social Services	0	13,604	13,604
Arts- Entertainment & Recreation	0	866,691	866,691
Accommodation & Food Services	0	4,208,714	4,208,714
Other Services	0	3,101,791	3,101,791
Government & Non Naics	0	15,676,975	15,676,975
<b>Total</b>	<b>1,457,953,568</b>	<b>274,321,423</b>	<b>1,732,274,984</b>

Source: Authors' estimate based on IMPLAN IO model

**Table 11: Decomposition of Value-added Impact**

	Direct Impact (\$M)	Indirect Impact (\$M)	Total Impact (\$M)
A. Labor Income (B + C)	884	169	1054
B. Employee Compensation	731	143	874
C. Proprietors Income	153	26	180
D. Other Property Type Income	453	84	537
E. Indirect Business Tax	120	21	141
<b>Total Value-Added (A+D+E)</b>	<b>1457</b>	<b>274</b>	<b>1732</b>

Source: Authors' estimate based on IMPLAN IO model

**Table12: Indirect Business-Tax Impact of Green Industry for 2005**

Industry	Direct Impact (\$)	Indirect Impact (\$)	Total (\$)
Ag, Forestry, Fish & Hunting	0	151,376	151,376
Greenhouse and Nursery Production	7,127,781	852,046	7,979,828
Landscape Service	25,324,828	8,821	25,333,650
Mining	0	51,182	51,182
Utilities	0	294,409	294,409
Construction	0	88,383	88,383
Manufacturing	0	246,656	246,656
Prefabricated Metal Buildings and Components	10,992	40	11,033
Lawn and Garden Equipment Manufacturing	129,273	949	130,222
Wholesale Trade	14,066,959	9,031,632	23,098,592
Transportation & Warehousing	0	959,927	959,927
Rail Transportation	5,232	17,735	22,968
Truck Transportation	190,271	158,952	349,224
Retail Trade	73,131,327	892,979	74,024,304
Information	0	1,090,502	1,090,502
Finance & Insurance	0	1,050,792	1,050,792
Real Estate & Rental	0	4,102,613	4,102,613
Professional- Scientific & Tech Services	0	694,259	694,259
Management Of Companies	0	145,917	145,917
Administrative & Waste Services	0	262,681	262,681
Educational Services	0	1,187	1,187
Health & Social Services	0	248	248
Arts- Entertainment & Recreation	0	84,401	84,401
Accommodation & Food Services	0	589,724	589,724
Other Services	0	92,002	92,002
Government & Non Naics	0	22,447	22,447
Total	119,986,664	20,891,861	140,878,525

Source: Authors' estimate based on IMPLAN IO model

**Table13: Tax Impact of Green Industry**

	Employee Compensation	Proprietary Income	Household Expenditure	Enterprises (Corporations)	Indirect Business Tax	Total
Federal Government Non-Defense	Corporate Profits Tax			25,890,403		25,890,403
	Indirect Bus Tax: Custom Duty				2,363,458	2,363,458
	Indirect Bus Tax: Excise Taxes				8,004,879	8,004,879
	Indirect Bus Tax: Fed Non-Taxes				2,505,979	2,505,979
	Personal Tax: Estate and Gift Tax					0
	Personal Tax: Income Tax			57,872,579		57,872,579
	Personal Tax: Non-Taxes (Fines- Fees					0
	Social Ins Tax- Employee Contribution	54,336,093	8,536,327			62,872,420
Social Ins Tax- Employer Contribution	55,725,275				55,725,275	
<b>Total</b>	<b>110,061,368</b>	<b>8,536,327</b>	<b>57,872,579</b>	<b>25,890,403</b>	<b>12,874,316</b>	<b>215,234,993</b>
State/Local Govt. Non-Education	Gross Revenue Tax (B&O)			14,983,788		14,983,788
	Indirect Bus Tax: Motor Vehicle Lic				914,896	914,896
	Indirect Bus Tax: Other Taxes				8,202,223	8,202,223
	Indirect Bus Tax: Property Tax				35,903,183	35,903,183
	Indirect Bus Tax: S/L Non-Taxes				4,528,702	4,528,702
	Indirect Bus Tax: Sales Tax				78,237,763	78,237,763
	Indirect Bus Tax: Severance Tax				217,442	217,442
	Personal Tax: Estate and Gift Tax					0
	Personal Tax: Income Tax					0
	Personal Tax: Motor Vehicle License			1,272,319		1,272,319
	Personal Tax: Non-Taxes (Fines- Fees			4,900,231		4,900,231
	Personal Tax: Other Tax (Fish/Hunt)			514,142		514,142
	Personal Tax: Property Taxes			487,492		487,492
	Social Ins Tax- Employee Contribution	538,056				538,056
Social Ins Tax- Employer Contribution	1,462,410				1,462,410	
<b>Total</b>	<b>2,000,466</b>	<b>0</b>	<b>7,174,183</b>	<b>14,983,788</b>	<b>128,004,209</b>	<b>152,162,646</b>
<b>Total</b>	<b>112,061,834</b>	<b>8,536,327</b>	<b>65,046,762</b>	<b>40,874,191</b>	<b>140,878,525</b>	<b>367,397,639</b>

Source: Authors' estimate based on IMPLAN IO model

## **6: SUMMARY**

In order to understand the relative size and secondary effect of any industry in a given state economy, economic impact analysis is a standard approach. Economic impacts may be measured in sales, jobs or value added. From our IO analysis we have seen that in the year 2005 the Green Industry generated \$ 2.48 billion of total output (sales), and \$ 1.73 billion of value-added income to the Washington State economy. Directly and indirectly, the industry creates almost 43,000 jobs. Total state and local tax revenues generated by the Green Industry in Washington are \$158 million. The above figures of sales, value-added, tax and job creation in combination with high rates of industry growth suggest the increasing economic importance of the Green Industry in the Washington economy.

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## **APPENDIX 1: PRODUCTION FUNCTIONS FOR LANDSCAPING AND NURSERY INDUSTRIES**

The Landscape Industry contributes significantly to the value-added side of state economy (Appendix 1, Table A1.1). Value-added is measured as payments to labor and capital in a given industry plus indirect business taxes (property taxes and other taxes on business inputs).

**Table A1.1: Value-Added for Landscape Industry**

<u>Value-Added</u>	<u>Coefficients</u>	<u>Inputs (\$M)</u>
Employee Compensation	0.2938	226.992
Proprietary Income	0.0962	74.362
Other property Income	0.2083	160.954
Indirect Business tax	0.0257	19.874
<u>Total Value added</u>	<u>0.6240</u>	<u>482.182</u>

Source: Production Function, IMPLAN 2002

For every dollar the consumer spends on Landscape Services, the industry makes a payment of \$.29 to its employees and generates property income worth \$.29. For every dollar of sales, Landscape Industry makes a value added payment of \$.62 (Table A1.1).

Looking at purchased inputs, Greenhouse and Nursery products are the largest input to the Landscape Industry with roughly 12 percent of total industry expenditure followed by Wholesale Trade with roughly 4 percent of industry expenditure (Table A1.2). (Wholesale Trade represents the wholesale markup on inputs purchased by the Landscape industry).



**Table A1.2: Input demand by Landscape Industry per Dollar of Sales**

Industry Code (IMPLAN)	Industry Description 2002	Adjusted Gross Absorption Coefficient
6	Greenhouse and Nursery Production	0.1236
390	Wholesale Trade	0.0414
391	Air Transportation	0.0232
432	Automotive Equipment Rental and Leasing	0.0219
437	Legal Services	0.0218
142	Petroleum Refineries	0.0148
156	Nitrogenous Fertilizer Manufacturing	0.0147
431	Real Estate	0.0136
422	Telecommunications	0.0125
426	Securities, Commodity Contracts, Investments	0.0113
447	Advertising and Related Services	0.0108
394	Truck Transportation	0.0106
42	Maintenance and Repair of Farm and Non-Farm Residence	0.0097
444	Management Consulting Services	0.0069
455	Business Support Services	0.0048
350	Motor Vehicle Parts Manufacturing	0.0037
446	Scientific Research and Development Services	0.0029
479	Hotels and Motels- Including Casino Hotels	0.0029
159	Pesticide and Other Agricultural Chemical Manufacturing	0.0029
438	Accounting and Bookkeeping Services	0.0026
424	Data Processing Services	0.0022
483	Automotive Repair and Maintenance- Except Car Wash	0.0021
428	Insurance Agencies- Brokerages- and Related	0.0021
398	Postal Service	0.0018
499	Other State and Local Government Enterprises	0.0014
326	Lighting Fixture Manufacturing	0.0012
481	Food Services and Drinking Places	0.0011
502	Used and Secondhand Goods	0.0010
228	Cutlery and Flatware- Except Precious- Manufacturing	0.0010
241	Hardware Manufacturing	0.0008
145	Petroleum Lubricating Oil and Grease Manufacturing	0.0007
258	Lawn and Garden Equipment Manufacturing	0.0006
337	Storage Battery Manufacturing	0.0004
395	Transit and Ground Passenger Transportation	0.0004
392	Rail Transportation	0.0003

414	Periodical Publishers	0.0003
393	Water Transportation	0.0003
418	Motion Picture and Video Industries	0.0003
385	Gasket- Packing- and Sealing Device Manufacturing	0.0002
126	Paperboard Container Manufacturing	0.0002
277	Heating Equipment- Except Warm Air Furnaces	0.0001
134	Sanitary Paper Product Manufacturing	0.0001
411	Miscellaneous Store Retailers	0.0001
272	Photographic and Photocopying Equipment Manufacturing	0.0001
101	Textile Bag and Canvas Mills	0.0001
136	Manifold Business Forms Printing	0.0001
125	Paper and Paperboard Mills	0.0001
325	Electric Lamp Bulb and Part Manufacturing	0.0000
404	Building Material and Garden Supply Stores	0.0000
402	Furniture and Home Furnishings Stores	0.0000
405	Food and Beverage Stores	0.0000
408	Clothing and Clothing Accessories Stores	0.0000

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Source: IMPLAN 2002<sup>8</sup>

In terms of industry sales, the largest consumers of Landscape Industry services are Owner Occupied Dwellings (Table A1.3) followed by the Real Estate Industry (The Real Estate Industry includes rental housing while housing owned by homeowners is include in the Owner Occupied category). Government consumes almost \$51 million worth of Landscape Industry services (Table A1.4).

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<sup>8</sup> Gross Absorption Coefficient indicates input payment required to produce one unit (\$1) of the product

**Table A1.3: Intermediate/ Industry Demand for Landscape Services**

Industry Code	Industry Description	Gross Absorption Coefficient	Gross Inputs (\$M)
509	Owner-Occupied Dwellings	0.027	451.149
431	Real Estate	0.006	105.905
33	New Residential 1-Unit Structures- Nonfarm	0.005	35.069
351	Aircraft Manufacturing	0.001	22.437
467	Hospitals	0.002	9.733
390	Wholesale Trade	0.000	6.531
481	Food Services and Drinking Places	0.001	5.386
39	Highway-Street-Bridge- and Tunnel Construction	0.004	5.235
478	Other Amusement- Gambling- and Recreation Industri	0.003	4.919
491	Religious Organizations	0.006	4.340
463	Other Educational Services	0.004	3.857
479	Hotels and Motels- Including Casino Hotels	0.003	3.855
468	Nursing and Residential Care Facilities	0.001	3.824
42	Maintenance and Repair of Farm and Nonfarm Residential	0.005	2.995
476	Fitness and Recreational Sports Centers	0.009	2.887
498	State and Local Government Electric Utilities	0.000	2.356
465	Offices of Physicians- Dentists- and Other Health	0.000	2.320
343	Miscellaneous Electrical Equipment Manufacturing	0.006	2.283
125	Paper and Paperboard Mills	0.001	2.231
37	Manufacturing and Industrial Buildings	0.002	1.647
410	General Merchandise Stores	0.001	1.646
60	Frozen Food Manufacturing	0.001	1.505
430	Monetary Authorities and Depository Credit Interme	0.000	1.451
209	Primary Aluminum Production	0.002	1.300
470	Social Assistance- Except Child Day Care Services	0.001	1.230
469	Child Day Care Services	0.001	1.162
405	Food and Beverage Stores	0.000	1.038
422	Telecommunications	0.000	0.912
411	Miscellaneous Store Retailers	0.001	0.837
311	Semiconductors and Related Device Manufacturing	0.001	0.660
432	Automotive Equipment Rental and Leasing	0.001	0.592
453	Facilities Support Services	0.002	0.429
108	Accessories and Other Apparel Manufacturing	0.001	0.026
	Total Industry Demand		691.747

Source: IMPLAN 2002

**Table A1.4: Institutional/ Final Demand for Landscape Industry**

Description	Gross Final Demand (\$M)
Federal Government Non-Defense	0.162
Federal Government Defense	0.474
State/Local Govt. Non-Education	45.54
State/Local Govt. Education	5.636
Total	51.812

Source: IMPLAN 2002

The Greenhouse and Nursery Industry differs from the Landscape Industry primarily on the percent of expenditures going to value-added. Its contribution to the value-addition (85%) (Table A1.5) per dollar of sales is higher than that of landscape (62%). Employee compensation in Landscape Industry is relatively low in comparison to per-job employee compensation in Greenhouse and Nursery Industry. The Greenhouse and Nursery Industry also generates a higher percent of “other property income” compared to the Landscape Industry. This industry has a significant value added impact on the economy. For \$1 worth of business in this sector, it adds \$.86 as a value-added. Among the industries comprising its input supply, agriculture and forestry support activities, greenhouse and nursery production, real estate, power generation and supply, wholesale trade, plastic plumbing fixtures and all other plastics, petroleum refineries and warehousing and storage are the main ones.

**Table A1.5: Value-Added for the Greenhouse and Nursery Industry**

Description	Coefficients	Value-Added
Employee Compensation	0.442	161.15
Proprietary Income	0.098	35.70
Other Property Income	0.302	110.09
Indirect Business Taxes	0.015	5.52
Total	0.856	312.46

Source: IMPLAN 2002

**Table A1.6: Input Demand for the Greenhouse and Nursery Industry per Dollar of Output**

Commodity Code	Description	Gross Absorption Coefficient	Gross Inputs
18	Agriculture and Forestry Support Activities	0.0235	8.5910
6	Greenhouse and Nursery Production	0.0190	6.9252
431	Real Estate	0.0174	6.3669
30	Power Generation and Supply	0.0122	4.4522
390	Wholesale Trade	0.0109	3.9716
177	Plastics Plumbing Fixtures and All Other Plastics	0.0086	3.1313
142	Petroleum Refineries	0.0071	2.5907
400	Warehousing and Storage	0.0048	1.7348
156	Nitrogenous Fertilizer Manufacturing	0.0032	1.1700
427	Insurance Carriers	0.0028	1.0337
430	Monetary Authorities and Depository Credit Interme	0.0028	1.0138
294	Industrial Truck- Trailer- and Stacker Manufacturing	0.0027	0.9766
159	Pesticide and Other Agricultural Chemical Manufact	0.0022	0.8184
394	Truck Transportation	0.0017	0.6294
257	Farm Machinery and Equipment Manufacturing	0.0017	0.6269
485	Commercial Machinery Repair and Maintenance	0.0016	0.5913
43	Maintenance and Repair of Nonresidential Buildings	0.0016	0.5666
422	Telecommunications	0.0015	0.5640
438	Accounting and Bookkeeping Services	0.0012	0.4536
157	Phosphatic Fertilizer Manufacturing	0.0012	0.4237
32	Water- Sewage and Other Systems	0.0010	0.3598
350	Motor Vehicle Parts Manufacturing	0.0010	0.3542
493	Civic- Social- Professional and Similar Organization	0.0010	0.3511
425	Nondepository Credit Intermediation and Related	0.0009	0.3148
172	Plastics Packaging Materials- Film and Sheet	0.0009	0.3126
229	Hand and Edge Tool Manufacturing	0.0008	0.2809
179	Tire Manufacturing	0.0007	0.2522
434	Machinery and Equipment Rental and Leasing	0.0007	0.2462
437	Legal Services	0.0007	0.2407
391	Air Transportation	0.0006	0.2045
150	Other Basic Inorganic Chemical Manufacturing	0.0005	0.1826
460	Waste Management and Remediation Services	0.0005	0.1742
432	Automotive Equipment Rental and Leasing	0.0004	0.1619
337	Storage Battery Manufacturing	0.0004	0.1384
288	Pump and Pumping Equipment Manufacturing	0.0004	0.1290
232	Prefabricated Metal Buildings and Components	0.0004	0.1278
392	Rail Transportation	0.0003	0.1103
483	Automotive Repair and Maintenance- Except Car Wash	0.0003	0.1050
295	Power-Driven Handtool Manufacturing	0.0003	0.0998
479	Hotels and Motels- Including Casino Hotels	0.0003	0.0992

423	Information Services	0.0002	0.0845
398	Postal Service	0.0002	0.0737
15	Forest Nurseries- Forest Products- and Timber Trac	0.0002	0.0729
24	Stone Mining and Quarrying	0.0002	0.0725
145	Petroleum Lubricating Oil and Grease Manufacturing	0.0002	0.0698
234	Plate Work Manufacturing	0.0002	0.0680
255	Miscellaneous Fabricated Metal Product Manufacturing	0.0002	0.0655
194	Concrete Pipe Manufacturing	0.0002	0.0591
123	Miscellaneous Wood Product Manufacturing	0.0002	0.0576
414	Periodical Publishers	0.0001	0.0544
481	Food Services and Drinking Places	0.0001	0.0523
31	Natural Gas Distribution	0.0001	0.0493
171	Other Miscellaneous Chemical Product Manufacturing	0.0001	0.0480
389	Buttons- Pins- and All Other Miscellaneous Manufac	0.0001	0.0403
401	Motor Vehicle and Parts Dealers	0.0001	0.0370
393	Water Transportation	0.0001	0.0341
207	Steel Wire Drawing	0.0001	0.0325
301	Scales- Balances- and Miscellaneous General Purpos	0.0001	0.0308
180	Rubber and Plastics Hose and Belting Manufacturing	0.0001	0.0293
410	General Merchandise Stores	0.0001	0.0280
293	Overhead Cranes- Hoists- and Monorail Systems	0.0001	0.0278
137	Books Printing	0.0001	0.0278
241	Hardware Manufacturing	0.0001	0.0274
405	Food and Beverage Stores	0.0001	0.0271
426	Securities- Commodity Contracts- Investments	0.0001	0.0249
476	Fitness and Recreational Sports Centers	0.0001	0.0238
396	Pipeline Transportation	0.0001	0.0210
387	Broom- Brush- and Mop Manufacturing	0.0001	0.0207
118	Cut Stock- Resawing Lumber- and Planing	0.0001	0.0183
334	Motor and Generator Manufacturing	0.0000	0.0176
404	Building Material and Garden Supply Stores	0.0000	0.0161
243	Machine Shops	0.0000	0.0161
230	Saw Blade and Handsaw Manufacturing	0.0000	0.0159
406	Health and Personal Care Stores	0.0000	0.0157
473	Independent Artists- Writers- and Performers	0.0000	0.0155
411	Miscellaneous Store Retailers	0.0000	0.0154
103	Other Miscellaneous Textile Product Mills	0.0000	0.0149
450	All Other Miscellaneous Professional and Technical	0.0000	0.0147
132	Envelope Manufacturing	0.0000	0.0140
408	Clothing and Clothing Accessories Stores	0.0000	0.0123
292	Conveyor and Conveying Equipment Manufacturing	0.0000	0.0122
412	Nonstore Retailers	0.0000	0.0113
403	Electronics and Appliance Stores	0.0000	0.0106
395	Transit and Ground Passenger Transportation	0.0000	0.0091
402	Furniture and Home Furnishings Stores	0.0000	0.0087
407	Gasoline Stations	0.0000	0.0087
472	Spectator Sports	0.0000	0.0086
134	Sanitary Paper Product Manufacturing	0.0000	0.0075

325	Electric Lamp Bulb and Part Manufacturing	0.0000	0.0058
474	Promoters of Performing Arts and Sports and Agents	0.0000	0.0045
409	Sporting Goods- Hobby- Book and Music Stores	0.0000	0.0044
471	Performing Arts Companies	0.0000	0.0036
478	Other Amusement- Gambling- and Recreation Industri	0.0000	0.0035
383	Office Supplies- Except Paper- Manufacturing	0.0000	0.0024
136	Manifold Business Forms Printing	0.0000	0.0022
161	Paint and Coating Manufacturing	0.0000	0.0022
237	Ornamental and Architectural Metal Work Manufactur	0.0000	0.0015
381	Sporting and Athletic Goods Manufacturing	0.0000	0.0012
138	Blankbook and Looseleaf Binder Manufacturing	0.0000	0.0003
		0.1437	

Source: IMPLAN 2002

**Table A1.7: Final Demand for Greenhouse and Nursery**

Description	Gross Final Demand (\$M)
Households Less Than 10k	6.307
Households 10-15k	5.254
Households 15-25k	11.172
Households 25-35k	16.077
Households 35-50k	25.227
Households 50-75k	44.781
Households 75-100k	42.294
Households 100-150k	36.627
Households 150k+	22.988
Federal Government NonDefense	0
Federal Government Defense	0
Federal Government Investment	0
State/Local Govt NonEducation	16.313
State/Local Govt Education	0
State/Local Govt Investment	0
Capital	0
Inventory Additions/Deletions	2.796
<hr/>	
	229.838

Source: IMPLAN 2002

## APPENDIX 2: AGGREGATION SCHEME FOR IMPLAN INDUSTRIES

**Table A2.1: Sectoring Scheme for IMPLAN Industries**

Industry	Sectors Included (Sector No. Corresponds to IMPLAN 2002 Sectoring Scheme)
Ag, Forestry, Fishing	1-5, 8-18
Greenhouse and Nursery Production	6
Landscape Service	7
Mining	19-29
Utilities	30,31,32
Construction	33-45
Manufacturing	46-389
Prefabricated Metal Buildings and Components	232
Lawn and Garden Equipment Manufacturing	258
Wholesale Trade	390
Transportation & Warehousing	391, 393, 395-400
Rail Transportation	392
Truck Transportation	394
Retail Trade	401-412
Information	413-424
Finance & Insurance	425-430
Real Estate & Rental	431-436
Professional- Scientific & Tech Services	437-450
Management of Companies	451
Administrative & Waste Services	452-460
Educational Services	461-463
Health & Social Services	464-470
Arts- Entertainment & Recreation	471-478
Accommodation & Food Services	479-481
Other Services	482-494
Government & Non NAICs	495-509



## **APPENDIX 3: INPUT-OUTPUT MODELS AND ECONOMIC IMPACT ANALYSIS**

### **Input-Output Modeling**

Input-Output (I/O) economic analysis was developed by Wassily Leontief. According to I/O analysis, sales in an industry can be analyzed in terms of demand for the product and all the inputs necessary for its production. The model has a set of equations representing supply and demand for the whole economy. Supply is assumed to meet demand. Industry supply responds with a new level of output that meets the changes in demand, and a new general equilibrium in the economy is reached. In this study, the economic impact of the Green Industry in Washington State is found using I/O analysis.

An I/O model is a system of simultaneous linear equations (for example, see equation 1 in this Appendix) that traces the supply of and demand for products at a point in time (year) for an economy. The two basic types of I/O models are Type I models, where consumption by households is considered exogenous, and Type SAM models, where household consumption is considered endogenous. Capital investment, inventory additions and deletions, government spending, and domestic and foreign exports are the usual exogenous variables in a Type SAM model.

Input-Output models work on two necessary assumptions. First is the assumption of fixed price. I/O models assume prices to be fixed. Product price does not respond to a change in demand. This is because each industry uses a combination of fixed inputs for the production of its commodity and the return to scale for each industry is constant.

Construction of an I/O model begins with the formation of a matrix of technical coefficients, called the **C** matrix. The **C** matrix is a matrix of all the production functions within an economy. The production functions are arranged so each is a column in the **C** matrix. Each

element in the **C** matrix is an input coefficient representing the amount of the row industry needed to produce one unit of the column industry output. The rows then represent the supply from each industry needed to produce a unit of column industry output. These elements are called Gross Absorption Coefficients. Table A3.1 represents a “**C** matrix” for a simple hypothetical economy that consists of three industries, Greenhouse & Nursery, Landscape and Other.

**Table A3.1: Input Coefficient Matrix (Regional Purchase Coefficients or RPC), Matrix “C”**

<i>from</i>	<i>into</i> Greenhouse & Nursery	Landscape	Other	
Greenhouse & Nursery	0.018 (.43)	0.123 (.43)	0.090 (.43)	} <b>C</b>
Landscape	0.000	0.000	0.150 (1.00)	
Other	0.125 (.6)	0.253 (.6)	0.450 (.6)	
Total Gross Absorption Coefficients	0.143	0.376	0.690	
Value-Added	0.857	0.624	0.310	

In this simple economy for example, the Greenhouse & Nursery Industry produces Greenhouse & Nursery products where total production cost is a function of .018 percent nursery and .125 percent other products. The remaining 86 percent comprise value-added income, such as labor income and returns to capital, which are not included in the **C** matrix. Units of output here are in dollar terms, so when inter-industry requirements are not considered, \$1 million of Greenhouse and Nursery products requires \$18,000 of nursery products as inputs, \$125,000 of Other inputs, and \$860,000 of Value-Added inputs. However, the coefficients in matrix **C** are import imbedded. For example, Landscape Industry requires 0.123 percent of Greenhouse and Nursery products as its basic input, however only 43% of those input are supplied in Washington

(RPC is .43). The remaining 57% are supplied from out of state. Therefore, the effective coefficient is  $0.018 \times 0.43 = 0.008$ . After adjusting all other coefficients we get the adjusted **C** matrix, which we refer to as matrix **A**.

**Table A3.2: Adjusted Coefficient Matrix (Regional Purchase Coefficients or RPC), Matrix “A”**

<i>from</i>	<i>into</i>	Greenhouse & Nursery	Landscape	Other
Greenhouse & Nursery		0.008	0.053	0.039
Landscape		0	0	0.15
Other		0.075	0.1518	0.27
Total Gross Absorption Coefficients		0.083	0.217	0.5037
Value-Added + Import Coefficient		.857+0.060	0.624+0.171	.310+0.231

In equation 1, column vector **Y** contains the final demands for each industry. For the Washington model, consumption of Nursery and Greenhouse products and the marketing margins required to move them to market are the elements, in dollar terms, which make up the **Y** vector. The column vector **X** represents the output (sales) of each industry. For the Washington model, each element of the column vector **X** is the output of one of the 528 industries in the study area, also measured in dollar terms. **I** is an identity matrix of the same dimensions as the **A** matrix (here it is three). With these components, the Leontief inverse is algebraically derived from the **A** matrix through the following steps:

$$\mathbf{X} = \mathbf{AX} + \mathbf{Y} \quad (1)$$

$$(\mathbf{I} - \mathbf{A}) \mathbf{X} = \mathbf{Y} \quad (2)$$

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{Y} \quad (3A)$$

$$\Delta \mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} \Delta \mathbf{Y} \quad (3B)$$

The  $(\mathbf{I}-\mathbf{A})^{-1}$  Leontief inverse can then be used to calculate changes in supply throughout the economy due to changes in final demand (equation 3B, where  $\Delta$  represents change). Table A3.2 is the  $(\mathbf{I}-\mathbf{A})^{-1}$  matrix for the hypothetical economy whose “ $\mathbf{A}$ ” matrix is represented in table A3.1. Multiplying the Leontief inverse by the column vector of final demands  $\mathbf{Y}$ , results in the solution output for each industry shown in the column vector  $\mathbf{X}$ .

**Table A3.3: Simple  $(\mathbf{I}-\mathbf{A})$  Inverse**

	Greenhouse & Nursery	Landscape	Other
Greenhouse & Nursery	1.013	0.064	0.067
Landscape	0.016	1.033	0.213
Other	0.107	0.221	1.421

Table A3.4 is the matrix representation of the impact from a hypothetical \$1 million increase in Greenhouse and Nursery final demand. The change in total output is represented on the left side of the equation, i.e., the  $\mathbf{X}$  column vector. Results from the hypothetical model show a \$1 million increase in final demand for Greenhouse and Nursery products requires an increase of \$1.013 million in the Greenhouse and Nursery sector, a \$0.016 million increase in the Landscape sector, and a \$0.107 million increase in the other sector.

**Table A3.4: Economic Impact on  $\mathbf{X}$**

$$\begin{pmatrix} 1.013 \\ 0.016 \\ 0.107 \end{pmatrix} = \begin{pmatrix} 1.013 & 0.064 & 0.067 \\ 0.016 & 1.033 & 0.213 \\ 0.107 & 0.221 & 1.421 \end{pmatrix} * \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

The increases in the  $\mathbf{X}$  vector results from the two impacts described above: Direct and Indirect effects. Direct effects are the unitary changes to industry output in which the final demand change occurs. Direct effects in table A3.4 are \$1 million for the Greenhouse and

Nursery sector. Indirect effects are \$0.013 million for Nursery and Landscaping, \$0.016 million for Landscape, and \$0.107 million for Other.