Regional Metabolism
(Resource Flow Analysis)

for the
Northern Neck
and
Middle Peninsula
Planning Districts

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for

Governor's Economic Development Advisory Council #14
Serving Virginia's River Country
Neal J. Barber, Director
Saluda, Virginia

Natural Logic

Contents

The Governor's Economic Development Advisory Council #14

The Governor's Economic Development Advisory Council #14 fosters compatible economic development in the Middle Peninsula and Northern Neck regions. It has recently launched a new initiative, Virginia's River Country, to create a Regional Economic Development Partnership which will be eligible for funds allocated by the "Regional Competitiveness Act."

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Executive Summary

In 1996, the Governor's Economic Development Advisory Council #14 (GEDAC) received special funding from the Virginia Coastal Resources Management Program of the Department of Environmental Quality to undertake a study of baseline economic and environmental conditions in the Middle Peninsula and Northern Neck region. The goal of the study was to:

- identify potential business opportunities,
- provide resources to the local economy that are being imported from outside the region,
- add value to products produced in the region prior to departure from the region, and
- utilize existing waste material in a productive manner.

This study provides both a general survey of existing economic activity and a specific contribution towards a strategic economic development plan which is compatible with the region's natural resources and cultural heritage.

Compatible economic development makes good economic sense. When natural resources are adversely impacted, there are always business costs to pay. For instance, environmental quality can actually be a limiting factor on economic growth; as an example, groundwater or surface water contamination may reduce a region's ability to attract new manufacturing concerns that require water clean enough to meet industrial process standards. Conversely, environmentally sensitive business strategies create new economic opportunities; as an example, promoting regional water efficiency may, in effect, provide an economically advantageous "new" water source when new sources of supply are expensive or inconvenient.

The study focuses on the flows of energy, materials, and water in the region—the region's "metabolism"—broken down by county and economic sector. Understanding the underlying metabolism makes it possible for new and existing businesses to harvest new revenue streams by turning wastes into resources, improve resource efficiency, use local resources in place of imported ones, and add value locally.

This metabolic analysis also compares economic flows with the energy, materials, and water flows of the natural landscape, which are the fundamental resources that sustain economic life. This makes it possible to identify economic sectors which are currently underexploited, those which need to be developed with particular environmental sensitivity, and those which may face resource challenges in order to not overwhelm existing natural flows.

Virginia's River Country has a diverse economy; the most important sectors include the wholesale & retail trade, manufacturing, government, services & tourism, construction &

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maintenance, and infrastructure (including utilities and transportation), representing more than $1.1 billion in value added, with about $210 million and some 6000 jobs contributed by manufacturing.

"Nature's services" are primary drivers of the region's resource economy and quality of life. While solar energy is abundant, water resources may be under some stress and timber harvest significantly exceeds growth rates in at least two counties.

Primary resource sectors—agriculture, forestry, fisheries—are significant as both direct producers and resource suppliers to local value-added industries. This study has identified additional opportunities in "clusters" that can maximize value-adding resource exchange opportunities

Manufacturing is dominated by the food and forest product processing industries, with recent growth in other sectors. The paper products mill in King William county is far and away the largest consumer of energy and water in the region. Annual expenditures for utility bills in the region exceed the entire value-added of the manufacturing sector. This suggests that resource efficiency strategies have the potential to create dozens of new jobs without looking outside the region for help.

Two possible business clusters, one based on agriculture/forestry/industrial and the other on food/textiles offer great potential for waste matching, import substitution, and local value-added production. These clusters, or ones like them, can serve as a focal point for economic development efforts. By building on the synergies and infrastructure of existing clusters, it is possible to improve environmental quality while creating jobs from optimal use of resources. The region should attract businesses which complement the clusters, and support enterprises which help make the clusters more effective.

The region is ripe for diversification in both the agricultural and forestry sectors; this process can be facilitated through the clusters, and by serving emerging markets for agricultural products, including biofuels, construction products, inks, and industrial feedstocks. At the same time, diversification into vegetables and other crops, particularly when accompanied by environmentally sensitive practices, should find local market niches. Value-added processing should also be encouraged in the forestry sector, including furniture production, building materials, and sustainably harvested wood products.

As the region solidifies its identity through the Virginia's River Country initiative, it can deliberately recruit businesses which will be socially and environmentally responsible corporate citizens, which will diversify the local economy, which will enhance its regional identity, and which will support existing clusters of activity. While the environmental sector is one possibility for such businesses, there are many other sectors compatible with the region's cultural heritage and natural resources.

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There are five key steps Virginia's River Country can take in pursuing compatible economic development:

Eco-Efficiency: Extract More Economic Value Per Unit of Resources

Examples

- Energy Efficiency
- Water Efficiency
- Materials Efficiency
- Pollution Prevention

Motivation

- Using resources more efficiently pays for itself in decreased resource costs
- This keeps dollars in the local economy and generates skilled jobs
- Existing infrastructure can be stretched further, helping business recruitment efforts
- Eco-efficiency is good for business and good for the environment

Wastes into Resources: Turn Waste Streams into Revenue Streams

Examples

- Waste straw as a building material
- Textile scraps reused for children's clothing
- Materials Recovery Facility (MRF) to sort local wastes into recyclable materials
- Enhance materials exchanges between agriculture, forestry, and paper products sectors, creating a "cluster" which optimizes resource use

Motivation

- Create several jobs turning waste into a resource for every job disposing of waste
- Reduced environmental impacts and costs
- Strengthen and diversify local economy

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Agricultural and Forestry Diversification: New Products and New Methods

Examples

- Selective Forestry Practices Bring Market Premiums
- Organic Produce for D.C. Market
- Soybeans and Corn as Industrial Feedstocks for Fuels, Inks, and Oils

Motivation

- Standard agricultural commodities are being over-produced; time to diversify
- Environmentally sensitive agriculture and forestry brings both market differentiation and premium prices while protecting natural amenities

Compatible Development and Recruitment

Examples

- Businesses which Complement Existing Clusters of Activity
- Businesses in the Environmental Sector

Motivation

- Build on existing regional strengths while protecting natural amenities
- Preserve the region's character to maintain tourism potential

Import Substitution and Value-Added Production

Examples

- Furniture, Crafts, and Flooring Materials from Local Wood Products
- Use Local Wood Products in Local Construction Industry
- Specialty Seafood Products

Motivation

- Diversify and stabilize regional economy
- Keep dollars circulating in the regional economy
- Optimize value added per unit of natural resources extracted in the region
- Maintain solid employment base without endangering local resource base

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While we were able to get a qualitative understanding of many of the resource flows in the region, local data remains scarce, and we often had to rely on extrapolations from similar regions. There is spotty or even conflicting data on waste generation, water use, and energy use. Therefore, in order to act on the suggestions of this report, it will be necessary to perform a considerable amount of "ground truthing" within the region. We have identified several priorities, as well as some interesting possibilities for future exploration. Implementing them will depend both on creating strong partnerships and on detailed feasibility studies. There are many pathways available to Virginia's River Country as it charts a course towards a compatible economic development strategy.

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1. Introduction

Background

In 1996, the Governor's Economic Development Advisory Council #14 (GEDAC) received special funding from the Virginia Coastal Resources Management Program of the Department of Environmental Quality to undertake a study of baseline economic and environmental conditions in the Middle Peninsula and Northern Neck region.

The Coastal Commission has played a vital role in the innovative "compatible economic development" effort pursued by Virginia's Eastern Shore (Northampton and Accomack Counties.) This effort has helped form a strong alliance among local governments, citizen's groups, and businesses dedicated to preserving the region's cultural resources and natural heritage. The alliance has already launched a number of projects, including a special marketing campaign for hayman potatoes and an "eco-industrial park" (see Section 3) at Cape Charles.

While the Middle Peninsula and Northern Neck region has somewhat different characteristics than the Eastern Shore, it can benefit from a similar compatible economic development strategy which minimizes the unnecessary costs and unwanted impacts of conventional development. In a recent community visioning process for the region, citizens emphasized values like: "quaint villages", "rural traditions", "old homes and buildings", "abundant wildlife", "prime agricultural land", "scenic countryside", and "compatible businesses." With careful attention, economic development can preserve these values while meeting strong needs for diverse and well-paying jobs, affordable housing, and improved prosperity.

In keeping with the spirit of the Eastern Shore initiative, the GEDAC issued a request for proposal (RFP) for a study to provide "an analysis of the resources being used by the local economy, the products that are being produced within the region and the by-products that result from the economic activity of the region. The goal of the analysis is to

- identify potential business opportunities,
- provide resources to the local economy that are being imported from outside the region,
- add value to products produced in the region prior to departure from the region,
- and utilize existing waste material in a productive manner."

Gil Friend and Associates was selected to conduct this study, and is pleased to submit this report.

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Purpose

This analysis provides both a general survey of existing economic activity and a specific contribution towards a strategic economic development plan which is compatible with the region's natural resources and cultural heritage.

The analysis focuses on the flows of energy, materials, and water in the region, broken down by county and economic sector. Understanding the underlying "metabolism"—the flow of resource inputs and outputs—of the region, can make it possible to identify new business opportunities. For instance, a waste stream from one business may turn out to be a useful input to a second business. Turning waste into resource can generate significant added value— reducing disposal costs to the first business, decreasing resource costs to the next, and benefiting the overall environmental health and quality of life in the region.

The following schematic illustration shows inputs—including energy, water, and materials—and outputs—including products and non-product outputs (NPOs) like air emissions and wastewater—for a typical company. In a similar way, we have looked at natural, industrial, commercial, and residential flows for the entire region.

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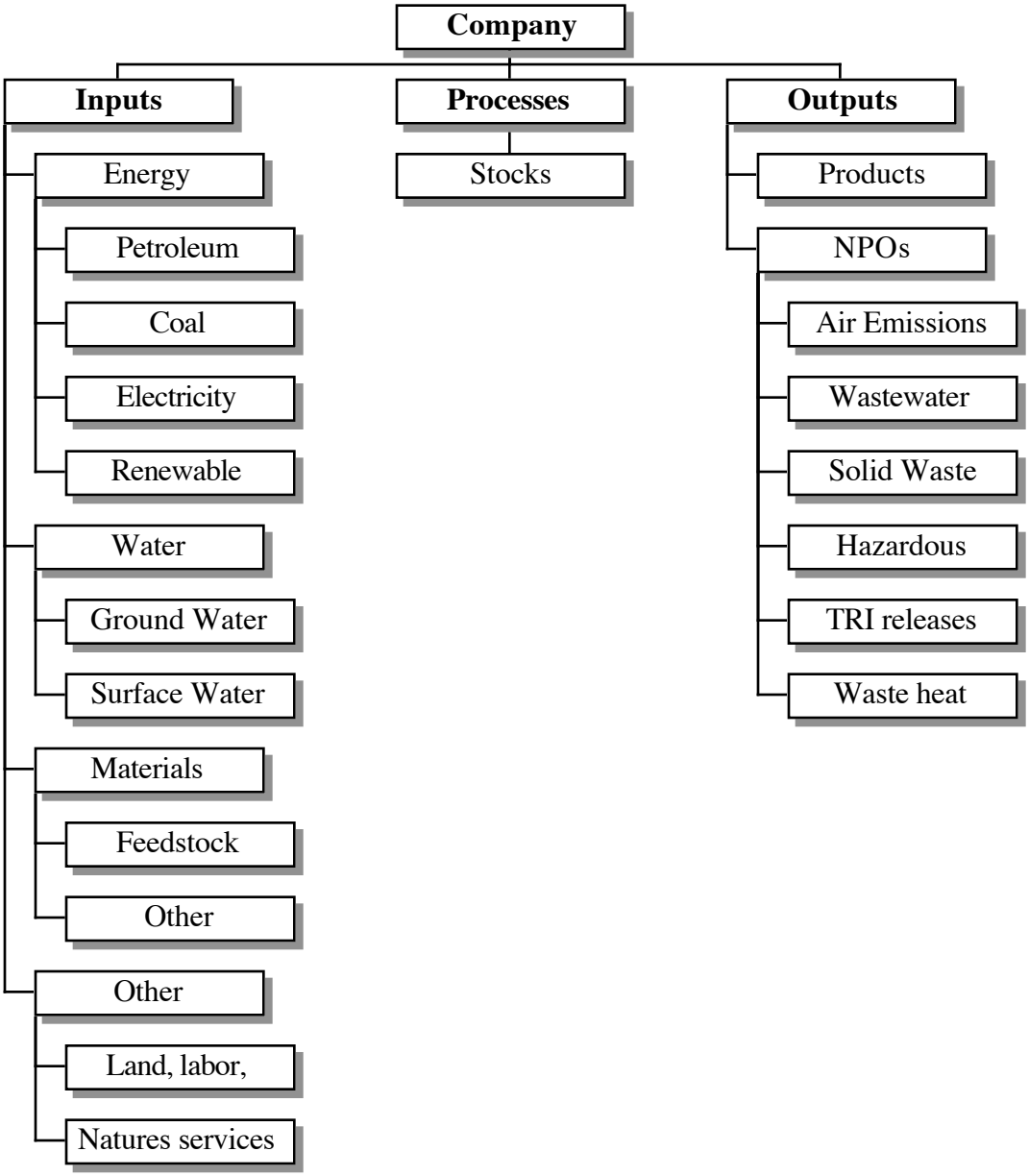

The analysis is also intended as a helpful tool for identifying opportunities for import substitution—using local resources in place of imported ones—and adding value locally—additional processing to enable the local economy to benefit optimally from local resources. The general "metabolic efficiency" goal for any economic institution is to improve two key ratios:

- the ratio of outputs to inputs (by improving production efficiency and yields), and
- the ratio of product to non-product output (by source reduction, pollution prevention, and turning "wastes" into resources).

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The metabolic analysis also includes an overview of the energy, materials, and water flows of the natural landscape—the fundamental resources that sustain economic life. By comparing economically induced flows with natural flows, it is possible to identify economic sectors which are currently underexploited, those which need to be developed with particular environmental sensitivity, as well as those which may face resource challenges. By definition, compatible economic development does not overwhelm existing natural flows. Instead, it works within the limits dictated by those flows, emphasizing appropriate scale as well as efficiency of resource use.

The quantitative results of this analysis are presented in two ways: as statistical summaries which appear in the appendices of this report, and as a database in disk form. This narrative report summarizes the results of the metabolic analysis, placing them in an economic development context. The analysis itself is designed to be a tool for a range of individuals and groups dealing with regional economic issues.

Caveat

This analysis is of course limited by the completeness and precision of available data. Because of those limits, we have performed extrapolations to fill data gaps, have computed results based on correlations with best available data from other regions, etc.

In most cases (especially economic input-output, energy and some water data) we have relied on 1990 data, since that provided the most complete data baseline. However, we have had to use data from different years for different resources, which may mask key economic trends (such as new business entry).

As a result, it is important to read this analysis with several grains of salt. The data are useful to provide a sense of proportion and priority, but should not be considered precise descriptions of actual reality in the region.

The metabolic analysis has important implications for the economic development strategy of the region. Virginia's River Country, which includes the ten-county region of the Middle Peninsula and Northern Neck, is currently establishing a Regional Economic Development Partnership which will be eligible for funds allocated by the "Regional Competitiveness Act." Virginia's River Country has an excellent opportunity to regionally coordinate its economic development and business recruitment efforts, infrastructure investments, and planning.

Compatible economic development makes good economic sense. When natural resources are adversely impacted, there are always business costs to pay. For instance, environmental quality can actually be a limiting factor on economic growth; as an example, groundwater or surface water contamination may reduce a region's ability to attract new manufacturing concerns that require water clean enough to meet industrial process standards. Conversely, environmentally sensitive business strategies create new economic opportunities; as an example, promoting regional water efficiency

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may, in effect, provide an economically advantageous "new" water source when new sources of supply are expensive or inconvenient.

This study identifies a number of ways in which Virginia's River Country can effectively integrate natural resource stewardship with economic development.

Compatible Economic Development

Economic development strategies commonly focus on attracting large new facilities or companies to a region. However, only 500 large firms nationwide seek a new location or open a new facility each year. These firms are actively recruited by 30,000 communities [Center for Compatible Economic Development, p. 3.9]—often with expensive competition over tax incentives and other public spending. In addition, the very amenities which attract people to Virginia's River Country—historic towns and villages, hundreds of miles of rivers and coastline, diverse wildlife and vegetation—may be adversely affected by new large-scale facilities.

This suggests a multi-leveled approach which builds on existing regional economic, resource, and cultural strengths while carefully targeting recruitment efforts on enterprises of appropriate scale and type. In this approach—described by The Center for the New West as a "gardening" strategy, in contrast to the typical economic development "hunting" strategy—it is just as important to support local businesses, entrepreneurs, and communities as it is to bring in the new expertise and opportunities offered by outside firms.

Compatible economic development seeks to protect the existing cultural heritage and natural resources of the region. It can draw on a wide range of strategies:

- Create jobs and businesses by using resources more efficiently.
- Create jobs and businesses by recycling or remanufacturing a wide range of existing commercial and industrial waste streams.
- Substitute imported industrial feedstocks, consumer products, and services with locally produced ones. This keeps dollars flowing in the regional economy, increasing the local "multiplier effect" substantially.
- Add the greatest possible value locally to products through additional processing and manufacturing steps provides additional highly-skilled jobs. This allows the local economy to benefit optimally from its natural resources.
- Focus recruitment efforts on companies with a strong track record of social and environmental responsibility.
- Promote low-impact conventional tourism, as well as the fast-growing eco-tourism sector. The region is easily accessible from the Washington, D.C. area.
- Create a financial infrastructure and technical assistance to help entrepreneurs and businesspeople wishing to pursue this strategies. A good example is provided by the Virginia Eastern Shore Sustainable Development Corporation (see Section 2).
- Help businesses improve their "eco-efficiency" to reduce both expenses and the flow of resource dollars (including about $200 million for energy alone) out of the region.

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These strategies have proven highly successful for a wide variety of rural and urban regions. Good examples include Chattanooga, Tennessee and Menominee, Wisconsin [Bernard and Young]; Missoula, Montana [Kemmis]; the Clinch Valley in the Appalachians and the Ace Basin, South Carolina [Center for Compatible Economic Development]; and the Sky Islands of the Southwest [Weeks]. In each of these cases, innovative attempts to bring together environmental and economic concerns have generated increased prosperity without adversely affecting natural amenities.

These strategies offer opportunities for significant job creation at a variety of income levels, while minimizing the need for new investments in large-scale infrastructure or for expensive marketing efforts. By design, they minimize adverse effects on the character, scenic qualities, and natural resources of the region.

Organization of the Report

In Section 2, we provide a brief **overview by sector** from a metabolic perspective, providing some interpretation of the statistical appendices.

In Section 3, we discuss opportunities for **waste exchanges** at a variety of scales. It has been said that waste is a resource in the wrong place at the wrong time in the wrong quantities. By brokering local and regional waste exchanges between companies, it may be possible to tap this rich resource, creating jobs in the process.

In Section 4, we investigate strategies for providing resources to the local economy that are presently being imported from outside the region. This **import substitution** can be achieved through local economic diversification, which helps buffer a community against the inevitable ups and downs of individual economic sectors. Import substitution can make communities more resilient, and provide people with a wider range of local employment opportunities, goods, and services.

In Section 5, we look at a range of possibilities for **adding value locally** and regionally. By taking primary resources through additional stages of processing, it is possible to provide more jobs and economic value than from primary resource extraction alone.

In Section 6, we discuss **business development**, focusing on certain sectors which are particularly compatible with Virginia's River Country.

In Section 7, we present **conclusions** and discuss possible **next steps**.

The metabolic analysis is summarized in the **appendix**, and is also provided in user-friendly form on the accompanying disk.

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2. Overview by Sector

General Observations

In this section, we provide an overview of Virginia's River Country by economic sector. The region has a diverse economy, as Figure 1 shows. The most important sectors include the wholesale & retail trade, manufacturing, government, services & tourism, construction & maintenance, and infrastructure (including utilities and transportation), representing more than $1.1 billion in value added, with about $200 million and some 6,000 jobs contributed by manufacturing. The resource-based sector has been of great importance historically, and remains a vital part of the economy with significant contributions from agriculture, forestry, and fisheries.

The paper products mill in King William county is far and away the largest consumer of energy and water in the region. The paper products industry tends to be resource-intensive, and the mill is quite large, providing about one-fifth of all manufacturing jobs in the region. Other important manufacturing sectors include forestry, textiles, food processing, and tool/part fabrication.

It is worth noting that annual expenditures for utility bills in the region were the equivalent of about two-thirds the entire value-added of the manufacturing sector. This suggests that resource efficiency strategies have significant potential to boost profits and create new jobs without looking outside the region for help. There are currently strong infrastructure limits around water and wastewater, which also points to eco-efficiency as an important economic development strategy.

The region's abundant natural amenities, including hundreds of miles of rivers and coastline, proximity to a sophisticated urban area, and rich history have made it an increasingly popular tourist destination. Furthermore, as the region gains a new sense of identity as Virginia's River Country, joint marketing efforts of increasingly diverse agricultural, fishery, and forestry products should find new urban niches.

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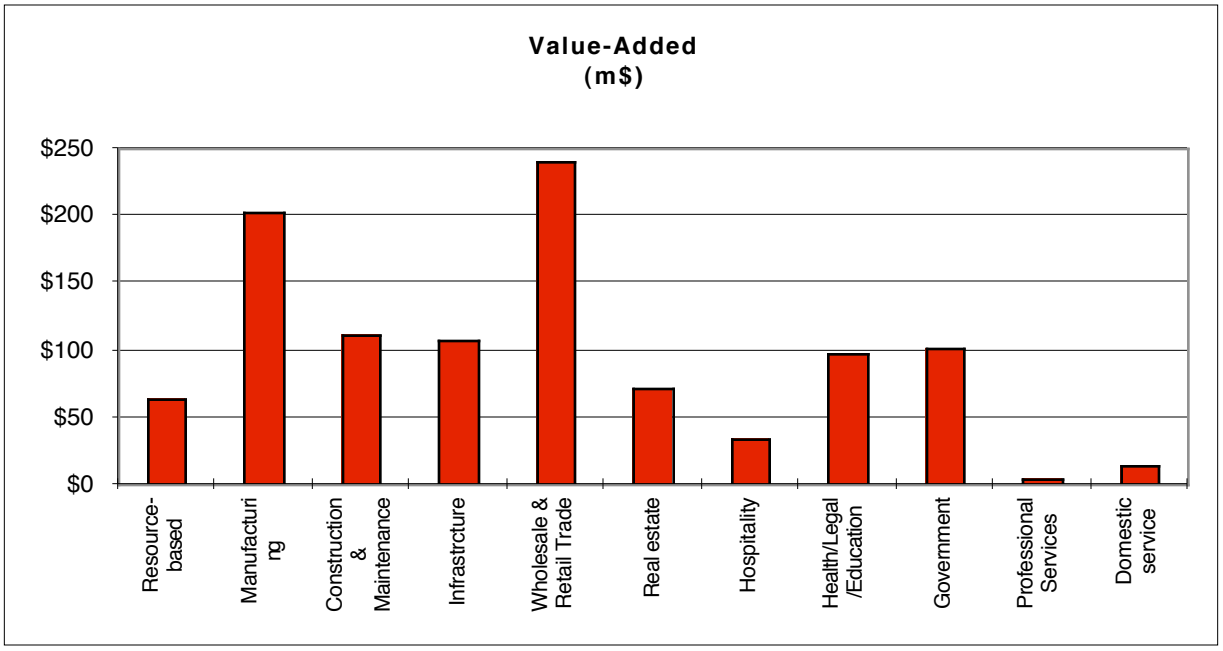

Nature's Services

It may be helpful to think of the biological productivity and natural "services" offered by the landscape of Virginia's River Country as an economic sector in its own right. Scenic amenities - including rivers, the Chesapeake Bay, woodlands, shoreline - are one of qualities most valued by regional citizens and tourists alike. While it is notoriously difficult to place a monetary value on this sector, such a value would certainly be comparable to that of other sectors.

The natural services provided by the region include flood control, water and air purification, forage, climate regulation, groundwater recharge, natural pest control, soil fertility, nursery functions for marine organisms, and fish and game habitat [Daily, 1997]. Furthermore, the agricultural, fisheries, and forestry sectors are all completely dependent on landscape or biological productivity. In the recently released book, *Nature's Services*, several noted economists estimate the worldwide value of these natural services as comparable in scale to the global Gross Domestic Product—and perhaps larger. On that basis, it is safe to assume that these products and services indirectly contribute hundreds of millions of dollars annually "off the books" to the regional economy—and all are highly susceptible to the adverse impacts of poorly-designed development.

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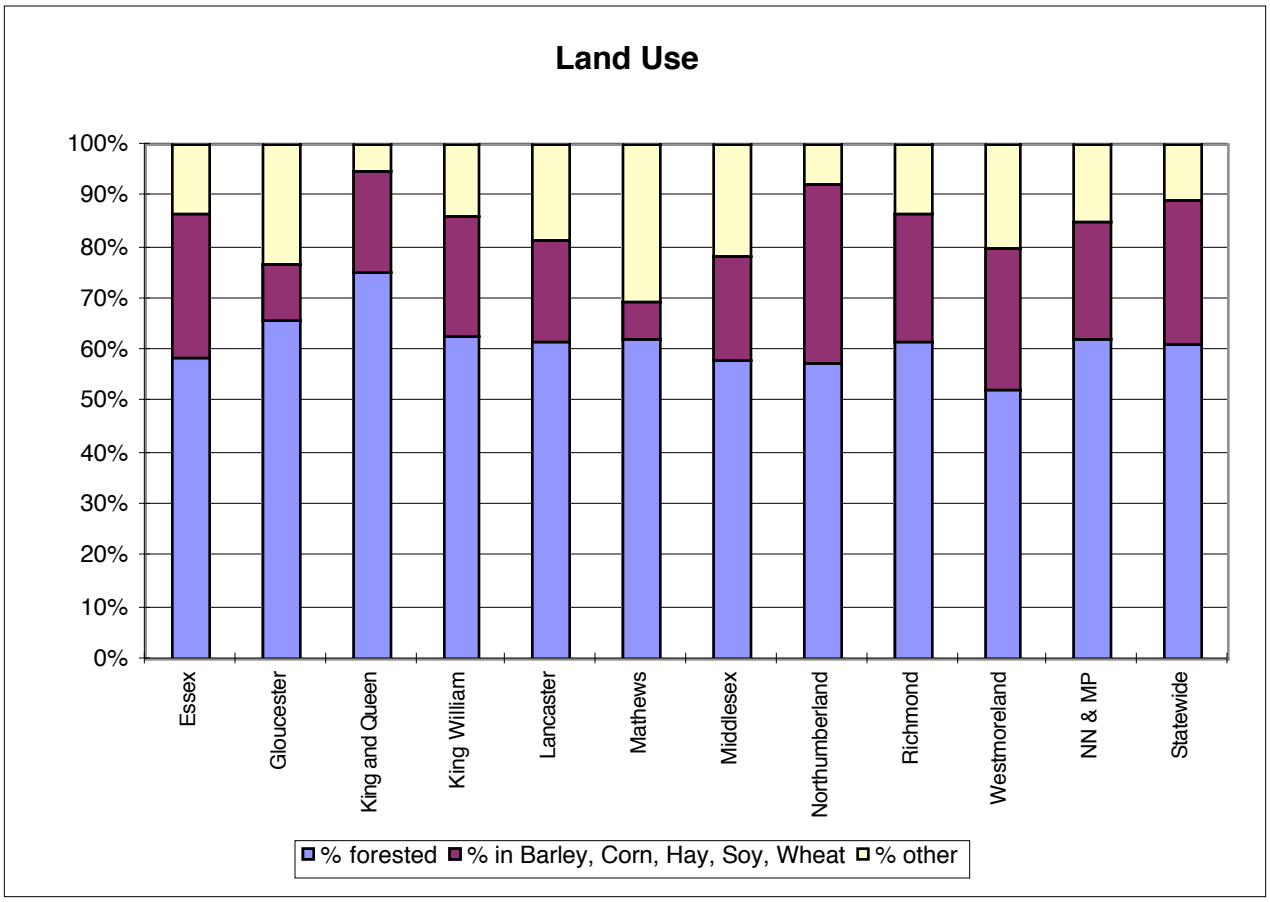
Land



The predominant land use in Virginia's River Country is forest (see Figure 2), and most of this is held privately by corporations or individuals. Most of the remaining land is agricultural, of which about two-thirds is in crop production in any given year. There are also significant wetland and riparian areas in the region.

Solar Energy

It is helpful to compared the solar energy received by the region with the region's energy use. Multiplying the region's area by the average insolation (or solar energy received per unit area), we can calculate the theoretically available solar energy. This works out to about 30 billion million-BTUs per year ($3x10^{16}$ BTUs per year).

By way of comparison, if one percent of the region's land was devoted to capturing that energy (whether by biomass energy, photovoltaics, or other technologies) and was converted at 10%

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efficiency, it could still provide for twice the region's energy demand in the manufacturing sector, which is estimated to be about 15 quadrillion BTUs per year.

While photovoltaics for direct generation of electricity remain expensive, biomass or biofuels (see Section 5) may represent a viable energy supplement for the region, given its relatively low energy demands and high solar potential.

Water

The largest regional water demand is for industrial water in King William county, corresponding to the paper products mill (see Figure 3). There is very little additional industrial water consumption by comparison. There are significant demands for irrigation water in each county, in some cases exceeding domestic and commercial use. Total water demand in the region amounts to about 35 million gallons per day, over half of which is accounted for by King William County. Water efficiency measures can significantly reduce consumption in each of these areas.

It is interesting to note that total precipitation in the region amounts to about 43 inches per year, which works out to about 4,300 million gallons per day. Thus annual consumption represents about one percent of the total available. (Most precipitation is immediately lost to runoff or evapotranspiration.) While water *quantity* is not limiting, water *quality* may be.

According to the Virginia Water Quality Assessment For 1994, the state's estuaries are more significantly at risk than its rivers, for which concerns are more localized. According to the report, "Numerous causes and sources of use impairment were discussed. Among these, fecal coliform bacteria, and pesticides were the most extensive causes of impairment of rivers, while nutrient enrichment most affected estuarine waters. Agriculture and pasture land were major sources of pollutants to rivers and streams."

Figure 4 provides an assessment of the level of risk which Virginia's rivers, estuaries, and coastal shoreline currently face. In the figure "fully supporting" refers to water sources which can meet the widest possible range of uses (e.g. fishing, swimming, etc.), and "partially supported" and "not supporting" have corresponding interpretations. Maintaining the quality of the region's water bodies will require diligence, and is extremely important to the overall success of economic development efforts, given potential negative impacts on tourism, resource-based industries, and business recruitment.

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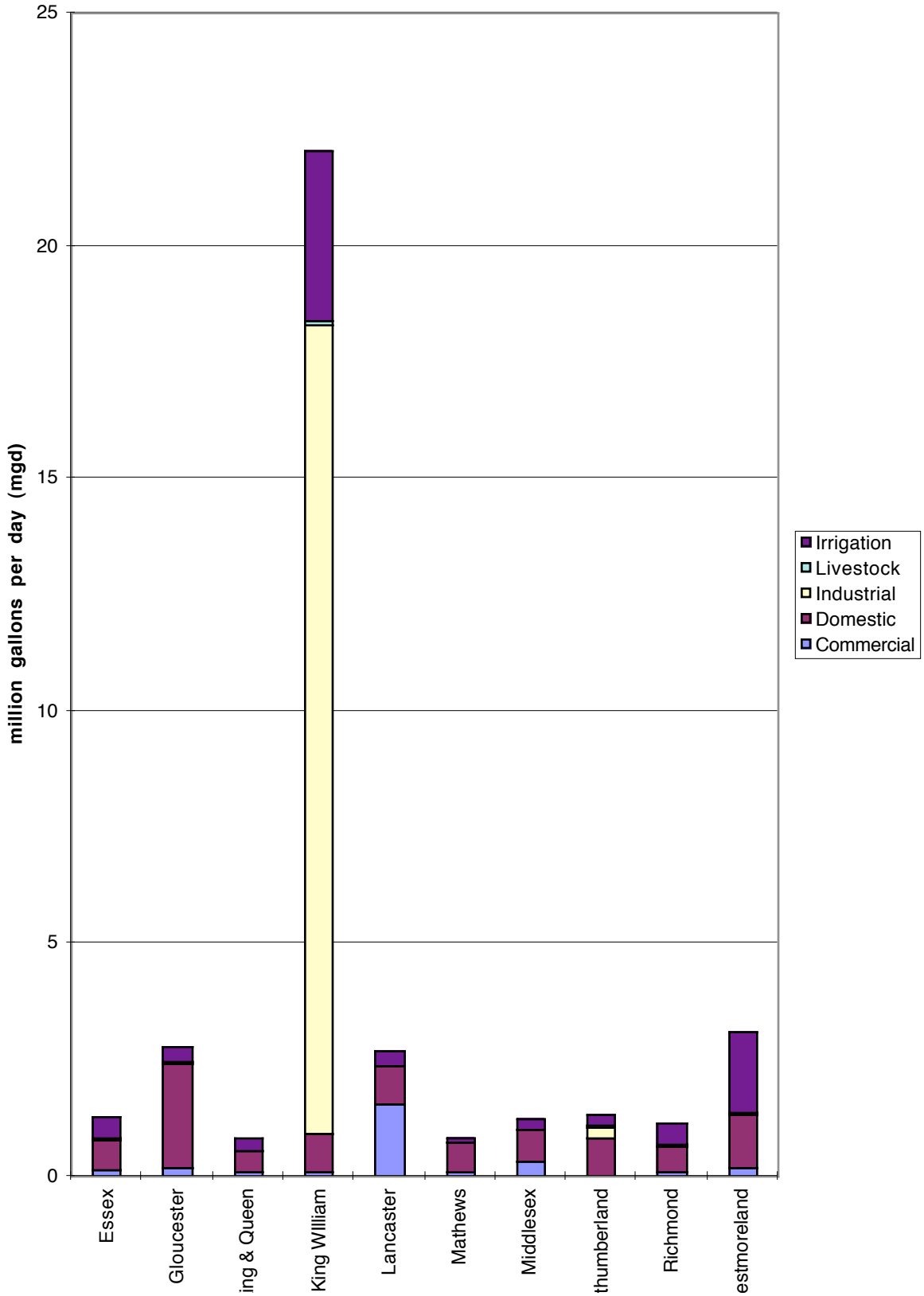
Figure 3. Water Use by County



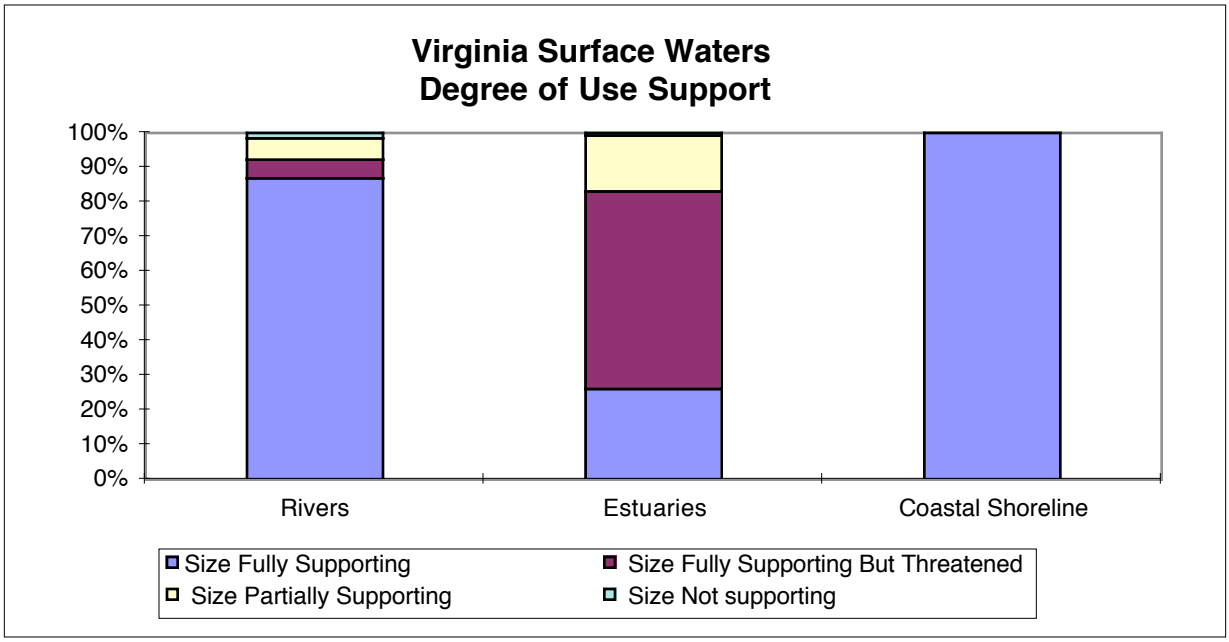


Figure 4. Virginia Surface Waters "Degree of Use Support"
(ability to support full range of functions)

Resource-Harvesting Industries

Agriculture

The farms of Virginia's River Country lend it a good part of its rural charm. In 1995, the region had about 285,000 acres in active farming. Soy accounted for almost half of this at 122,000 acres; corn was 62,000 acres; wheat was 61,000 acres; and barley was 28,000 acres. Unfortunately, farming has been in decline in the region for many years. The main crops—soybeans, corn, and wheat—are standard commodities which face strong competition from other growers around the country. The economics of farming are now shifting away from some of these traditional crops. Most new farms are small, diversified, and often organic.

There are some promising signs of agricultural diversification in the region. There are now some significant berry and vegetable producers, as well as experiments with vineyards. This diversification, combined with innovative uses for traditional crops (inks, biofuels, etc.), may add new vitality to the agricultural sector. Given the region's abundance of farmland—nearly one-quarter of its land area—and favorable climate, it could be considerably more self-sufficient in greens, vegetables, and herbs. In addition, organizations like the American Farmland Trust provide assistance to farmers wishing to protect their land with conservation easements and land trusts.

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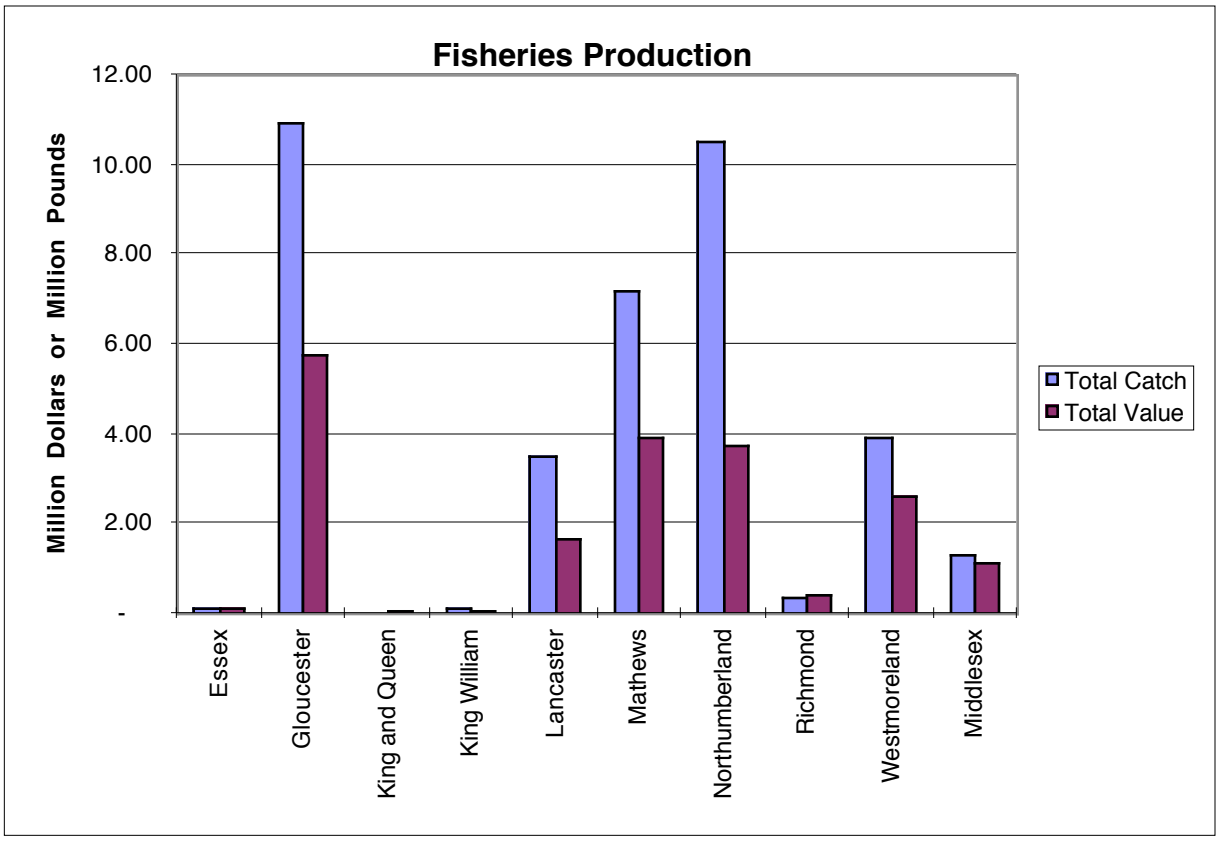
Fisheries

The fisheries sector remains highly productive, exceeding one million dollars per year in six counties. The diverse fishery, combined with crab and clam harvests, yields $19,500,000 per year, with a total catch of 19,000 tons. While oysters have declined for a variety of reasons, there is some hope that the industry may be revitalized in the next few years.



There is also a secondary processing industry, including marine oil processing and fresh and frozen fish packaging, with additional opportunities for niche marketing of specialty products. The health of the fisheries partly depends on maintaining water quality in regional estuaries, bays, rivers, and creeks. Compatible development that protects water quality benefits the fisheries industry. Any development which adversely affects water quality will carry substantial hidden costs to fisheries industry, and decisions should be made accordingly.

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Forestry

The forestry sector is very significant, with about 800,000 acres in Virginia's River Country classified as forest. The vast bulk of this land is in private hands. Principal forest types include loblolly-shortleaf, oak-pine, and oak-hickory, and less common types include oak-gum-cypress and elm-ash-cottonwood. Most counties are continuing to increase their standing stock , which points to the possibility of practicing selective or sustainable forestry. With environmentally sensitive forestry, the region can employ more people while harvesting fewer trees. The price premium for products from this kind of forestry can easily compensate for a decreased rate of cut.

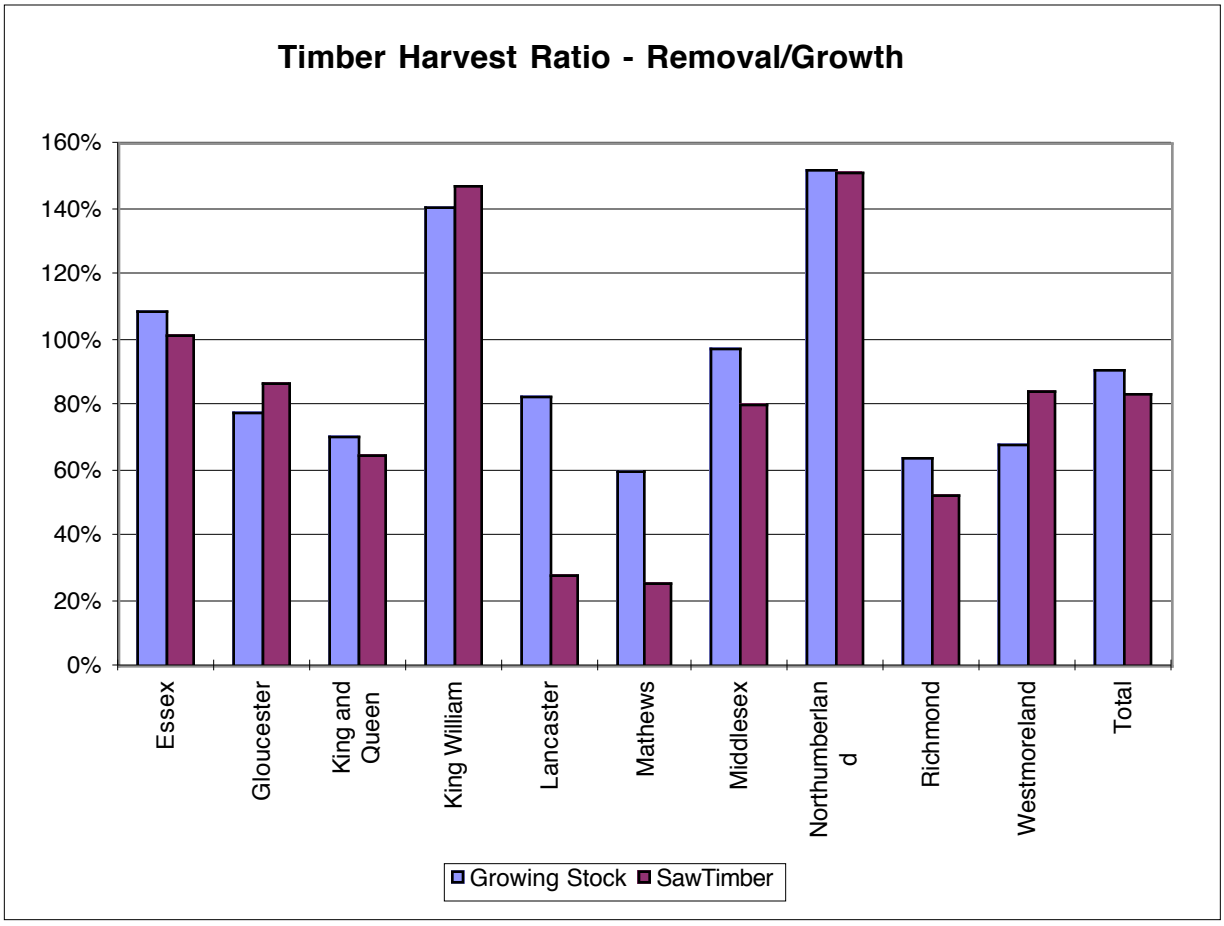

Figure 6. Ratio of Timber Removal to New Growth

Note that two counties, King William and Northumberland, are harvesting at significantly higher than replacement rate—a warning sign for possible future dislocation or disinvestment.

There is a substantial secondary forest products industry at present, including several planing mills, as well as plywood manufacturers, paperboard mills, container manufacturers, and

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wood preservers. There are still opportunities to add more value in this sector through specialized local milling and the manufacture of a variety of advanced wood products, including veneers, flooring, and wallboards. Furniture and crafts are other obvious avenues for adding value within the forestry sector.

Construction

Construction remains an important economic sector for Virginia's River Country, representing the most substantial value added after trade and manufacturing. In metabolic terms, this industry is in transition across the United States. Many large construction firms, including Turner Construction, are making efforts to minimize construction waste—a significant percentage of the region's waste stream—recycle building materials, and use materials which are non-toxic and environmentally sensitive. Houses are being designed with increased attention to passive solar heating and cooling. There is great interest in eco-development, with clustered houses, walkable neighborhoods, and mixed uses.

Virginia's River Country has a critical need for affordable housing. It also has a number of historic towns with compact cores which are suitable for redevelopment. Currently, most construction is occurring in the rural countryside, with some danger of rural sprawl and its attendant costs. Such sprawl will rapidly strain the modest infrastructure capacities of the region, and negatively impact the tourist industry and many natural amenities.

Manufacturing

The major manufacturing sectors in Virginia's River Country are shown in the accompanying figures. This sector has been in decline for some years. Fortunately, there are a wide range of compatible manufacturing industries which could help reverse this trend. In the next section, we discuss possibilities for waste exchanges between industries, as well as between the manufacturing, agricultural, forestry, and fisheries sectors.

Value-adding processing of agricultural, fisheries, and forestry products makes particular sense, given the region's strengths in these areas. Wood products, boatbuilding and related industries have been of great traditional importance, and build on the region's heritage; higher technology equipment manufacturers now make up part of the mix. Heavily polluting industries are typically not compatible with the region, although specific companies with strong environmental track records may be acceptable.

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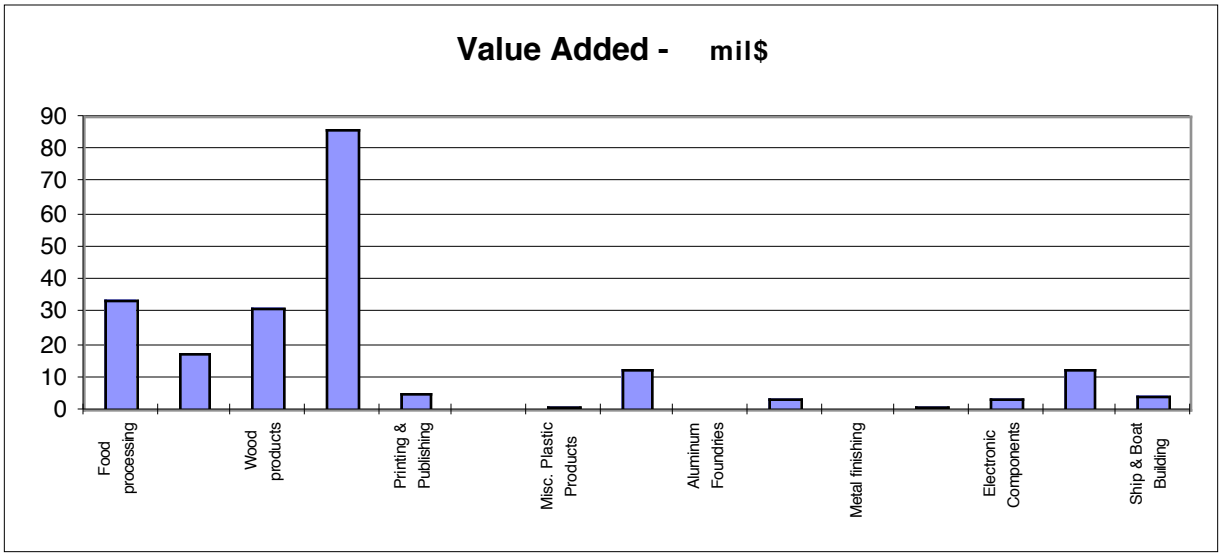

Figure 7. Value Added in the Manufacturing Sector (Millions of Dollars)

2-Digit SIC	Description of Sector (not all elements necessarily present in region)
20	Animal and Marine Fats and Oils; Fresh or Frozen Packaged Fish; Bottled and Canned Soft Drinks
22	Fabric Mill and Finishing
23	Apparel; Schiffi Machine Embroideries
24	Logging Contractors; Sawmills and Planing Mills; Veneer and Plywood; Wood Products; Wood Preserving
26	Paper Mills
27	Newspapers
32	Ready-Mixed Concrete; Asbestos Products; Minerals, Ground or Treated
34	Sheet Metal Work; Architectural Metal Work; Metal Stampings; Plating and Polishing
35	Conveyors and Conveying Equipment; Machine Tools/Industrial Machines
36	Electronic Components
37	Motor Vehicle Parts and Accessories; Boat Building and Repairing
38	Photographic Equipment and Supplies

Figure 8. Major Manufacturing Sectors in the Region by 2-digit SIC

Infrastructure: Transportation and Public Utilities

Virginia's River Country offers easy access to electrical hookups, but does not offer natural gas hookups. It has strong water and wastewater limitations, given the sensitive nature of local groundwater and estuaries. These limitations pose a substantial potential obstacle to further development in the region.

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Two approaches can help deal with these limitations. The first is to employ eco-efficiency strategies to minimize the drain on existing resources. These strategies, which are good investments in themselves, free up additional resources for new development. In addition, pollution prevention efforts help maintain the overall quality of water, which may be critical in attracting new manufacturing concerns requiring clean water for their industrial processes.

The second is to compatibly enhance existing infrastructure. There are some interesting alternatives to conventional wastewater treatment systems which offer significant economic and financial benefits. Constructed wetlands can purify sewage or a variety of industrial wastewater streams to tertiary treatment levels. Ecologically engineered systems, which rely on the inherent abilities of a wide range of species to purify sewage and industrial wastes, offer better treatment at less expense than conventional systems. Both kinds of systems help protect the health of the region's waters, which is important for tourism, fisheries, and industry. In addition, they can be used as aquaculture systems and provide high-value plant products.

Wholesale Trade, Retail Trade, Services, and Government

These sectors are of great economic importance to the region. Fortunately, their environmental impacts are relatively light. Given our focus in the metabolic analysis on physical flows in the region, we do not have specific comments on these sectors—except that they are typically significant generators of paper and packaging wastes. Eco-efficiency remains a good strategy for these sectors.

Financial, Insurance, and Real Estate

Financial institutions play a critical role to play in compatible economic development. We are beginning to see the emergence of a new kind of financial institution which preferentially invests in and provides technical support for compatible development. For example, the ShoreTrust Trading Group of Ilwaco, Washington, has the following investment criteria (taking from a recent prospectus):

- Harvest no more than what is replenished naturally
- Manage natural resources to restore and maintain biological diversity
- Prefer native species to introduced new ones
- Process and add value to raw materials before exporting them
- Use new technologies to increase productivity rather than just using more resources
- Apply the highest standards of energy efficiency

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- Control waste emissions to prevent damage to the environment
- Seek social as well as business returns

ShoreTrust offers savings, checking, CD, and money market accounts known as EcoDeposits, marketed nationally at competitive interest rates. ShoreTrust invests these EcoDeposits directly in the Willapa Bay watershed, one of the largest and most pristine estuaries on the west coast. ShoreTrust offers capital and assistance to local restorative enterprises of all kinds, ranging from high value-added seafood products to sustainable logging operations. ShoreTrust is catalyzing the formation of a compatible economy for Willapa Bay, and is becoming a significant regional force with the EcoDeposits now capitalized at ten million dollars.

ShoreTrust is an unusual partnership between South Shore Bank of Chicago and Ecotrust of Portland. South Shore Bank is an internationally respected community development bank which has been actively rebuilding inner cities through an innovative combination of banking, real estate development, venture capital, and specialized jobs and housing programs. Ecotrust is an environmental non-profit which has emphasized conservation-based development.

A second example of a financial institution dedicated to fostering compatible economic development is provided by the Virginia Eastern Shore Sustainable Development Corporation. The Nature Conservancy played the key role in the formation of this corporation. With an initial capitalization of $2.6 million, its corporate charter requires it "to develop and support products, business ventures, and land uses that enhance the local economy, achieve community goals, and preserve the natural resources on the Virginia Eastern Shore.... The corporation will assure through its structure, governance, and operations that economic profits are not secured at the expense of environmental or community degradation." The Nature Conservancy has created the Center for Compatible Economic Development to further explore the same approach elsewhere.

Residential

We make special mention of the residential sector because of its significant and growing resource impact, and the vast potential for resource efficiency and recycling in the home.

In many areas, governments and utilities have offered incentives and technical assistance to homeowners wishing to weatherize their homes, improve their windows, retrofit their lighting, or move to energy and water efficient appliances. These steps can significantly lower utility bills, which particularly helps lower-income residents, and generally benefit the regional economy by keeping more money local.

While the institutional (and geographic) barriers to recycling are high, the potential benefits are also great, including significant job creation. It is estimated that three to four jobs are created in

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recovering waste for every job in waste disposal. More modest steps would include programs to collect hazardous materials (which could cause groundwater contamination) and reusable items (which can be repaired and resold). Most counties have recycling programs which they can continue to build on and improve.(Reported recycling rates in the region for 1995—including commercial and industrial wastes—average 23%, and ranged from a low of 2% (for Middlesex County) to a high of 63% (Essex).

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3. Waste Exchange Opportunities

Economics of Waste Exchanges

There has been tremendous growth of interest in recent years in reusing industrial waste streams of all kinds. Amory Lovins, of the Rocky Mountain Institute, has shown that hundreds of billions of dollars worth of waste can be reclaimed annually in the U.S. economy. Companies like 3M, Monsanto, and Coors have made substantial profits by reducing their waste streams and turning them into new sources of revenue. In addition, reusing waste carries many environmental benefits.

From an individual firm's point of view, an existing waste stream is a financial liability, incurring storage, processing, transportation, and disposal costs. If the waste stream can be sold to, or even taken by, another company, there may be a significant economic advantage. Barriers to waste exchanges include the lack of an effective marketplace for waste materials, problems with poor characteristics or impurities in waste materials, the often irregular supply of waste materials, regulatory hurdles, and—above all—lack of information. Despite these obstacles, waste exchanges remain an attractive form of economic development, often creating skilled jobs.

While it is often assumed that waste re-use efforts are not intensified due to a lack of economically advantageous opportunities, current rates of industrial and domestic waste re-use actually occur at a much lower rate than that which would be seen under ideal market conditions. It follows directly that many barriers to waste re-use are non-economic. Central amongst these are a lack of information to potential waste customers about the availability of waste-based substitutes, lack of information to potential waste suppliers about opportunities to sell waste, false perceptions of secondary material value, and numerous perceived or real barriers including regulatory limits, resistance to change within organizations, and fear of legal disputes.

A central role, then, for government or non-government agencies trying to advance economically and environmentally sound development in a specific region is to assist existing and potential industries in overcoming non-economic barriers to waste exchange. This may be accomplished by first developing a clear understanding of existing resource use and waste generation patterns in the region and then identifying economically and environmentally beneficial options for a) cascading and upgrading existing waste streams, and b) integrating new industries into a growing network of waste exchange.

We can identify three types of waste exchanges:

- **direct match**—one company's existing waste stream can be directly used as a feedstock by a second company;

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- **waste upgrade**—through process redesign, one company's waste stream can be upgraded sufficiently to become an attractive feedstock for a second company (of course, in this case the cost of the upgrade must be recovered during the lifetime of the project);
- **feedstock substitution**—a company currently using virgin materials (typically from outside the region) can use a local company's lower-grade wastestream as feedstock instead.

When a match is made, special-purpose contracts can be written which specify the characteristics, timing, and quality of materials to be delivered. These contracts are increasingly routine, and with capable legal help more widely available. There are also opportunities for haulers, processors, brokers, and waste exchange networks to serve as intermediaries between the companies undertaking waste exchanges.

Manufacturing

In our metabolic analysis, we focused on waste exchange opportunities among manufacturing concerns. We examined (at the 4-digit SIC) companies with more than twenty employees, and relied on input/output analyses, employment correlations, and industry profiles in these categories to get a qualitative understanding and quantitative estimates of materials flows. This allowed us to identify *possible* exchanges. In practice, only some of these exchanges would prove feasible due to company by company variations in technology, production schedule, and so forth.

Non-Product Output (NPO) is a term coined by Bruce Cranford of the U.S. Department of Energy to more clearly label what we usually think of as "wastes." NPOs are all those materials "produced" by a company—that, like products, are in effect manufactured, with inputs of raw material, energy and labor, infusions of capital and equipment. Unlike products, NPOs produce no revenue, and often generate costs, e.g., for waste treatment, or liabilities, e.g. possible consequences of hazardous wastes.

Therefore it is usually worthwhile for a business to try to minimize its NPOs—both overall, and as a percentage of product produced—by both (1) increasing production efficiency and (2) finding beneficial uses of NPOs, turning wastes into resources. The graphic on the next page gives a schematic illustration of both recycling NPOs and reducing throughput (becoming increasingly resource efficient.) In the diagram, the magnitude of the flows is proportional to the width of the arrow. Following the graphic, there is a figure listing existing waste flows and possible beneficial matches for each major manufacturing sector in the region.

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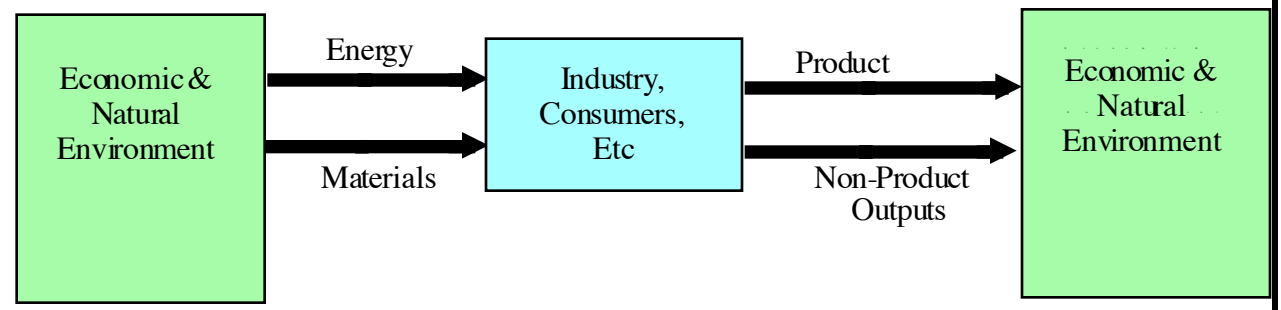
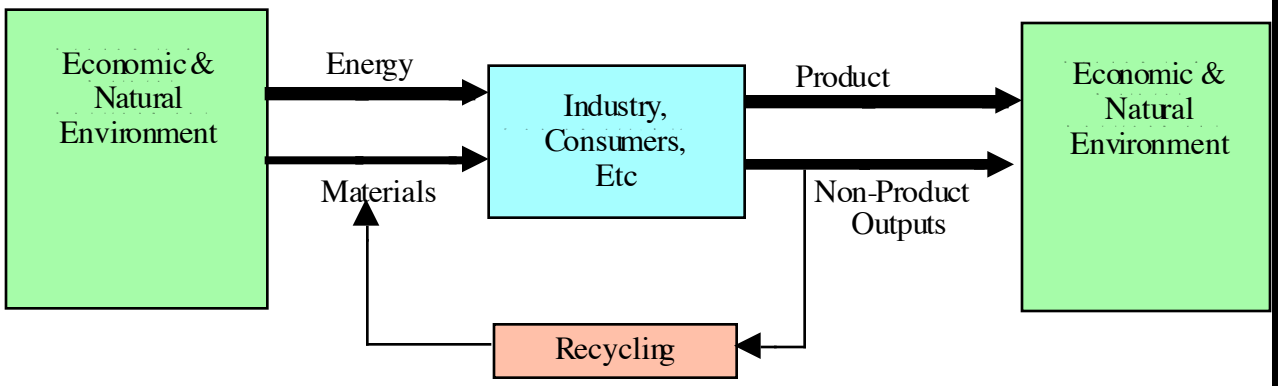
Metabolic Efficiency Strategies



Recycle NPOs



Reduce Throughput

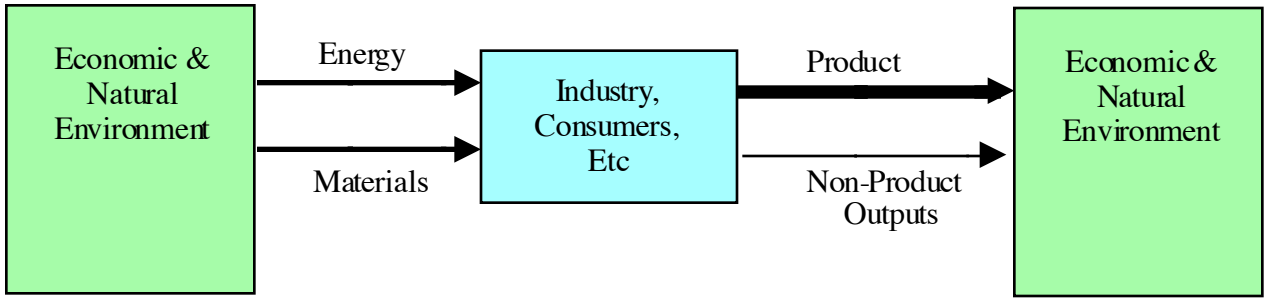


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Figure 9. Manufacturing Wastes and Possible Matches

Manufacturing Use Sector (4-digit SIC)	Flow Category	Description	Possible Matching Uses
ALL SECTORS - GENERIC FLOWS	Paper	Packaging and Everyday Operations	Recyclable
	Plastics	Packaging and Everyday Operations	Recyclable
	Glass	Packaging and Everyday Operations	Recyclable
	Metals	Packaging and Everyday Operations	Recyclable
	Wood	Packaging, Pallets, and Everyday Operations	Recyclable
	Chemicals	Motor Oil	Recyclable
	HazMat	Batteries	Recyclable
	Water	Wastewater	Ecological Treatment to Tertiary Quality
Animal And Marine Fats And Oils (2077)	Chemicals	Sanitizers	Source Reduction
	Organics	Animal and Fish Protein	Agriculture
	Organics	Fats, Oils, Grease	Agriculture
	Water	Nutrient- Rich Wastewater	Ecological Treatment
Apparel Made From Purchased Materials (2325)	Chemicals	Dyes	Source Reduction
	Chemicals	Sizings	Source Reduction
	Textiles	Cloth scraps, cotton/wool	Agriculture, Paperboard Mill, Specialty Clothing
	Textiles	Cloth scraps, synthetics	Agriculture, Paperboard Mill, Specialty Clothing
Architectural Metal Work (3446)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
Asbestos Products (3292)	Chemicals	Asbestos fibers	Source Reduction
Bottled Or Canned Soft Drinks & Water (2086)	Chemicals	Sanitizers	Source Reduction
	Organics	Sugars & syrups	Agriculture
	Water	Nutrient-Rich Wastewater	Ecological Treatment
Broadwoven Fabric Mills And Finishing (2221)	Chemicals	Dyes	Source Reduction
	Chemicals	Sizings	Source Reduction
	Textiles	Cloth scraps, cotton/wool	Agriculture, Paperboard Mill, Specialty Clothing
	Textiles	Cloth scraps, synthetics	Agriculture, Paperboard Mill, Specialty Clothing

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Conveyors and Conveying Equipment (3535)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
Electronic Components (3679)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Paint	Source Reduction
	Chemicals	Solders	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
	Metal	Precious metals	Recyclable
	Plastic	Circuit boards	Recyclable
Fabricated Textile Products (2399)	Chemicals	Dyes	Source Reduction
	Chemicals	Sizings	Source Reduction
	Textiles	Cloth scraps, cotton/wool	Agriculture, Paperboard Mill, Specialty Clothing
	Textiles	Cloth scraps, synthetics	Agriculture, Paperboard Mill, Specialty Clothing
Industrial Machines (3599)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Paint	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
Logging Contractors (2411)	Wood	Wood chips	Agriculture, Biofuels, or Paperboard Mill
	Wood	Wood scraps	Agriculture, Biofuels, or Paperboard Mill
Metal Stampings (3469)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable

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Minerals, Ground Or Treated (3295)	Misc.	Mineral wastes	Possible additive for concrete manufacturing
Motor Vehicle Parts And Accessories (3714)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Paint	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
	Plastic	Circuit boards	Recyclable
	Plastic	Misc. parts	Recyclable
Newspapers (2711)	Chemicals	Inks	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Paper	Newsprint	Paperboard Mill
Paperboard Mills (2621)	Chemicals	Adhesives	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Solvents	Recyclable
	Paper	Mill waste	Agriculture, Bedding or Absorbent Materials, Construction Materials
	Wood	Wood chips	Agriculture
	Water	Nutrient- Rich Wastewater	Ecological Treatment
Photographic Equipment. And Supplies (3861)	Metal	Silver	Recyclable
	Plastic	Film scrap	Recyclable
Plating And Polishing (3471)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
Prepared Fresh Or Frozen Packaged Fish (2092)	Chemicals	Sanitizers	Source Reduction
	Organics	Fish and shellfish wastes	Agriculture
	Water	Nutrient-Rich Wastewater	Ecological Treatment
Ready-Mixed Concrete (3273)	Mineral Wastes	Gravel	Possible Construction Materials
	Mineral Wastes	Sand	Construction Materials
	Water	Slurry	Source Reduction
Sawmills And Planing Mills, General (2421)	Wood	Wood chips	Agriculture, Biofuels, or Paperboard Mill
	Wood	Wood scraps	Agriculture, Biofuels, or Paperboard Mill

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Schiffi Machine Embroideries (2397)	Chemicals	Dyes	Source Reduction
	Chemicals	Sizings	Source Reduction
	Textiles	Cloth scraps, cotton/wool	Agriculture, Paperboard Mill, Specialty Clothing
	Textiles	Cloth scraps, synthetics	Agriculture, Paperboard Mill, Specialty Clothing
Sheet Metal Work (3444)	Chemicals	Coatings	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
Ship Building And Repairing (3732)	Chemicals	Coatings	Source Reduction
	Chemicals	Epoxies	Source Reduction
	Chemicals	Fiberglass	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Oils	Source Reduction, Recyclable
	Chemicals	Paint	Source Reduction
	Chemicals	Solders	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Chemicals	Treatments	Source Reduction
	Metal	Metal scraps	Recyclable
	Wood	Wood scraps	Agriculture, Biofuels, or Paperboard Mill
Veneer And Plywood (2435)	Chemicals	Adhesives	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Solvents	Recyclable
	Wood	Wood chips	Agriculture, Biofuels, or Paperboard Mill
	Wood	Wood scraps	Agriculture, Biofuels, or Paperboard Mill
Wood Containers (2448)	Chemicals	Adhesives	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Wood	Wood chips	Agriculture, Biofuels, or Paperboard Mill
	Wood	Wood scraps	Agriculture, Biofuels, or Paperboard Mill
Wood Preserving (2491)	Chemicals	Adhesives	Source Reduction
	Chemicals	Finishes	Source Reduction
	Chemicals	Solvents	Source Reduction, Recyclable
	Wood	Wood chips	Agriculture, Biofuels, or Paperboard Mill
	Wood	Wood scraps	Agriculture, Biofuels, or Paperboard Mill

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While Figure 9 identifies qualitative flows based on standard industry profiles, quantitative identification is far more difficult. Waste stream characterization by industry is a very poorly developed practice in the United States. While some documentation of residential waste generation is available (see below), relatively little data is available for manufacturing and commercial wastes.

EPA estimates the total national solid waste flow at about 12,915 million tons per year, of which only 180 million tons (about 1.5%) ends up as municipal solid waste. Without detailed surveys of individual businesses, it is virtually impossible to determine the portion of industrial solid waste which does not go into municipal solid waste.

We have been able to obtain data from a pilot project conducted by the Los Angeles, California, Integrated Solid Waste Management Office, which surveyed firms to identify both waste characterization and waste generation rates by SIC code. We applied this data to the River Country industry mix and employment data to generate a rough estimate of the non-hazardous solid waste stream in this region. Several important caveats: it is not at all certain (or even likely) that waste stream characterization for a given industry will be the same in Virginia as in California; the Los Angeles data enabled us to estimate sold waste yields for only about half the manufacturing employment in the region; this data applies only to the small amount of solid waste which would typically go into the municipal waste stream—it does not include wastes normally privately disposed of.

In fact River Country regional data documents a significantly higher solid waste flow, though we are not able to allocate it to specific industries. Figure 10 suggests that the largest solid waste streams occur in the food processing, pulp and paper, and textile sectors, with paper and organics the major components of the waste.

Actual solid waste flow by county is summarized in Figure 20, showing categories of recycled, "source reduced" and disposed of (landfilled) materials by county; Figure 20A shows the recycling rates reflected by these data. Note that while the average recycling rate for the region—about 23%—exceeds the current statewide average, the rate varies widely from country to county. The rate for Essex County exceeds 60%—essentially the result of a reported flow of nearly 9000 tons/year of "auto parts" recycled—while the rates for King William, Mathews and Middlesex counties are well below 10%.

(For comparison purposes, Figure 20C shows estimated "municipal solid waste," excluding large industrial generators, based on county population and average waste characterization profiles (see Figure 20B). Reported flows are about 40% higher than these estimates—not unexpected since the reported flows include significant industrial waste.)

Following Figure 10, there are a number of overviews of the manufacturing sector by different resource categories. Figure 11 shows energy use in the manufacturing sector. The pulp

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and paper sector (SIC 26) is by far the largest user. Figure 12 shows that the food products (20) and forestry products sectors (24) also have high energy use. Figure 13 shows that air emissions are again dominated by sector 26, while concrete, minerals, and ceramics (32) also have a large contribution. Figure 14 provides data on effluent loading, again dramatically led by sector 26.

Figures 15 and 16 give important data on several key outside inputs purchased by the various economic sectors. Figures 16A and 16B show expenditures for utilities for the entire regional economy and for manufacturing. Petroleum, gas, and electricity expenditures top $200,000,000, while spending for water and wastewater is about $20,000,000. Figures 17, 18, and 19 provide important benchmarks for compatible economic development, by comparing economic value added in millions of dollars—the traditional economic measure—per ton of air emissions, ton of water emissions, and million kilowatt-hours of electricity respectively. These figures show quite dramatically that the most significant economic contributors are not necessarily the most efficient contributors. The greater the value added per unit of resource consumption, the more economic benefit a company can deliver per unit of environmental impact—something to consider when targeting industries for attraction.

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Figure 10. Solid Waste - Manufacturing Sectors
(Estimated)

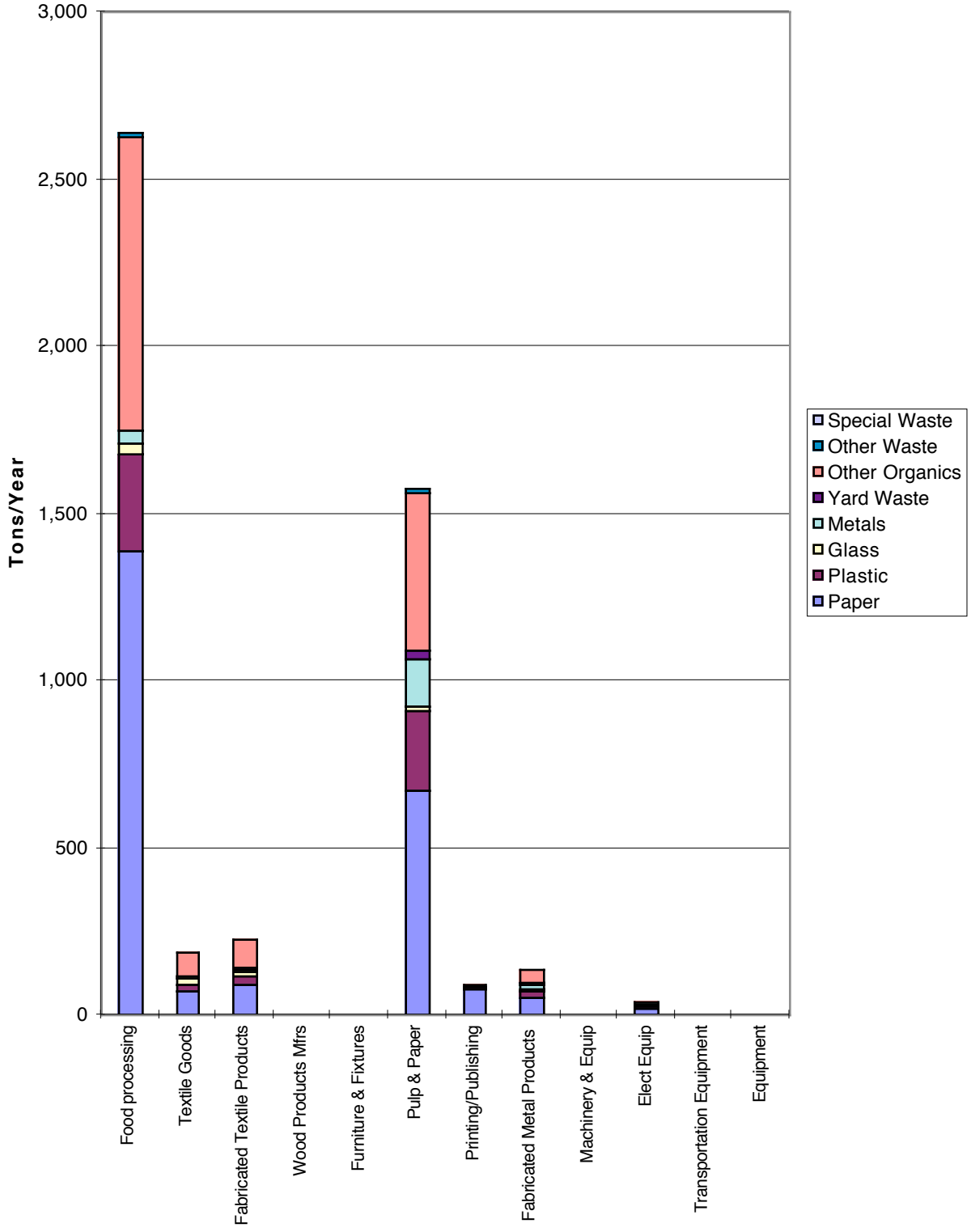

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Figure 11. Energy Use by Manufacturing Sector

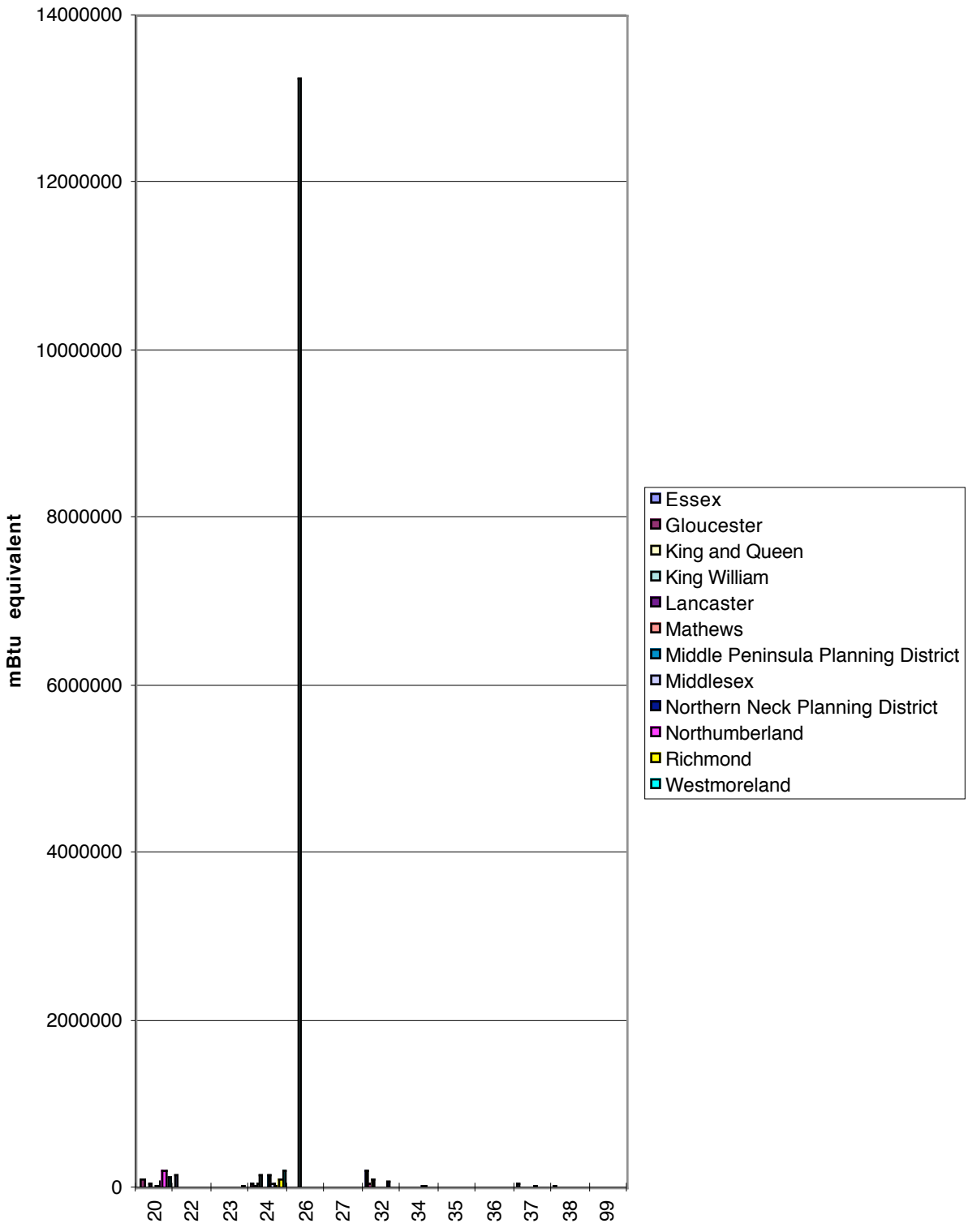

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Figure 12. Energy Use by Manufacturing Sector
(excluding SIC 26)

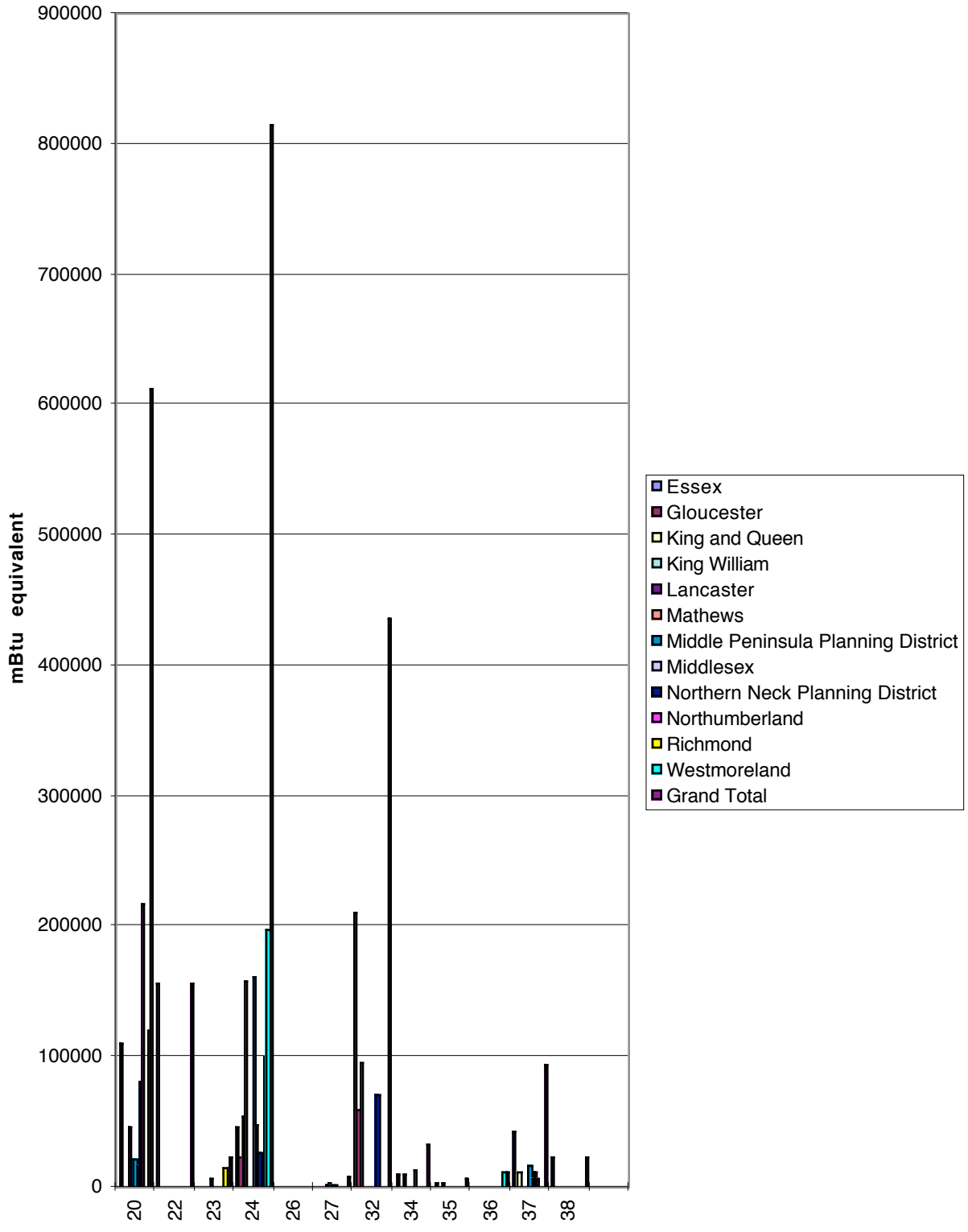

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Figure 13. Air Emissions - Manufacturing

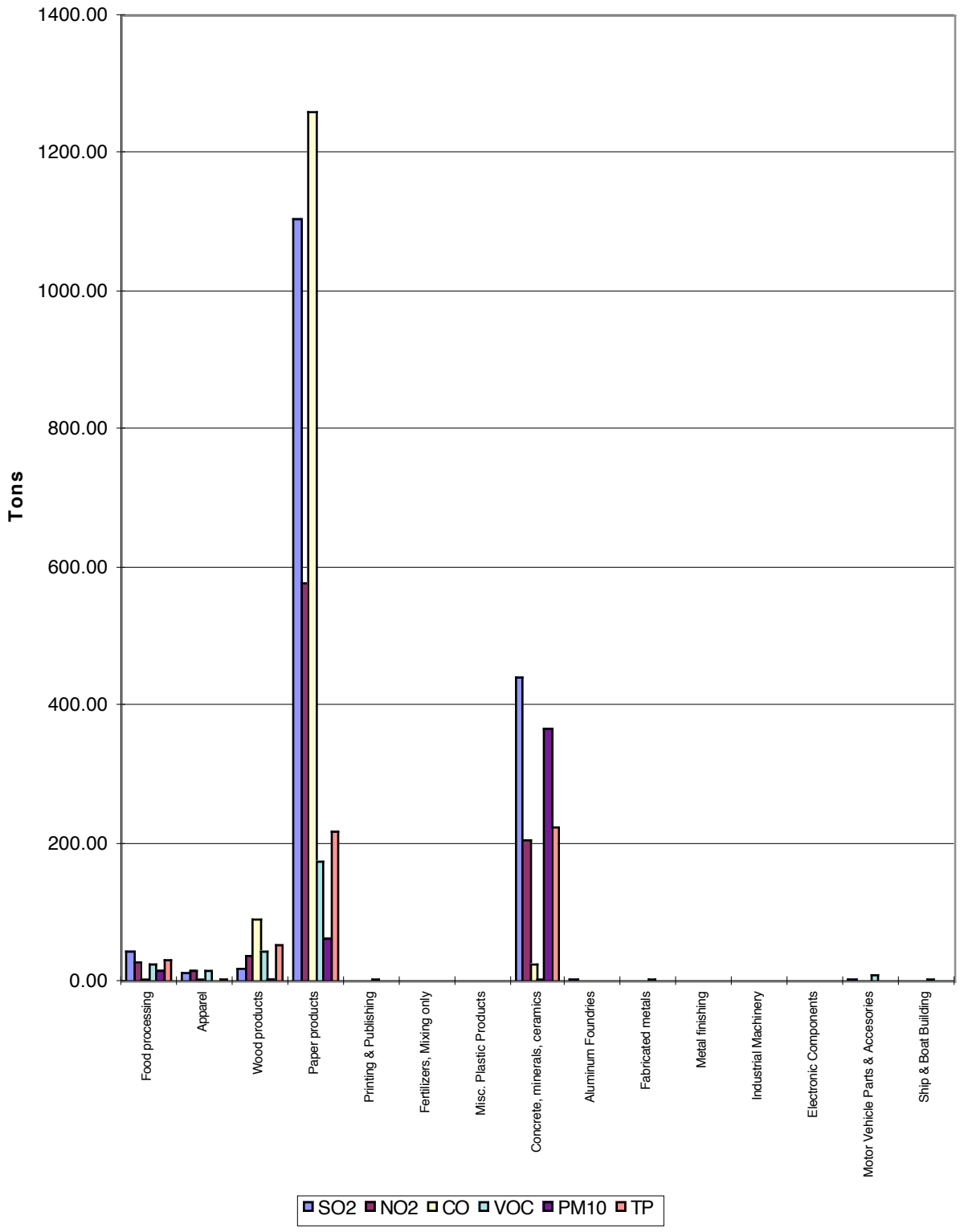

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Figure 14. Effluent Loading - Manufacturing

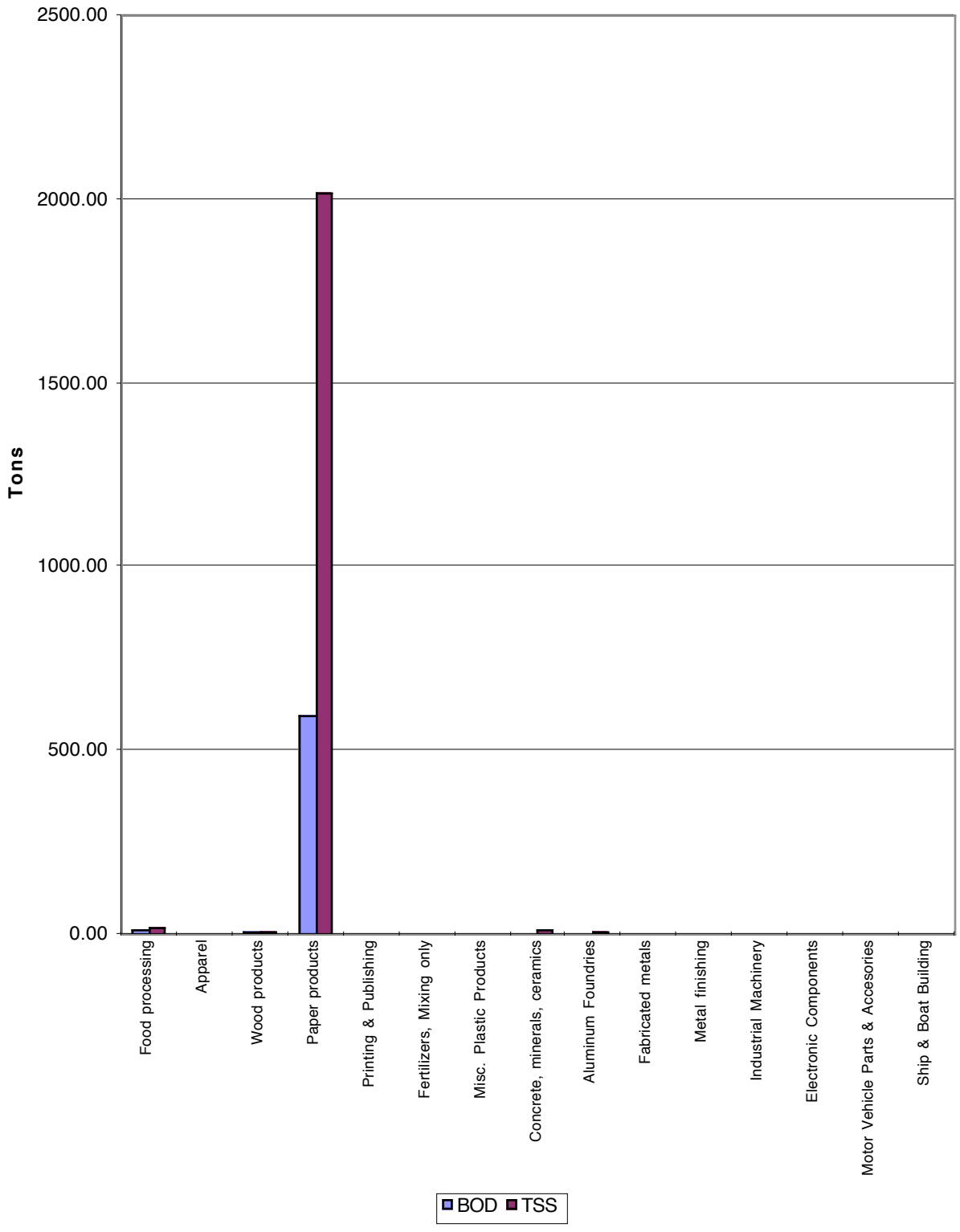

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Figure 15. Purchased Inputs
[Top Three Manufacturing Sectors]

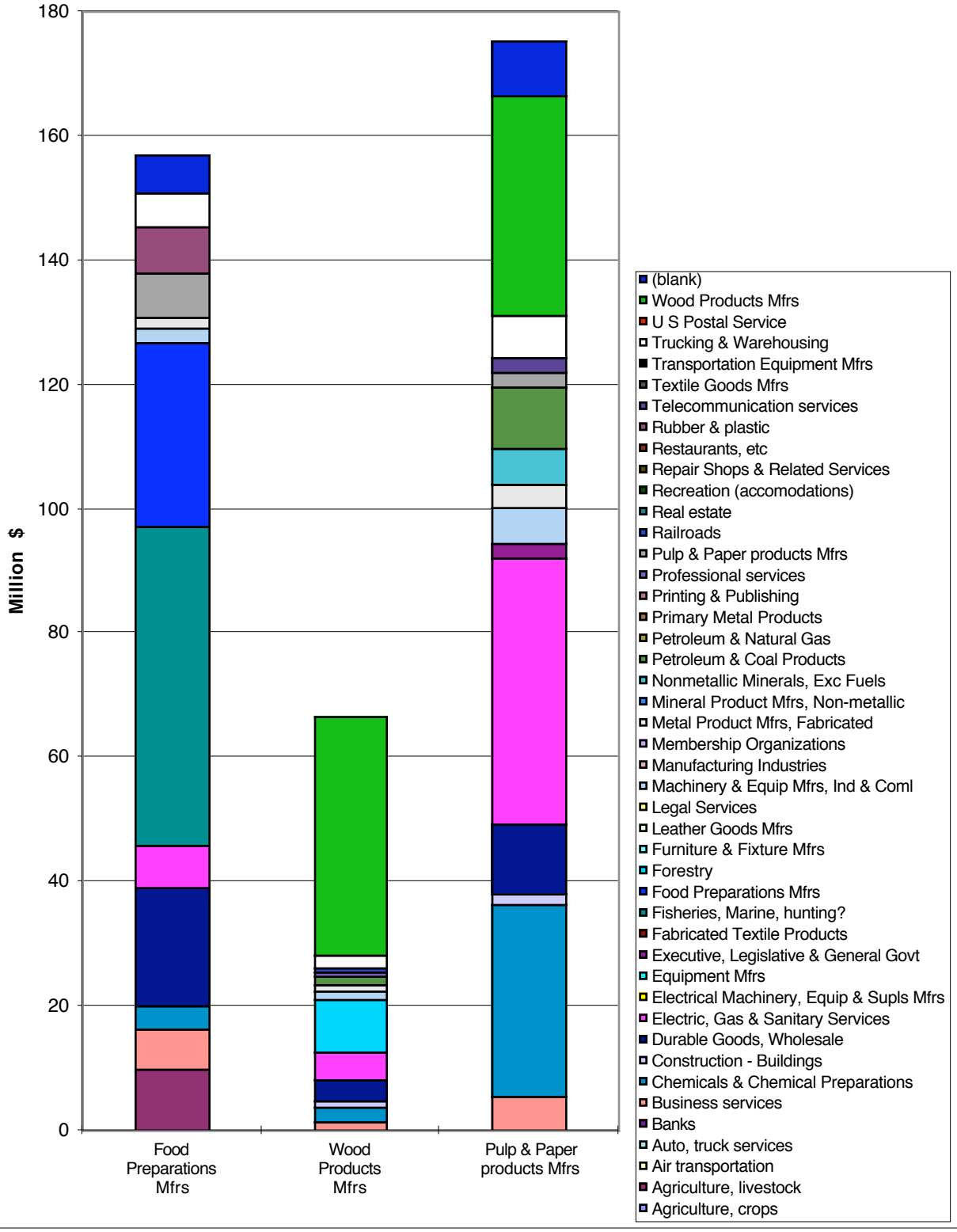

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Figure 16. Purchased Inputs
(Other Manufacturing Sectors)

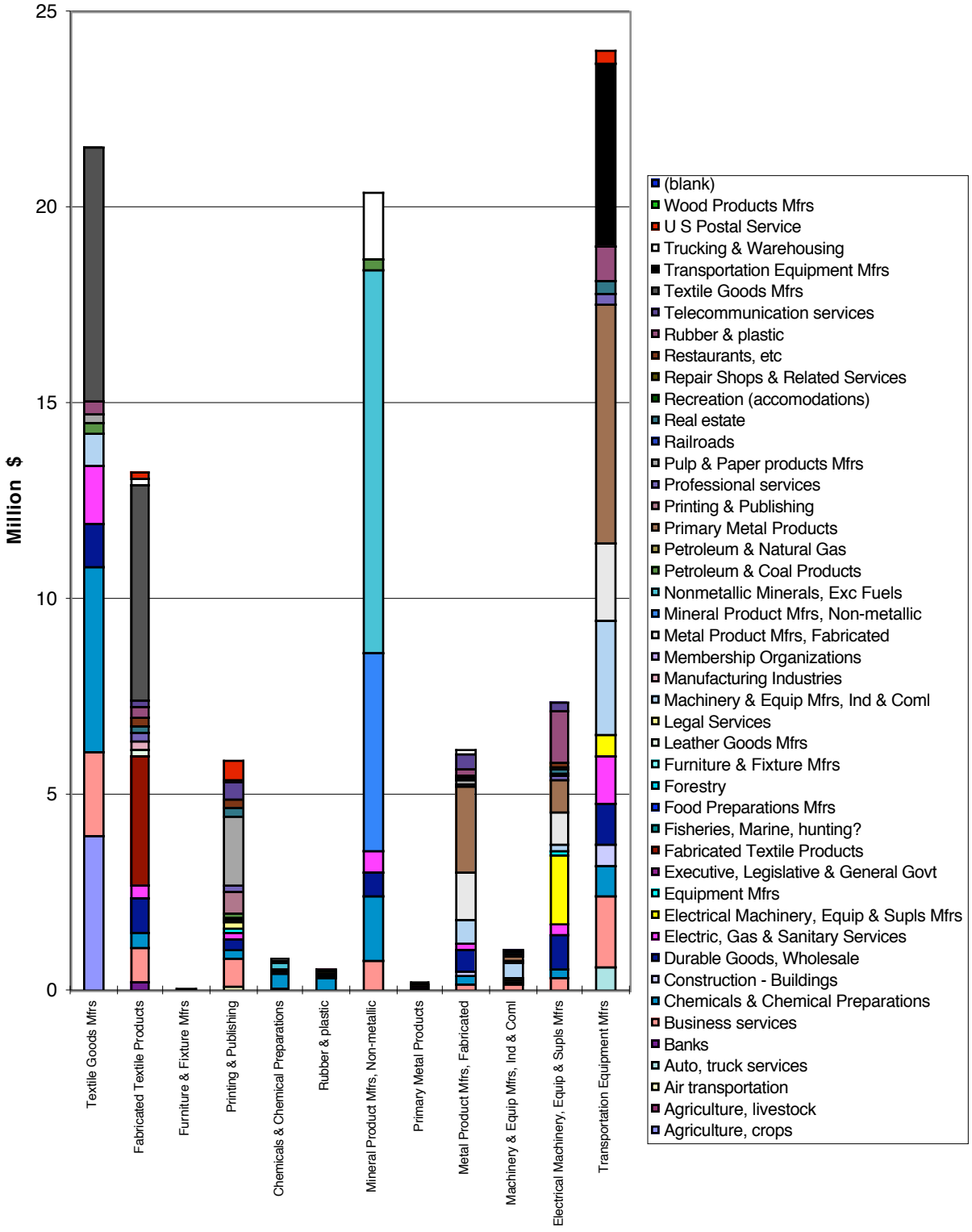

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Figure 16A. Expenditures for Utilities

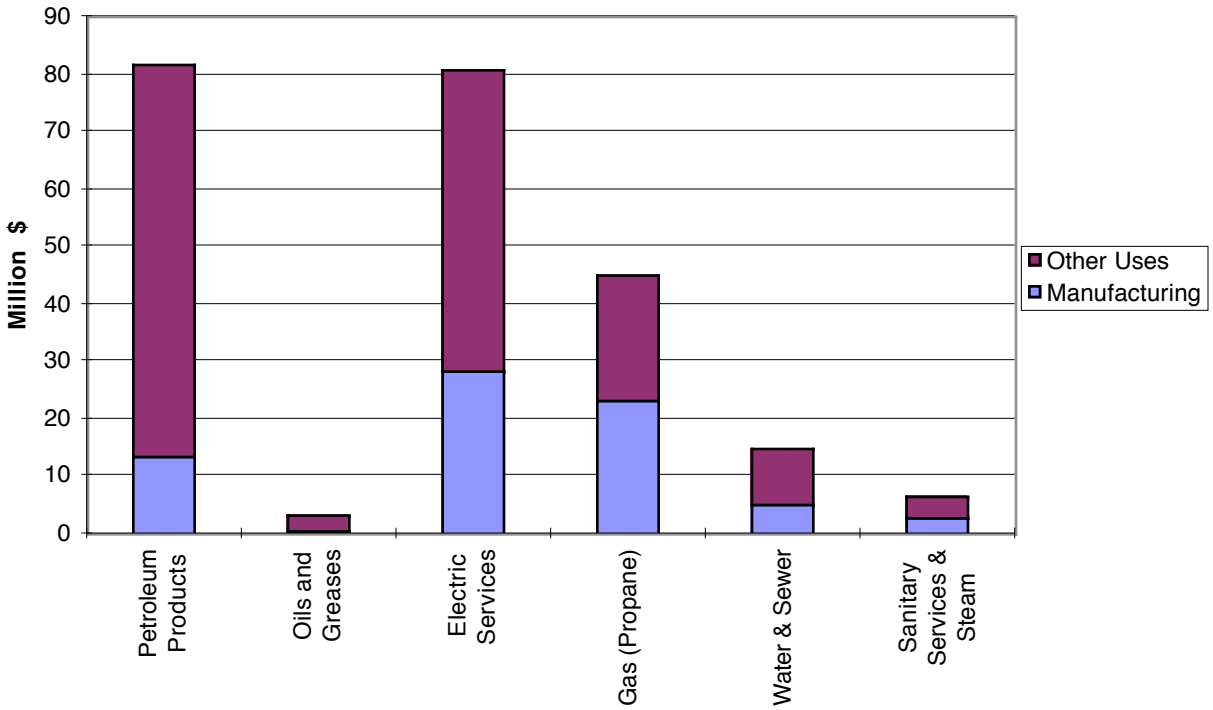

Figure 16B. Expenditures for Utilities [Manufacturing Sector]

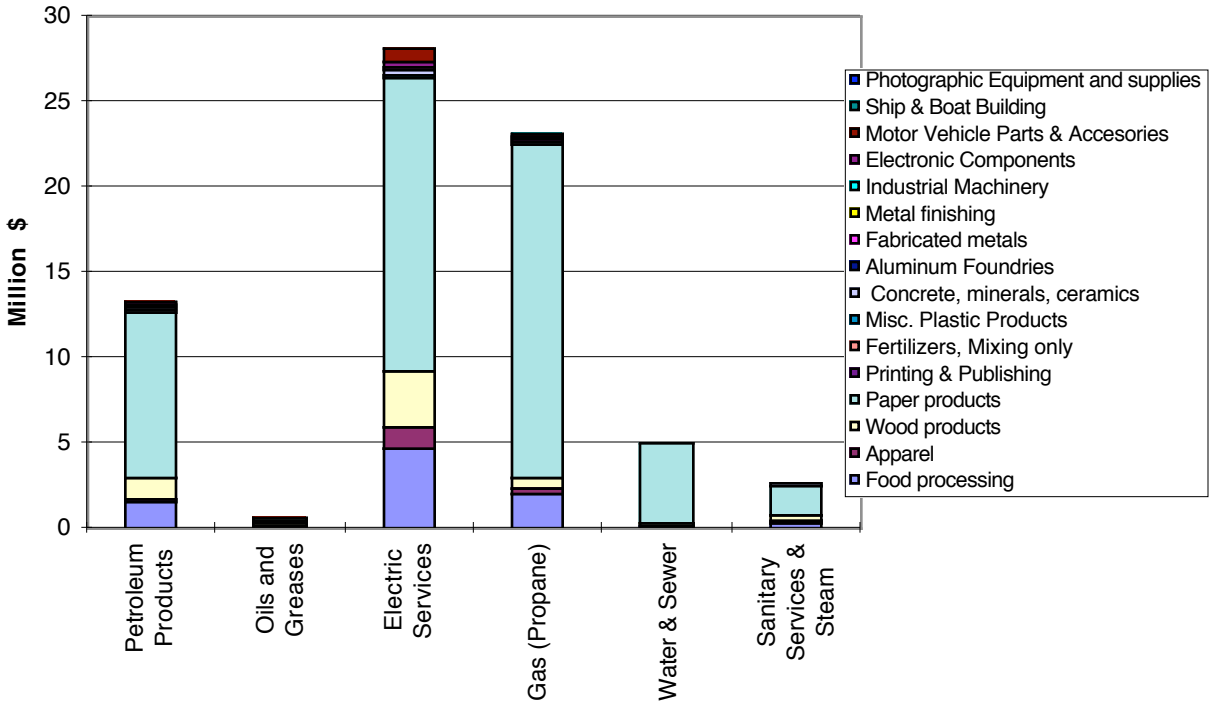

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Figure 17. Value Added Efficiency (1)
mil$/Ton Air Emissions

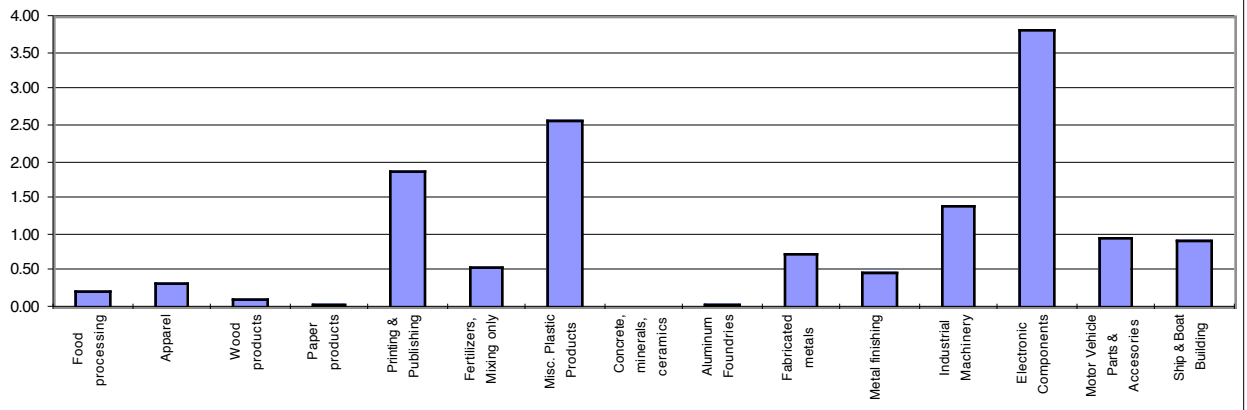


Figure 18. Value Added Efficiency (2)
mil$/Ton Water Emissions

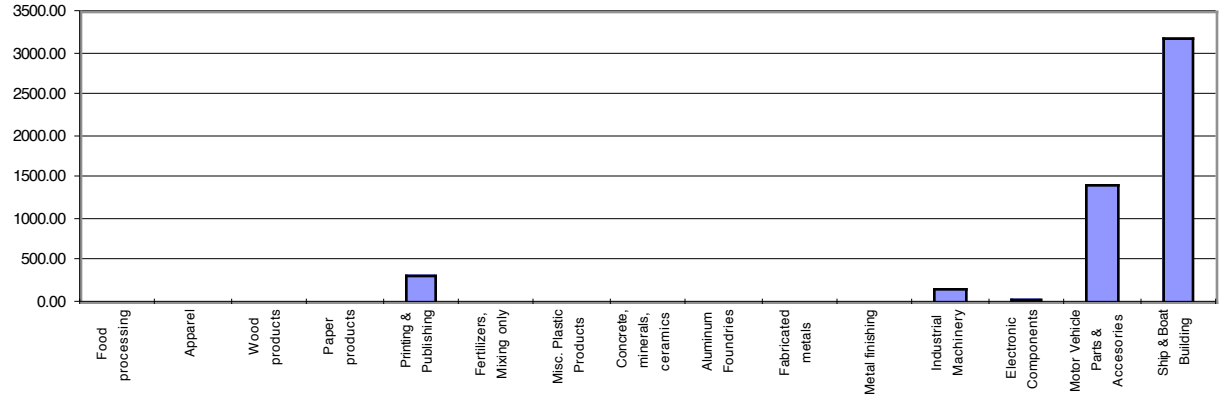
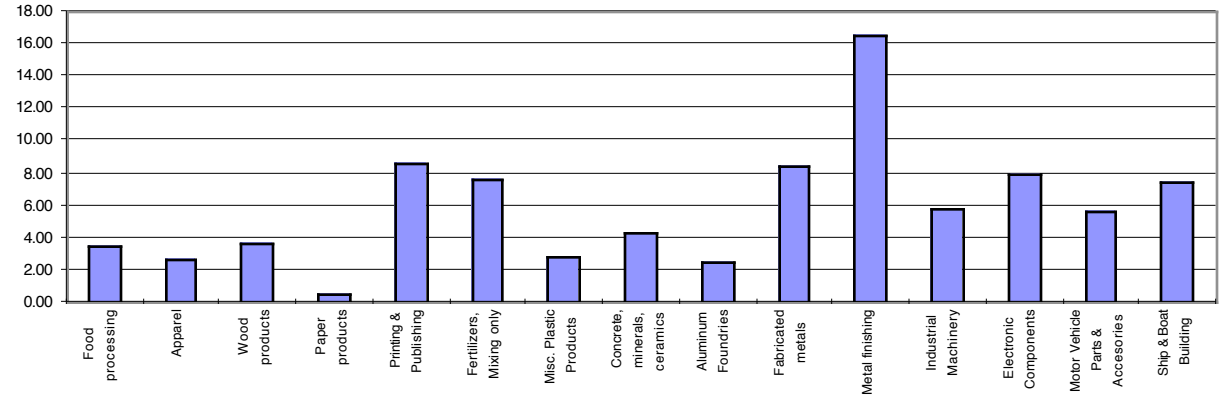


Figure 19. Value Added Efficiency (3)
mil$/mkWh electricity



Residential

Figure 20C shows an estimated breakdown of "municipal solid waste" (excluding large industrial) for the region, by materials. (The variations by county are due to population differences rather than differences in consumption patterns.) The waste categories, in order of size, are organics, paper, plastics, and glass and metals. While most counties have a good start on recycling programs, recycling rates vary widely from country to county; this suggests considerable room for improvement, and additional opportunity for waste-based production, especially if desired waste fractions can be economically harvested from the waste stream.

In particular, it may be worthwhile to consider establishing a Materials Recovery Facility (MRF) near an existing landfill or transfer station. MRFs allow advanced sorting and separation of waste materials so that more value can be recovered before landfilling the remaining fraction. Materials may then be able to be reused more effectively within the region (see the Agricultural/Forestry/Industrial Cluster discussion below) or shipped to external markets.

According to a study by Urban Ore, Inc., for a rural region in West Virginia, a small MRF processing from 25 to 100 tons/day would be economically feasible. This represents about 10% to 40% of Virginia River Country's approximately 250 tons/day of locally generated residential and commercial waste. Therefore, it may be possible to establish one or more MRFs in the region.

Currently, there are two large landfill operations in the region which are primarily receiving materials from other counties and states. The landfill in Gloucester County is operated by Waste Management Inc. (WMI) and the one in King and Queen County is operated by BFI. The Gloucester facility averages about 2,000 tons/day. Both facilities do have significant recycling and materials processing operations. Since they are privately run with privately sourced materials from outside the region, we have focused our MRF recommendations above on the regionally generated solid waste stream.

Construction

Construction is both a major regional economic activity and a major generator of solid waste. Nationwide, wood accounts for 42% of waste by weight, drywall 26%, and masonry 11%. (Composition of residential construction waste both by weight and by volume is shown in Figure 21.) Typical waste generation rates are about 3-5 pounds per square foot, or about 4 tons for an average 2,100 square foot residence [National Association of Home Builders]. Figure 22 uses this estimate, together with recent figures for housing starts, to estimate the residential construction waste. Commercial and public construction projects would likely double or triple these figures.

There are significant opportunities to reduce construction waste through efficient framing and improved jobsite practices. Construction waste is typically high-value, and construction

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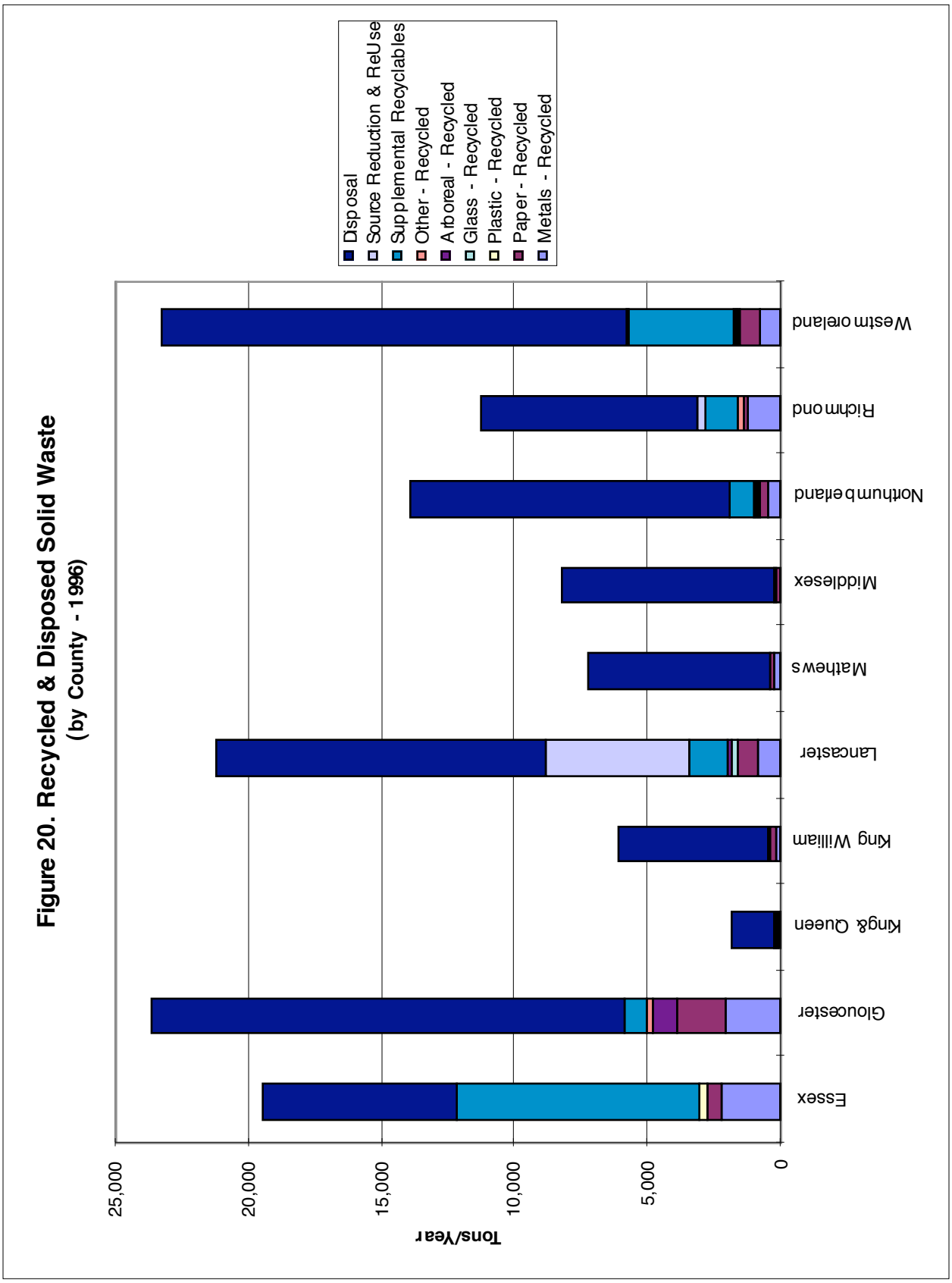

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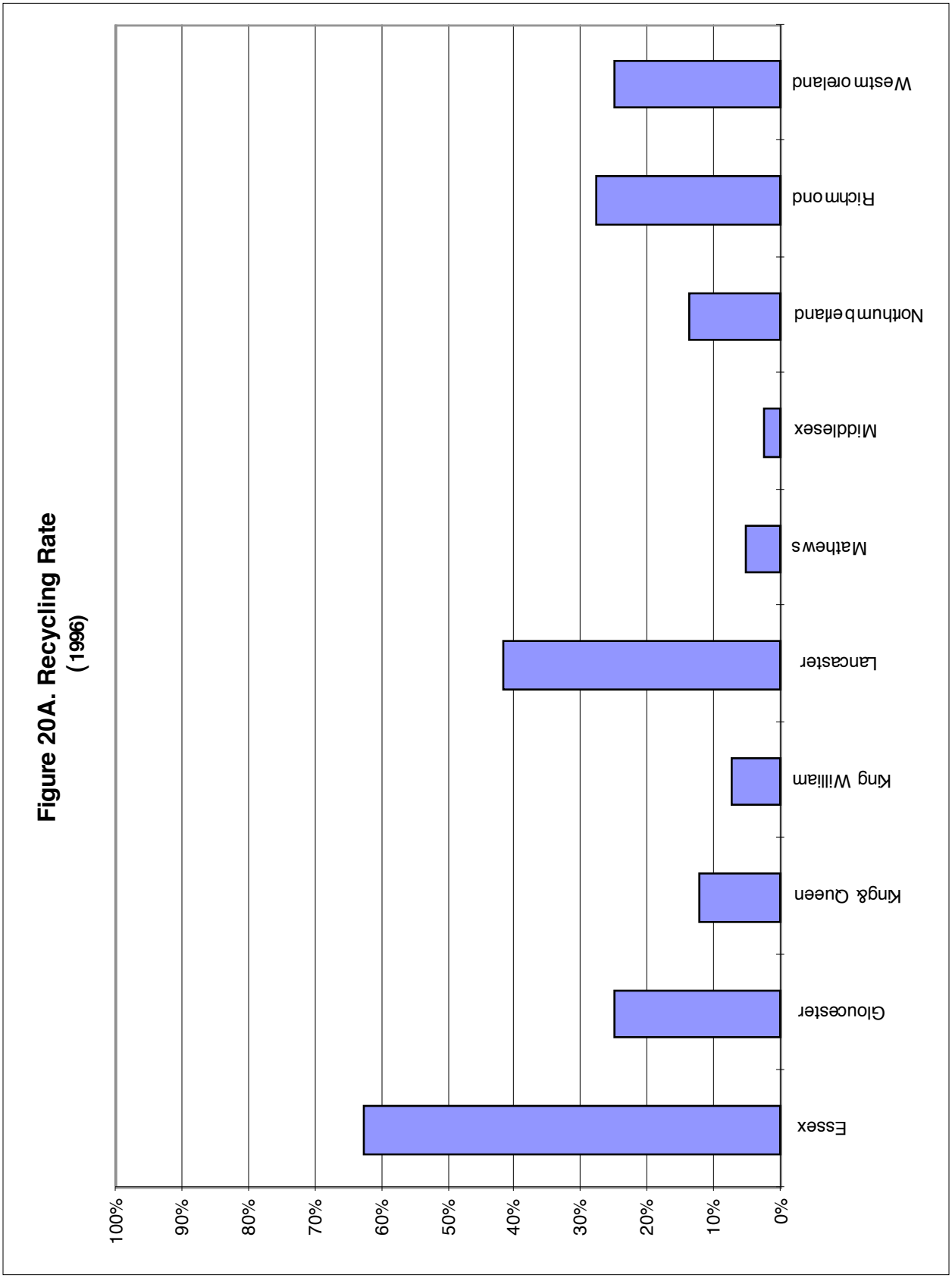

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Figure 20B. "Municipal" Solid Waste Characterization

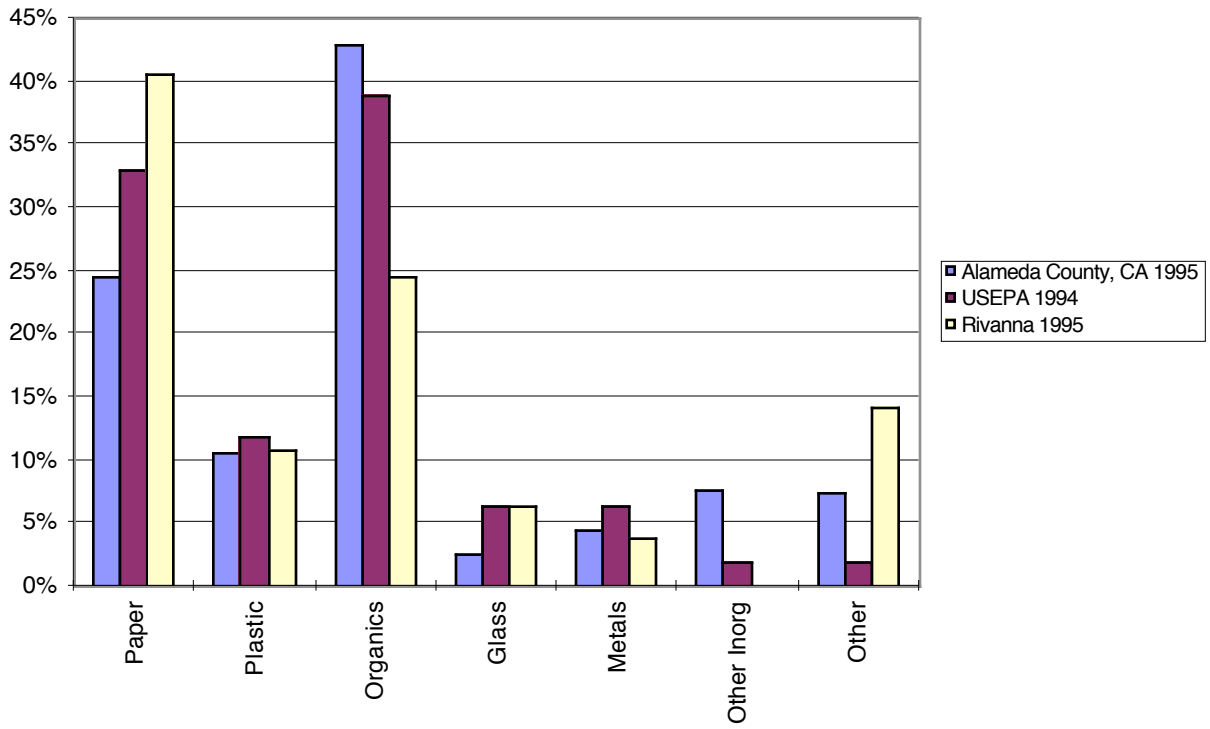

Figure 20C. "Municipal Solid Waste" - estimate
(excludes large industrial)

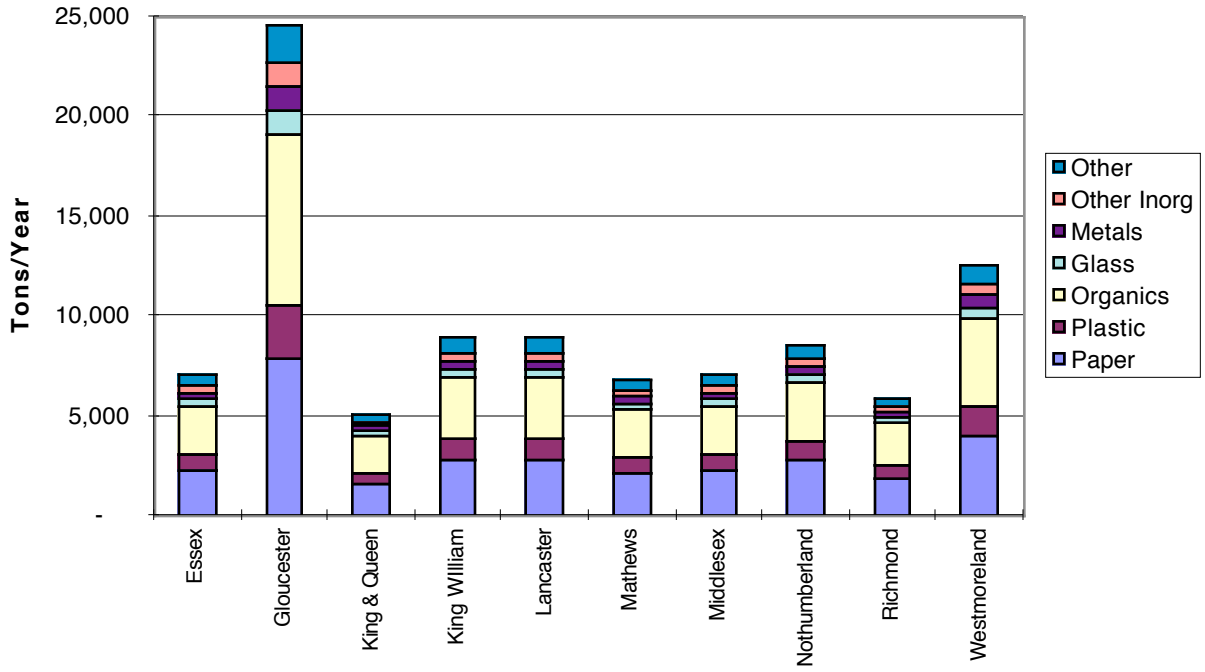

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Figure 21. Construction Waste
(National average)

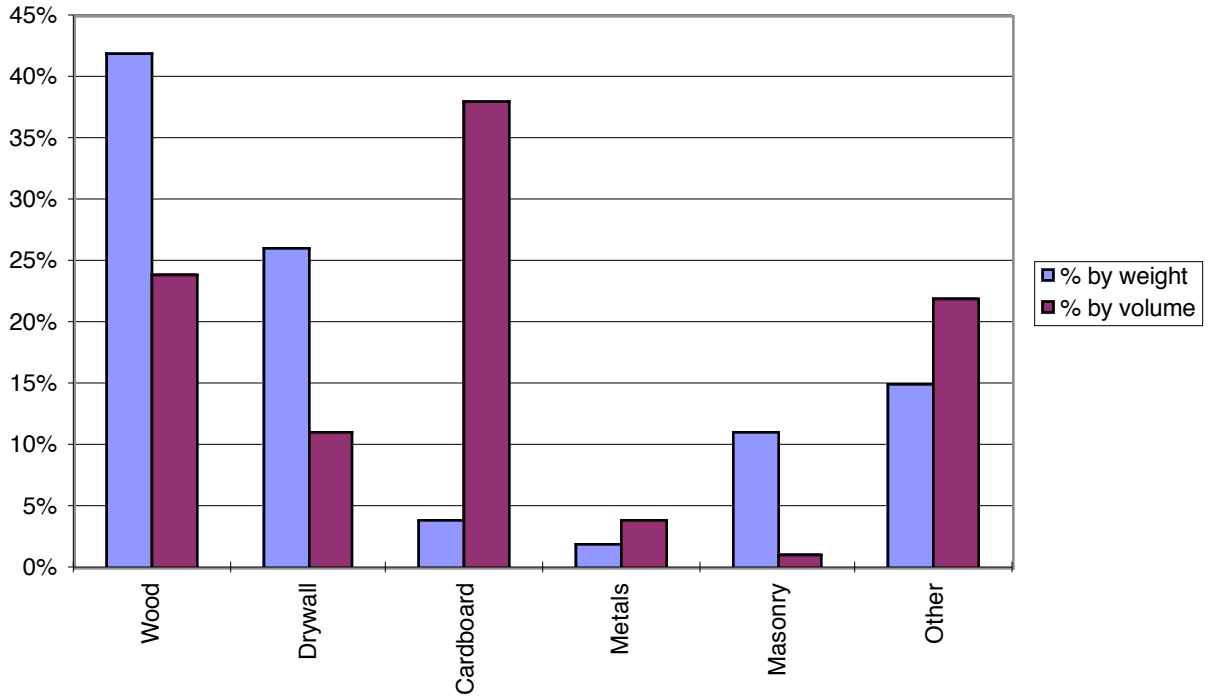
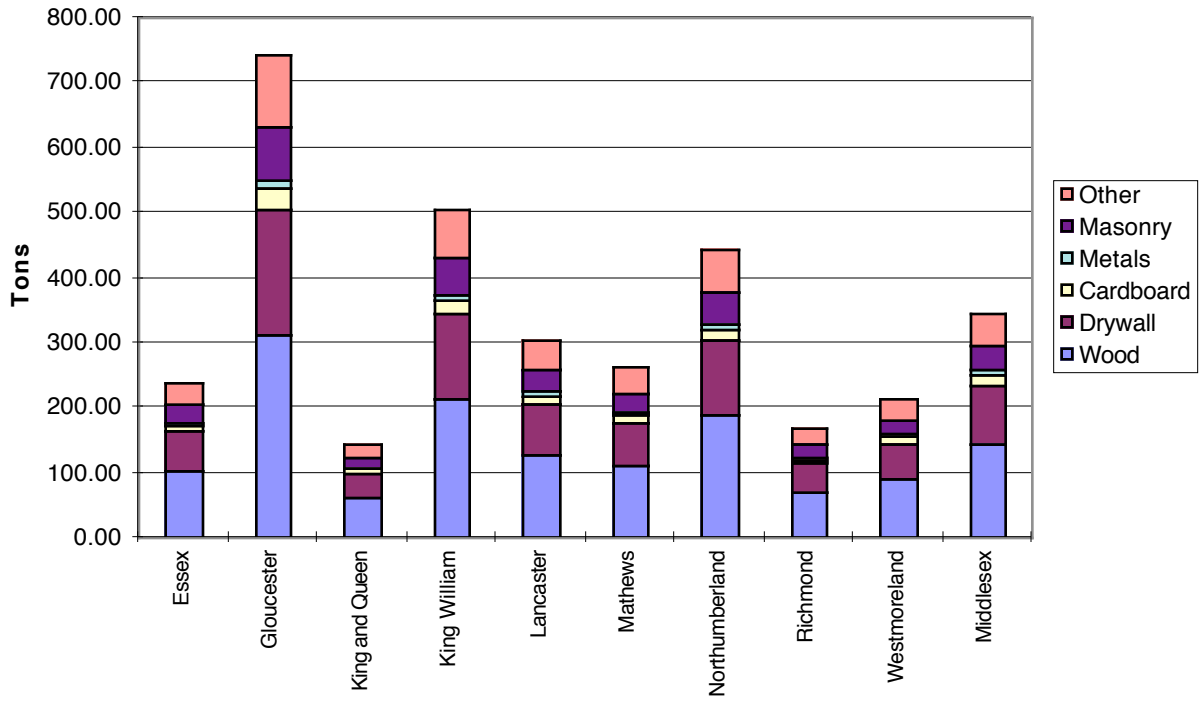


Figure 22. Construction Waste - Residential (estimate)



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materials recycling can often pay for itself in reduced tipping fees or good prices obtained for recyclable wood products.

Agriculture/Forestry/Industrial and Food/Textiles Cluster

We have identified two logical "clusters" of economic activity which could benefit from materials exchanges (see figures on the following pages), without requiring the physical closeness of an "eco-industrial park."

An agriculture/forestry/industrial cluster would enhance the value adding flow of wood products, wood wastes, and paper wastes between the forestry sector, agriculture, and the existing paper mill. It would be facilitated through the materials recovery facility (MRF), an advanced composting operation, and possibly biofuels production or ecological wastewater treatment.

In this cluster, wood chips and scraps from the secondary wood products industry and the MRF would be sent to the compost operation, the paperboard mill, or used as a biofuel. The composting operation would produce soil amendments, mulch, and compost for agriculture, as well as residues for biofuels. Agricultural wastes and crops grown specifically for energy use would become biofuels. By connecting together agriculture, forestry, and industry through these and other flows, the cluster could optimize resource use and minimize overall waste.

The food/textiles cluster could make use of the significant organic wastes from food processing and textile wastes from the textile sector. An operation to sort, process, and separate organic materials (like the one for the first cluster) could produce soil amendments, mulch, and compost for agriculture, as well as animal feed and other products. Textile scraps could be routed to the paper mill, to the composing operation, or to a new niche producer (for example, clothing manufacturers which use textile scraps for specialty clothing).

Nutrient-rich wastewater from the food processing sector could be treated ecologically through a constructed wetland or "living machine" system. This would produce tertiary quality water for habitat and for process reuse, as well as aquaculture and plant products. The possibility of "closed-loop" water systems is extremely attractive for large water users (like the paper mill and the food processors), as it can dramatically reduce costs by reducing water use and improving effluent quality.

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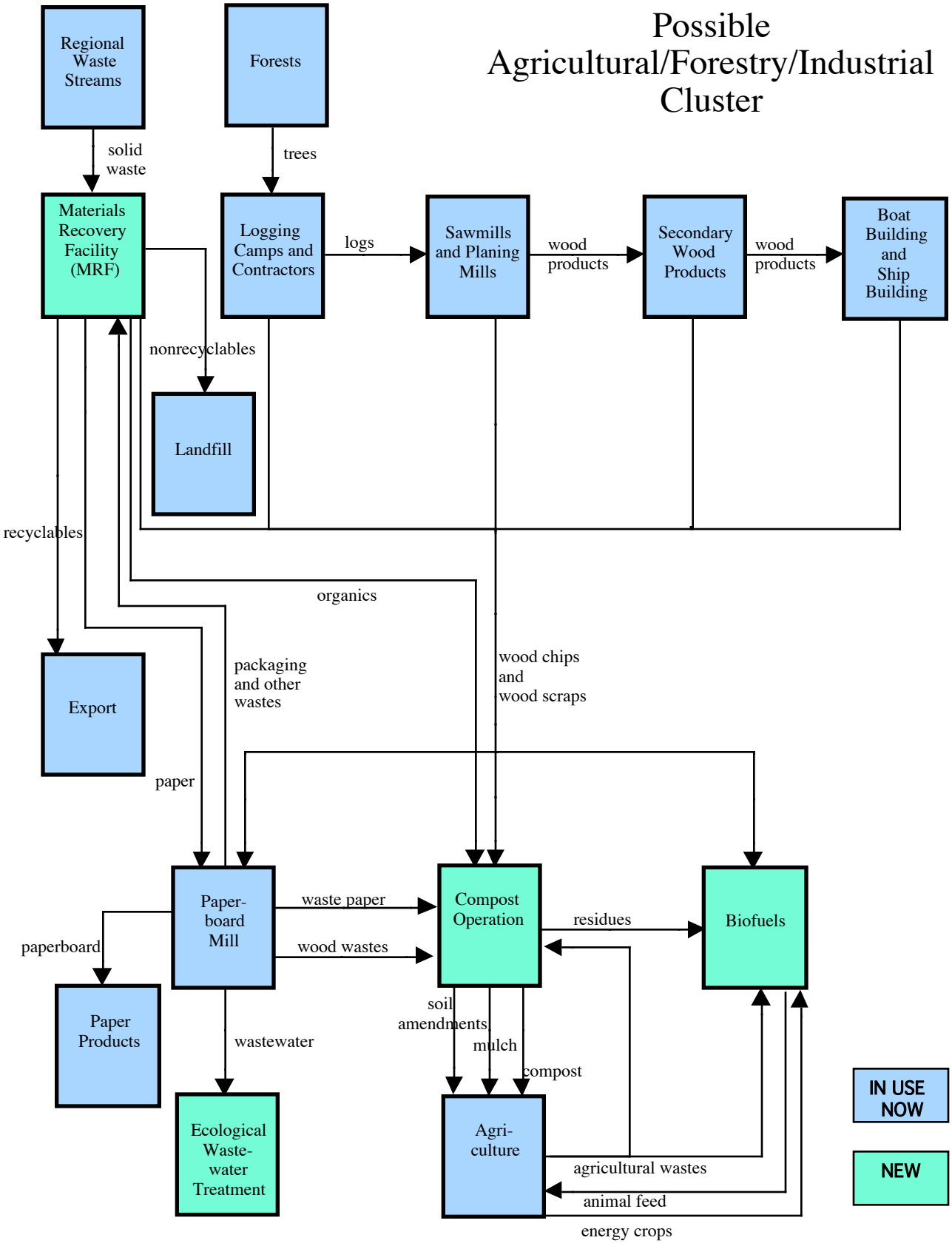
Possible Agricultural/Forestry/Industrial Cluster



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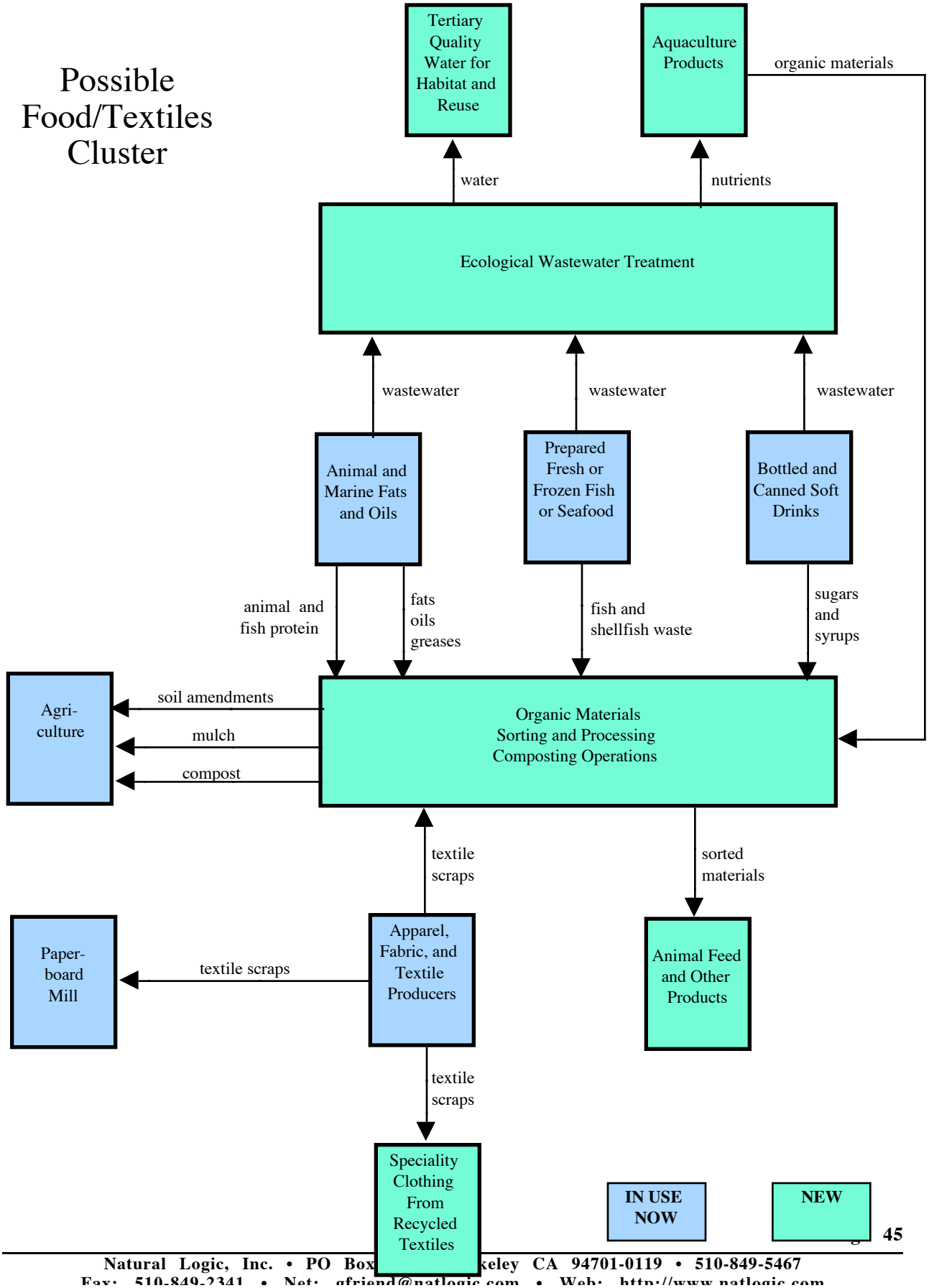
Possible Food/Textiles Cluster



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Existing Waste Exchange Networks

One long standing barrier to effective waste utilization has been information—simply knowing who wants the material you don't want. There have been a number of recent efforts to create materials exchanges, including at least a dozen state-level exchanges in the United States, which allow companies to post detailed descriptions of materials wanted or available. Companies are then free to contact each other and make deals. In some cases, the exchange takes a small commission. These can provide a valuable supplement to local programs. Materials/waste exchanges accessible via the WorldWide Web include:

Name of Exchange	**Web Site URL**
Global Recycling Network	http://grn.com/grn/ora.html
National Materials Exchange Network	http://www.earthcycle.com/g/p/earthcycle
Recycler's World	http://granite.sentex.net:80/recycle

Eco-Industrial Parks

The latest development in industrial parks clusters together compatible businesses which will be able to use each others' waste streams as feedstocks. The best-known such cluster, in Kalundborg, Denmark, includes an electric-power plant, an oil refinery, a pharmaceutical plant, a wallboard factory, a sulfuric acid producer, cement manufacturers, and local agriculture and aquaculture enterprises. A wide range of materials exchanges occur in the cluster, including waste sulfur from the refinery going to the sulfuric acid producer, and fly ash from the power plant going to the cement manufacturers. As a result of these exchanges, as well as "cascading" of waste heat from one enterprise to another, participating companies are reaping substantial cost savings and environmental benefits [Graedel and Allenby, p. 286-7]. For instance, the efficiency of coal utilization by the participating companies has more than doubled.

The President's Council for Sustainable Development has strongly promoted the eco-industrial park (EIP) concept. Parks are in the development stage in Cape Charles, Chattanooga, and Baltimore and more than ten other North American communities. Eco-industrial parks are an excellent form of compatible development because they are compact and can include advanced wastewater treatment and pollution control features.

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4. Import Substitution Strategies

Definition and Importance

Import substitution is the process of replacing goods and services presently imported from outside the region with locally and regionally produced goods and services. This keeps dollars from leaking outside the regional economy, increasing the regional multiplier effect. As the regional economy diversifies, people can meet more and more of their needs without traveling outside the region.

There are two ways of promoting import substitution. The first is to minimize imports of energy and resources from outside the region by improving the efficiency of resource utilization by enterprises in the region through a wide range of measures which are often very good investments in their own right. This "eco-efficiency" approach allows regional businesses to spend fewer dollars on outside resources, instead channeling them to more local investment, employment and spending. The second is to encourage local entrepreneurs and businesses to fill new niches. This process can be enhanced by targeted technical assistance and access to capital, such as are often provided by Small Business Development Centers (SBDC) and Small Business Investment Corporations (SBIC).

Eco-Efficiency Strategies for Import Substitution

Energy Efficiency

Most companies can significantly cut their energy use for lighting, heating, and manufacturing process—often by as much as one-quarter to one-half with energy-efficiency measures which have a payback period of six months to a few years [Romm]. Similar opportunities apply to houses, particularly those constructed before 1970.

Energy efficiency efforts create significant numbers of skilled jobs—typically twice as many jobs per dollar invested as development of new generating capacity [Laitner]. In effect, dollars that used to flow straight outside the region for electricity and oil purchases are now kept inside the region, keeping people employed. Energy-efficiency investments also improve the competitiveness of regional companies, allowing them to run much leaner. Recent evidence also points to productivity improvements as a side effect of energy efficiency improvements.

The main barrier to implementing these measures is a lack of information, training, technical assistance, and help with initial investments. In recent years, the energy efficiency industry has grown significantly. Utility companies often provide efficiency services, as well as direct delivery of

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power and fuels. Energy Services Companies (ESCOs) provide technical assistance, training, and capital investments in new energy-efficient equipment, typically in exchange for some share of the realized savings; for instance, an ESCO might insulate, install new lighting, and upgrade the physical plant of an existing commercial building—absorbing all up front costs —in return for 50% of the energy savings [Van der Ryn and Cowan, p. 89].

Water Efficiency

In the same way, many water efficiency measures often pay for themselves within a few years or less [Romm, RMI]. While the potential economic benefits are less dramatic than for energy efficiency, they can still be significant, particularly for companies in the water-intensive pulp and paper and food processing industries.

Lack of water—specifically water clean enough for industrial use—can be a significant limiting to development in Virginia's River Country. Water efficiency measures, when pursued on a regional scale, can create effective new capacity by can reduce pressures on the existing supply, allowing new development to occur. Improved water quality, as a result of pollution prevention and other programs, can enhance the suitability of water supply to incoming and expanding industry.

Resource Efficiency and Pollution Prevention

Businesses can also decrease their reliance on imports by using materials more efficiently. Getting more product and less waste out of each pound of materials, Btu of energy, and gallon of water is simply good business—why should companies spend on inputs per dollar of value added than they absolutely must? This kind of resource efficiency also creates jobs, shifting dollars from imported resources to local employees, while reducing burdens on the local environment.

Resource efficiency and pollution prevention programs also often have short payback times, though because of lack of awareness many companies still fear pollution prevention measures as "too expensive." Furthermore, companies are understandably reluctant to retool their processes and operations to improve efficiency and reduce pollution only to find that they are now exposed to a whole series of new environmental reviews and required to fill out more paperwork.

The Office of Pollution Prevention of the Virginia Department of Environmental Quality offers technical assistance for companies wishing to explore these options. Far-sighted regional materials policies, such as those in New Jersey and other areas [Institute for Local Self-Reliance and INFORM studies], also make it easier for companies to undertake new investments in resource efficiency and pollution prevention. Regions which can create a regulatory climate favorable to companies which are dealing with their environmental problems in innovative ways will increase their overall economic competitiveness.

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Economic Diversification Strategies for Import Substitution

A number of the economic sectors in Virginia's River Country are ripe for diversification and import substitution. As we discuss in the next section, the agricultural and forest products sectors, which have been stagnating for several years, can benefit from value-added and niche marketing strategies. While mainly export-driven, some of these niche products, like vegetables, can also be used to replace imports. The construction industry may be able to increase its use of local materials.

There is also potential for renewable energy sources in the region to displace some energy imports. While solar is still too expensive for most applications, wind power is rapidly becoming competitive. In addition, some of the region's large agricultural output can be channeled towards organically-derived fuels like methanol and ethanol (next section).

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5. Adding Value Locally and Regionally

Definition and Importance

Adding value locally and regionally refers to increasing the number of processing or manufacturing steps which are applied to locally extracted products. In many industries, the greatest portion of the value resides in these value-added steps rather than in primary production. In the forest industry, it is estimated that three or four jobs are created in the milling and finishing industries for every one in timber harvesting.

Each step of adding value creates skilled jobs and increases revenues. Each step improves the health of a rural economy without causing increased extraction of primary resources, which can commonly lead to adverse environmental impacts. On the Eastern Shore, a concerted marketing effort has led to marketing local vegetables and seafood under the "Eastern Shore Select" label. Many other areas have found ways to forge a strong marketplace identity based on special regional characteristics. Virginia's River Country, with its rich history and varied landscape, has an opportunity to do the same.

Niche Marketing of Regional Specialty Products

Agricultural Products

The agricultural sector has been in decline for several years in Virginia's River Country. Prices for standard crops, including corn, wheat, and soybeans, remain relatively low, and a number of farm subsidies are being phased out. In order to survive, many local farmers are diversifying towards vegetables, grapes, and berries. The regional climate is extremely favorable for a wide variety of specialty crops, and farmers should be encouraged to move in this direction with technical assistance and loan programs.

There is a growing trend for urban areas to establish strong ties with growers in nearby areas. Virginia's River Country is strategically placed to grow for the Washington, D.C. metropolitan area. Local farmers can be helped in their marketing efforts, and the region can tie into nearby farmers' markets and "community-supported agriculture" programs, as well as high value direct distribution to restaurants. This will support more stable income source, with higher produce prices, than can be obtained through standard channels.

Another possibility is to encourage local farmers to practice more environmentally sound farming methods which will allow their produce to achieve differentiation (and better prices) in the marketplace, often while reducing operating costs. This can range from "organic" certification

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(which can lead to a 100% premium in price) to a Nature Conservancy certification offered to Eastern Shore growers who practice low-impact methods.

Finally, a regional agricultural infrastructure which will allow pooled marketing of fresh produce as well as processing and packaging of dried, canned, and frozen foods can be a valuable support for the diversification efforts of small and mid-sized farmers.

Seafood Products

The waters of the Chesapeake region offer a diverse range of fish and shellfish. Despite the recent decline in the oyster harvest, this sector remains important, with its health is tied to environmental quality improvements in all activities that affect water quality. Significant value-added processing already occurs in the region. However, opportunities for further market differentiation and processing remain.

Wood Products

Virginia's River Country has considerable forest resources. While some milling and processing occurs locally, much of the timber is used for relatively low-value products or immediately exported. There are great opportunities to add more value in this sector through local milling and the manufacture of a variety of advanced wood products, including veneers, flooring, and wallboards. Furniture and crafts are other obvious avenues for adding value within the wood products sector.

In addition, there is growing demand for sustainably-harvested forest products. North American Resource Management, an innovative Charlottesville firm, is currently managing a number of important estates and woodlots for sustainable production, including Montpelier, Monticello, Woodlawn Plantation, and Westmoreland Berry Farm. Certified sustainably harvested wood products can fetch a significant premium over standard products, and sustainable harvesting also offers environmental advantages for individual woodlots as well as for entire watersheds.

Agricultural Feedstocks to Industry

Biofuels

A number of rural areas have created strong programs in biofuels derived from local crops. Biofuels like methane and ethanol can be used in suitably modified vehicle engines. The State of Minnesota has developed an innovative ethanol program that includes a strong economic development component, emphasizing small local producers. The program now produces eight percent of the state's vehicle fuels, from facilities owned cooperatively by 25% of the state's farmers [Morris/ILSR]. Farmers earn competitive prices on their crops, high protein residues provide feed

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for livestock, while local fuel generation provides another source of jobs and revenue, displacing some of the need for fuel imports. With 184,000 acres in soybeans and corn alone, the region could easily support significant biofuels production; if the region's entire corn crop was grown for biofuels, it could provide about the equivalent of about one-third of the region's gasoline use.

Inks, Papers, and Other Applications

Soybean oil has become a standard feedstock for a new generation of environmentally sensitive inks. These new inks are nontoxic and have superior printing properties. Vegetable oils are also being increasingly used for surface coatings, pigments and dyes, lubricants, solvents and other applications. Soybean protein and vegetable starches are finding use as glues and adhesives respectively.

Agriculture fibers, both grown for the purpose and waste, are finding increasing use in paper manufacture, including a range of specialty papers.

Plastics

Soybeans, corn, and other starchy crops are being used as a feedstock for a variety of nontoxic "bioplastics." These plastics are in great demand as consumers seek environmentally sensitive alternatives. The Institute for Local Self-Reliance in Washington, D.C. has done a great deal to research and promote a range of industrial applications for agricultural crops and wastes.

Building Products

Wheat straw, in bale form, is now in considerable vogue as a building material. Straw bale walls have very high thermal resistance, up to R-60, and are a cheap alternative to conventional wall systems. Straw bale walls are highly resistant to fire, and have a pleasant sculptural quality. Wheat straw building panels are also being developed. A wide range of agricultural crops and wastes are being used for walls, flooring, and other building systems.

Note:

Diverting agricultural feedstocks to industry is not without environmental costs, since agricultural "wastes" provide important soil building services that can reduce the need for fertilizer, tractor power and other agricultural inputs while benefiting crop yields. It is therefore important to ensure that any harvest of agricultural "wastes" proceed at appropriate rates.

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6. Business Development

Resource Preconditions for Successful Business Recruitment

Successful business recruitment requires adequate infrastructure—including water, wastewater treatment, energy, and transportation—and favorable business conditions, including reasonable costs for land and utilities, straightforward permitting and regulations, availability of skilled workforce, and high quality of life.

By these standards, Virginia's River Country is in a good position to attract small-sized companies (under a hundred or so employees). However, there are severe limits on suitable building sites, often due to water quality and wastewater capacity limits. The abundance of historic buildings, villages, and towns and natural amenities also place strong constraints on development. Therefore, regional business recruitment and planning efforts must be carefully integrated and geared to avoid the hidden costs of careless development efforts.

While Virginia's River Country needs the kind of economic stimulus a successful recruiting effort can provide, it need not sacrifice community or environmental values along the way. It can tailor its effort towards sectors which will balance and diversity the local economy while not straining existing infrastructure or eroding the area's rural character. Instead of pursuing large-scale new infrastructure projects to attract business, the region can pursue eco-efficiency strategies coupled with judiciously chosen infrastructure upgrades.

Virginia's River Country can deliberately recruit businesses which will be socially and environmentally responsible corporate citizens. It can become more resilient rather than increasingly dependent on a handful of sectors. It can seek businesses which will enhance rather than diminish its regional identity. Further, it can recruit businesses which form "clusters" with existing businesses, improving their effectiveness.

Environmental Sector

The environmental business sector is a recently designated and extremely diverse sector, ranging from vendors of pollution prevention equipment to environmental engineering firms; from integrated pest management to environmentally sensitive architectural practices. Businesses in this sector, by the very nature of their work, are economically compatible. This sector is large—representing an estimated $100-200 billion of activity in the US, and $200-600 billion worldwide—and is growing rapidly. The following figure provides a good summary of the sector and its emerging opportunities. Not all will be ideal target businesses for Virginia's River Country, but awareness of these trends may help local planners and developers notice suitable opportunities.

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Environmental Business Universe and Targeting

DOMAINS	BUSINESS ACTIVITIES	KEY SECTORS & STRATEGIC TARGETS
Environmental /renewable energy sources	Renewable energy generation - solar, wind, biomass, etc. Energy storage Demand Side Management Energy efficiency products & services	Renewable energy Energy end-use efficiency -- consulting-services-manufacturing Energy storage - batteries, flywheel
Biology, Ecosystems, Agriculture	Sustainable agriculture Bioremediation Ecosystem restoration	Agriculture - improved (precision, low input) techniques Agriculture - organics Agricultural biotechnology Bioremediation Water/estuary/bay cleanup/ research Ecosystem restoration
Water	Water infrastructure Water utilities Water purification Water use efficiency - DSM, products, services	Waste water treatment Water end-use efficiency Water, estuary & bay cleanup / research
Environmental consulting	Integrative - Strategic environmental management, industrial ecology Information - information systems and software; research services Control - hazardous materials management, regulatory compliance, hydrogeological, analytic services Prevention - pollution prevention, process redesign Engineering - environmental, ecological Other - emergency/risk management, environmental law, training	Hazardous materials-related Strategic environmental management Finance/investment Information services & software esp. emerging regulation, databases, business intelligence Pollution prevention & process redesign Hydro/geological Training & education Manufacturing monitoring, modeling and control
Manufacturing	Products - Monitoring and analytical equipment Pollution control, cleanup and prevention equipment Waste management, recycling equipment Energy equipment Biotech equipment Processes- Process efficiency improvement and process control Information systems and software	 Analytic & pollution control equipment Air pollution control equipment Pollution Prevention technologies Remanufacturing Catalysis Precision fabrication Process innovation & redesign Manufacturing w recycled materials
Transportation and infrastructure	Transportation systems Transportation equipment Vehicles	Transport-related products & services Electric vehicle components Transport alternatives- electric vehicles & alternative fuels
The built environment	Building design & construction Environmental health & toxicology Clean buildings	Indoor air pollution- diagnostics, sensors, remediation

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Environmental Business Universe and Targeting (continued)

DOMAINS	BUSINESS ACTIVITIES	KEY SECTORS & STRATEGIC TARGETS
End user products & services	Publishing & information Recreation & tourism Consumer products Retail Organic food Home energy	Contraception Consumer products
Waste management & control	Solid waste management Hazardous waste management Asbestos Abatement Pollution control	Materials separation technologies and operations Bioremediation Hazmat remediation
Resource recovery	Collection / Recycling services Waste exchange	Recycling Waste exchange Engineering for remanufacturing & manufacturing with recyclables
Remediation/restoration	Remediation and industrial services Restoration	Bioremediation Water, estuary & bay cleanup / research Restoration
Analytical services	Laboratory and testing services	Certification services Real time analytic services

This table is adapted from "Building an Environmental Economy: A Strategy for 'Environmental Business' Economic Development for the City of Berkeley," (Appendix A) by Gil Friend, Ernest A. Lowe, and David Glober. Gil Friend and Associates, Berkeley, California, 1993.

A number of cities, including Chattanooga, Tennessee and San Jose, California, and states, including Massachusetts, Minnesota and Oregon, have targeted business recruitment and development strategies in the environmental business sector.

Compatible Businesses

Other businesses, while not falling in the conventional environmental sector, are nevertheless compatible with Virginia's River Country. Some occur in sectors which intrinsically have low to minimal environmental impacts, including telecommunications, internet applications, and most service industries. Others can be higher-impact enterprises operated as socially and environmentally responsible corporate citizens—or those that complement the value adding strategies discussed above. Effective recruitment strategies are already being developed by Virginia's River Country for these kinds of compatible businesses.

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7. Conclusions and Next Steps

This regional metabolism analysis, while limited by data availability, yields several key findings that may provide useful guides to future economic development in the region. It suggests action in four key realms:

- Eco-Efficiency—maximize the economic productivity of resource use, and leverage existing infrastructure to meet economic development needs
- Wastes into Resources—develop materials exchange networks and clusters for local industry and natural resources sectors that can provide economic development leverage
- Agricultural and Forestry Diversification—target the growing markets for agricultural and forestry products as industrial feedstocks and pursue specialty product niche markets
- Compatible Development and Recruitment—target companies and sectors based on their fit with existing businesses and environmental compatibility, in addition to traditional revenue, employment, and taxation considerations
- Import Substitution and Value-Added Production—diversify the local economy and encourage additional value-added production steps

Eco-Efficiency

The region is currently spending more on energy—funds that are largely exported out of the region—than the entire value-added of its manufacturing sector. This points to resource efficiency as a huge untapped source of jobs and cost savings.

Many energy, water, and materials efficiency and pollution prevention measures offer rapid paybacks (under two years), and at least in the case of energy efficiency offers greater employment intensity than investment in new capacity. The pulp and paper sector is an obvious starting point for these efforts, since the region's largest concentrated energy and water use occurs there.

By systematically supporting the resource efficiency efforts of regional companies, Virginia's River Country can stretch infrastructure capacity much further, while helping maintain or improve environmental quality, which will aid its recruitment efforts. Furthermore, the region's companies will be increasingly competitive as environmental regulations become tougher and consumers continue to demand more environmentally-friendly products. The kind of alternative financial institution identified in Section 2, as well as a wide range of Federal, State and private pollution prevention and Eco-Efficiency programs, may be helpful in promoting eco-efficiency.

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Wastes into Resources

Two key sectoral clusters—agriculture/forestry/industrial and food/textiles—offer great potential for waste matching, import substitution, and local value-added production. Because they are significant both economically and metabolically—nearly 80% of the manufacturing value-added and more than 95% of manufacturing energy and water use (and more than one-forth of *all* energy and water expenditures)—and because their resource flows are compatible, these clusters, or others like them, can serve as a high-leverage focal point for economic development efforts. By building on the synergies and infrastructure of existing clusters, it is possible to improve environmental quality while creating jobs from optimal use of resources.

Economic development efforts should emphasize attracting businesses which complement the clusters, and aid existing enterprises which help make the clusters more effective. For instance, simply creating a directory of all wood-related producers and products in the region would help local businesses find local suppliers.

Waste exchanges of all kinds should be encouraged, ranging from identifying matches of existing waste flows to encouraging complementary businesses to co-locate, as in an eco-industrial park.

Agricultural and Forestry Diversification

The region is ripe for diversification in both the agricultural and forestry sectors, and this process can be facilitated through the clusters. Growing markets for agricultural and forestry products, including such uses as biofuels and biolubricants, construction materials, inks, and industrial feedstocks offer opportunities to improve farm and forestry incomes, diversify the region's industrial base, and strengthen the resource clusters identified above. At the same time, diversification into vegetables and other crops, particularly when accompanied by environmentally sensitive practices, should find local market niches. Value-added processing should also be encouraged in the forestry sector, including furniture production, building materials, and sustainably harvested wood products.

Compatible Development and Recruitment

As the region solidifies its identity through the Virginia's River Country initiative, it has an opportunity to carefully select the kinds of companies it attracts. It can deliberately recruit businesses which will diversify the local economy, which will enhance its regional identity, and which will support existing clusters of activity, and which will be socially and environmentally responsible corporate citizens. While the environmental sector is one possibility for such businesses, there are many other sectors compatible with the region's cultural heritage and natural

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resources. In general it would be worthwhile to consider the resource productivity of target companies and sectors, in addition to traditional revenue, employment, and taxation considerations, to encourage companies that will best contribute to economic growth that is sustainable, both economically and environmentally.

Import Substitution and Value-Added Production

When "hunting" for outside businesses to relocate to the region, "garden" by cultivating local entrepreneurs and businesses. Economic diversification helps keep dollars circulating in the local economy.

Value-added production extracts more dollars from every unit of resources, allowing the economy the flourish without adversely affecting the natural amenities which are so important for local residents and tourists alike. There are significant opportunities for import substitution and value-added production in the manufacturing, agricultural, forestry, and fisheries sectors.

Next Steps

The present study provides a rough baseline of current flows of energy, water, materials, and waste in the region. While it gives a sense of the relative magnitudes of natural, industrial, commercial, and residential flows, detailed local resource data remains scarce, and we often had to rely on extrapolations from similar (and sometimes dissimilar) regions. There is spotty or even conflicting data on waste generation, water use, and energy use. It was beyond the scope of our work to perform a detailed survey of individual local businesses and their resource patterns, and such information is not otherwise available.

In order to act wisely on the conclusions in this report, it will be advisable to perform a considerable amount of "ground truthing" within the region—validating this "bird's eye view" with actual data and day to day experience from specific enterprises.

We have identified several priorities, as well as some interesting possibilities for future exploration. Implementing them will depend both on creating strong partnerships and on detailed feasibility studies in relation to specific business opportunities. Fortunately, there are many resources to rely on (see Appendices 3, 4, and 5) which specialize in areas like waste-based job creation, commercialization of new agriculture products, sustainable and selective forestry, import substitution, and eco-efficiency.

There are many pathways available to Virginia's River Country as it charts a course towards a compatible economic development strategy. Pathways that build on existing regional strengths will maximize economic and quality of life returns, while minimizing capital investments required in both physical plant and public infrastructure.

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Appendices

Appendix 0. Figures Appearing in Report (and Sources)

Figure	Title	Source
1	Value-added by economic sector	IMPLAN data
2	Land use by county	Forest Service and Virginia Agricultural Statistics Servicee
3	Water use by county	USGS and Virginia DEQ
4	Virginia surface waters degree of use support	Virginia DEQ
5	Fish catch by county	Office of the Marine Resources Commission
6	Ratio of timber removal to new growth	Forest Service
7	Value-added in the manufacturing sector	IMPLAN data
8	List of manufacturing sectors	County Business Survey
	Metabolic Efficiency Strategies	GFA
9	Manufacturing wastes and possible matches	industry profiles
10	Solid Waste - Manufacturing Sectors (est.)	
10	Municipal solid waste - manufacturing sector	extrapolated from Los Angeles Integrated Solid Waste Management Office's study
11	Energy use by manufacturing sector	IMPLAN data
12	Energy use by manufacturing sector (excl 26)	IMPLAN data
13	Air emissions - manufacturing	IMPLAN data
14	Effluent loading - manufacturing	IMPLAN data
15	Purchased inputs - top three manufacturing sectors	IMPLAN data
16	Purchased inputs - other manufacturing sectors	IMPLAN data
16A	Expenditures for utilities	IMPLAN data
16B	Expenditures for utilities - manufacturing sector	IMPLAN data
17	Value added efficiency - air emissions	IMPLAN data
18	Value added efficiency - water emissions	IMPLAN data
19	Value added efficiency - electricity	IMPLAN data
20	Recycled and Disposed Solid Waste	County reports
20A	Recycling rates by county	County reports
20B	Municipal Solid Waste Characterization	Rivanna district, Alameda County, USEPA
20C	Municipal solid waste - estimate	extrapolated from national averages
21	Construction waste nationwide	National Association of Home Builders study
22	Construction waste - residential by county	extrapolated from NAHB study and recent housing starts
23	Possible Agriculture/Forestry/Fisheries Cluster	GFA
24	Possible Food/Textiles Cluster	GFA
25	Environmental Business Universe and Targeting	GFA

Note: figures are based on 1990 data, unless otherwise indicated.

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Appendix 1. Summary of Methodology

In undertaking this study, we have relied on data from a wide variety of sources. In some instances, very little detailed information was available on a county by county or business by business basis. For instance, landfill operators are not required to report either overall tonnages or the breakdown of materials entering their facility. In many economic sectors, there are only one or a handful of businesses operating, and it would have been impossible to obtain detailed energy and materials figures without violating their confidentiality.

Our purpose was to get a broad overview of the flows of materials, energy, and water in Virginia's River Country across all economic sectors, and even across the landscape itself. We sought to be as comprehensive as possible, generating a qualitatively accurate picture of the complex tangle of flows in the region. We did not perform site visits of local businesses or administer questionnaires to local residents and business, as this was beyond the scope of the study. Our recommendations and proposals are guides to possibilities; their implementation is of course completely dependent on a detailed understanding of local conditions.

In our study, we have generally relied on three kinds of data:

(1) DIRECT DATA - Exact figures reported by a variety of agencies and other sources. Reporting years range from 1990 to 1996.

(2) EXTRAPOLATED DATA - When direct data was not available, we used reasonable "proxy" data and appropriate conversion factors. For instance, to estimate residential waste generation in each county, we multiplied county population by per capita figures for a similar region. Reporting years range from 1990 to 1996.

(3) IMPLAN DATA - Economic input and output figures were generated by David Tice of North American Resource Management using the IMPLAN model. This model relies on data from 1992 and earlier, and also uses a number of standard estimating procedures. However, it remains a powerful tool, and is widely used by economic planners around the country.

The following list provides additional information on the sources and assumptions used to generate the various graphs and figures which appear in this report.

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Appendix 2. Statistical Reports: Energy, Materials, and Economic Flows

Provided On Disk

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Appendix 3. Further Resources

Alternative Agricultural Research and Commercialization Corporation

U.S. Department of Agriculture, 0156 South Building, 1400 Independence Avenue SW, Washington, D.C. 20250 • 202-690-1633

Venture capital firm that makes investments in companies to help commercialize biobased industrial products (non-food, non-feed) from agricultural and forestry materials and animal byproducts.

American Farmland Trust

Provides help with land-use planning and conservation easements for farmers wishing to maintain their farms.

Center for Compatible Economic Development

7 East Market Street, Suite 210, Leesburg, Virginia 20175 • (703) 779-1728

Provides training services and joint venture opportunities to communities wishing to balance environment and economics.

Ecotrust

1200 NW Front Avenue, Suite 470, Portland, Oregon 97209 • (503) 227-6225

A non-profit which specializes in "conservation-based" economic development. Has undertaken a variety of initiatives designed to bridge economic and environmental concerns, including an environmental investment bank (ShoreTrust).

Gil Friend and Associates

48 Shattuck Square #103, Berkeley, California 94704 • (510) 548-7904

Provides eco-efficiency and ecological audit services to companies, as well as economic development strategies to communities.

Institute for Local Self-Reliance

2425 Eighteenth Street NW, Washington, D.C. 20009 • (202) 232-4108

Works with rural and urban regions on waste-based job creation, including agricultural wastes.

Materials for the Future

The Thoreau Center for Sustainability, The Presidio, San Francisco, California • (415) 561-6530

Helps new businesses and entrepreneurs develop and market materials derived from waste streams.

North American Resource Management, Inc.

P.O. Box 6777, Charlottesville, Virginia 22906 • (804) 975-1390

Provides forest resource analysis services, and emphasizes value-added products. NARM is curently managing a number of historic estates in Virginia.

Ocean Arks International

1 Locust Street, Falmouth, Massachussets 02540 • (508) 540-6801

Implements ecologically engineered wastewater treatment systems.

Rocky Mountain Institute

1739 Snowmass Creek Road, Snowmass, Colorado 81654 • (303) 927-3128

Works with small communities on compatible economic development issues.

University of Virginia School of Architecture

Campbell Hall, Charlottesville, Virginia 22903 • (804) 924-3715

Under the direction of Dean William McDonough, the school is instituting an innovative interdisciplinary program in sustainable design. The University may be undertaking a similar metabolic analysis of the Charlottesville region.

Virginia Eastern Shore Sustainable Development Corporation

c/o Center for Compatible Economic Development above

An innovative for-profit development bank investing in compatible development on Virginia's Eastern Shore.

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Appendix 4. Bibliography

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Appendix 5. Supporting Documents and Disk

These items are included in a separate binder.

1. Disk containing a variety of Excel and Filemaker Pro data files. These files are extensive, and include detailed summaries of the IMPLAN model runs.
2. Alternative Agricultural Research and Commercialization Corporation, prospectus.
3. Center for Compatible Economic Development, *Community•Economy•Environment: A Citizen's Guide to Achieving a Healthy Community, Economy, and Environment*. Center for Compatible Economic Development: Leesburg, Virginia, 1996.
4. Friend, Gil, Ernest A. Lowe, and David Glober, "Building an Environmental Economy: A Strategy for 'Environmental Business' Economic Development for the City of Berkeley". Gil Friend and Associates: Berkeley, California, 1993.
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Appendix 6. Specific economic development opportunites

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I. Agricultural and Forestry Diversification & Value Added (1): Target growing markets for agricultural and forestry products as industrial feedstocks

Opportunity

Existing agricultural crops and residues can potentially be processed locally for additional value added. Some of the possibilities include:

- Corn, soy, alternate crops, crop residues -> biofuels, biolubricants, bioplastics
- Crop residues -> building materials (eg, grain straws -> Strawbale construction)
- Crop residues -> paper (eg, Straw->paper)

The Regional Metabolism report provides estimates of recent crop and crop residue production, and potential energy yields, to use as starting point for feasibility assessments.

Issues

Commodity prices, scale and location of markets, economies of scale of harvest and processing, capital costs of processing equipment, and soil/carbon management.

(Biofuels production from crop residues diverts carbon that would ultimately feed the soil into fuels. A significant diversion of carbon from the soil to gas tanks—or an intensive biofuels program relying on high input agriculture—could boost soil erosion, reduce soil fertility, and build demand for fertilizer and biocides that reduce net energy yields, unless farmers practice efficient, low input, soil conserving techniques.)

Next steps

Contact resources below to help match existing resources with motivated value-added processors. New Uses Council web site maintains searchable database that can help you narrow in on realistic opporunities. ISLR maintains active contact with companies in the region that are potential buyers and/or venture partners for these materials.

Resources:

Neil Seldman, Institute for Local Self-Reliance (ILSR)

2425 Eighteenth Street NW, Washington, D.C. 20009 • (202) 232-4108

New Uses Council

<http://ag.arizona.edu/OALS/NUC/NUCHome.html>

Alternative Agricultural Research and Commercialization Corporation

U.S. Department of Agriculture, 0156 South Building, 1400 Independence Avenue SW, Washington, D.C. 20250 • 202-690-1633

II. Agricultural and Forestry Diversification & Value Added (2): Pursue specialty product niche markets

Opportunity

While Virginia's River Country is an agriculturally rich area, the agriculture is not very diversified. U-pick and farm stands are in evidence in the region, but depend on tourist traffic.

Some agricultural land can grow higher value fresh market products, ideally in conjunction with direct-to-market strategies. Farmers in many near-urban regions are finding significant value added marketing opportunities in selling directly to restaurants, or to coop-like groups of urban residents.

A growing number of "high-end" restaurants now contract directly with growers for direct delivery of fresh produce. Restaurants benefit with higher quality produce at lower prices; farmers gain secure sales and premium prices (and in some cases a return flow of compostable waste).

In Community Supported Agriculture programs, farmers contract with groups of urban residents, typically providing weekly delivery to a central distrbution point, with the urban members handling breakdown and final distribution.

Issues

Ready markets (and market education), economies of scale, farmer experience with fresh market crops, growing season

Next steps

Identify farmers already producing fresh produce and/or interested in doing so; tie in available support from Ag Extension.

Identify "high-end" restaurants in nearby urban centers—Washington, Richmond, Norfolk—that would welcome regular supply of fresh produce.

Contact Community Supported Agriculture Association for information on developing that distribution channel.

Resources

Center for Compatible Economic Development

7 East Market Street, Suite 210, Leesburg, Virginia 20175 • (703) 779-1728

Community Supported Agriculture Association

(413) 528-4374

Agricultural Extension Service

III. Agricultural and Forestry Diversification & Value Added (3): Develop Wood Products Cluster; Improve Sustainability of Forestry Practices

Opportunity

Two key sectoral clusters—agriculture/forestry/industrial and food/textiles—offer great potential for waste matching, import substitution, and local value-added production. Because they are significant both economically and metabolically—nearly 80% of the manufacturing value-added and more than 95% of manufacturing energy and water use (and more than one-forth of *all* energy and water expenditures)—and because their resource flows are compatible, these clusters, or others like them, can serve as a high-leverage focal point for economic development efforts. Economic development efforts should emphasize attracting businesses which complement the clusters, and aid existing enterprises which help make the clusters more effective.

Issues

This is a potentially complex, with one large firm and lots of small firms. An Olympic peninsula (Washington) consortium was one effort that tried to bring together small mills, loggers, furniture makers, craftspeople, for joint marketing, enhance compatibility of materials, etc.

Next Steps

Create and distribute a directory of all wood-related producers and products in the region would help local businesses find local suppliers.

Catalog "waste" flows from these businesses; share with other local businesses, to broker secondary use opportunities.

Contact ILSR (below) to identify other possible purchasers of these flows. Encourage complementary businesses to co-locate near resource generators.

Encourage selective forestry (a/k/a certified or sustainable forestry), both for more sustainable resource managemnt and for premium pricing. (There is precedent for this in the region already, but considerable room for expansion.)

Resources

David Tice, North American Resource Management, Inc.

PO Box 6777, Charlottesville, VA 22906 • (804) 975-1390

Neil Seldman, Institute for Local Self-Reliance (ILSR)

2425 Eighteenth Street NW, Washington, D.C. 20009 • (202) 232-4108

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IV. Improved Solid Waste Harvest

Opportunity

The Middle Peninsula and Northern Neck generate an estimated 94,000 tons/year of "municipal solid waste"—essentially residential, commercial and small manufacturing waste—as well as an estimated 3,000 tons/year of construction and demolition waste from residential construction alone. (Note: These figures extrapolated from national averages; new Virginia legislation will result in better local waste stream data in coming years.)

In addition two major landfills import an esimated 4000 tons/day.

While recycling efforts are in place throughout the region, Virginia's statewide recycling rate is approximately 15%, well below targets; a considerably larger fraction of the solid waste stream is theoretically recoverable and/or compostable (including paper 33%, other organics 35%), as well as plastics 11%, glass and metals 10%.

Issues

This activity is very dependent on markets & price volatility, economies of scale, cost of separation, feasibility of better segregation (supported by better public education), and may be more significant as a support to other secondary materials based industries, and a job generator, rather than as a large profit center in its own right. On the other hand, since recycling mandates may drive activity in this area, the region might as well pursue those mandates with economic development benefits in mind.

Next

Develop locally specific characterization of solid waste flows, and data on current collection/recycling programs.

Contact specialists in small scale resource rcovery programs to explore economic feasibility and design of more intensive programs.

Resources:

Dan Knapp, Urban Ore Inc.

1333 Sixth Street, Berkeley, CA 94710 • (510) 559-4454

Neil Seldman, Institute for Local Self-Reliance (ILSR)

2425 Eighteenth Street NW, Washington, D.C. 20009 • (202) 232-4108

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V. "Constructed Wetlands" and "Living Machine" WasteWater Treatment

Opportunity

Nutrient rich waste water—especially from paperboard mill and food processing companies—puts a stressful environmental burden on waterways and estuaries, and potentially avoidable cleanup expense on the generating companies.

Advanced ecological waste water treatment systems have been shown to produce clean water at lower cost than other alternatives, and in many cases produce other marketable products as byproducts. Secondary products could include aquatic plant biomass for composting or energy generation; ornamental horticultural plants; long fiber plants (eg papyrus, hemp) to feed back into paper production; and marketable fish and shellfish.

Constructed wetlands are less capital intensive, more land intensive, and less optimized for secondary products. Living Machines™ (a product of Living Technologies, Inc.) are more capital intensive, less land intensive, and more optimized for secondary products.

Constructed wetlands have been used for wastewater treatment systems in a variety of climates, with application ranges from small rural communities, such as Mt. Angel, Oregon, to large urban areas, such as Phoenix, Arizona. Living Machines™ have been installed both as municipal wastewater treatment sytsems (eg Providence RI) and as industrial wastewater treatment systems, especially in the food processing industry.

Issues

General design issues concern flow rates, nutrient concentrations, and matching suitable species to those factors. Living Technologies CEO Michael Shaw reports that they have "done some bench scale work successfully [with pulp and paper wastes] but nothing full scale. Flows tend to be very large and lignums are slow to digest. However effluent temperatures can be good."

Resources

Michael Shaw, Living Technologies, Inc.

431 Pine Street, Burlington, VT 05401 • (802) 865-4460 • michael.shaw@together.org

Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural

D.A. Hammer, ed. Lewis Publishers, Inc.,1989, Chelsea, Michigan)

VI. Regional ecoefficiency—maximize the economic productivity of resource use, and leverage existing infrastructure to meet economic development needs

Opportunity

The region is spending more on energy—funds that are largely exported out of the region—than the entire value-added of its manufacturing sector. This points to resource efficiency as a huge untapped source of jobs and cost savings.

Many energy, water, and materials efficiency and pollution prevention measures offer rapid paybacks (under two years), and at least in the case of energy efficiency offers greater employment intensity than investment in new capacity.

The pulp and paper sector is an obvious starting point for these efforts, since the region's largest concentrated energy and water use occurs there. Sector has reportedly already undertaken ecoefficiency initiatives, but additional opportunities likely remain—in energy and water efficiency, materials substitution and process changes. (A new book from MIT Press——highlights changes and opportunities in this industry.)

Issues

Cost-effective outreach and technical assistance to the region's small and mid-sized firms—probably best provided at regional rather than county level—is essential, since these companies rarely have the resources to track the eco-efficiency field, or to design and implement their own improvement programs. Fortunately, both models and support may be available from fedral and state voluntary programs.

(Note: This could be a potential project for a regional partnership under Regional Economic Competitiveness Act.)

Resources

Gil Friend and Associates

(see also our Web site for extensive Pollution Prevention & EcoEfficiency links)

Elizabeth River Project—regional P2+EE outreach program

109 E Main Street Suite 305, Norfolk VA 23510 • (757) 625-3648

Virginia DEQ/Office of Pollution Prevention

PO Box 10009, Richmond VA 23240-0009 • (800) 592-54VA

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VI. Regional ecoefficiency

Resources

[continued]

US EPA/DOE voluntary programs (eg Climate Wise, Green Lights, Motor Master, etc) offer technical and financial support:

Climate Wise:
Gerald Kotas, USDOE (303) 275-4714; Pamela Herman USEPA (202) 260-4407
Motor Challenge Clearinghouse
PO Box 43171, Olympia WA 98504-3171. Hotline (800) 862-2086
EPA's Design for Environment program (metal finishing industry).
Jean E Parker (202) 260-0667
SBA's Energy and Conservation Loan Program (or the SBA's Pollution Control Loans)
(800) 827-5722

Energy Service Companies (ESCOs) provide financing for energy efficiency improvements
Many companies exist; service offerings should expand as utility dereglation takes effect.

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