APPENDIX E CONSULTANT REPORT

A Technical Report on Issues Associated with

Determining Value-Added and the Economic Impacts of Recycling Industries in the United States

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For the

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Introduction

This report addresses issues associated with determining the economic impacts of the many components of the recycling industry in the United States. There are three specific topics that this short report addresses:

- Defining value added as it is applied to both the recycling industry and the reuse industry in specific geographic areas.

- The appropriateness of RIMS II[2] tables (or other appropriate input-output systems) to estimate economic impacts of support firms to the recycling industry or manufacturing firms utilizing recycled materials.

- Methods for applying RIMS II models (or other appropriate input-output systems) to discerning the economic impacts of recycling and reuse industries.

The main report contains detailed recommendations for determining important economic information relating to the several dimensions of recycling and reuse in the U.S. This short report offers additional information on determining the value of recycling industries, not just in the aggregate but with regard to their linkages to other industrial sectors. In so doing, and in addressing the three specific topics listed above, we will make a case for gathering information that allows for an inter-industrial accounting of the recycling industry in the U.S. and its potential *impact* on other industries and on households.

I. Defining Value-Added as Applied to Recycling and Reuse Industries

Up to the point of its last use, every commodity has value added to it as it passes through successive industrial activities. Value-added is very good measure of the worth of an industrial activity because it closely approximates gross regional product. We measure the "value" of value-added as the amount of income and wealth generated in the industrial processes associated with each stage of production of a particular commodity. Income and wealth are measured simply as wages, salaries,

[2] RIMS referred originally to the Regional Industrial Multiplier System, which was based significantly on the work of Daniel H. Garnick (see "Differential Regional Multiplier Models," Journal of Regional Science, February 1970, pp 35-47) and Ronald L. Drake (see "A Short-cut to Estimates of Regional Input-Output Multipliers," International Regional Science Review, Fall 1976, pp 1-17). RIMS II is now known as the Regional Input-Output Modeling System. The system consists primarily of regional-specific and industrial-specific input-output multiplier tables encompassing some 500 U.S. industries. These multipliers reflect industrial earnings (salary, wages, and normal benefits values), employment, and output (as measured by total sales). RIMS II multiplier tables can be tailor-made for any configuration of counties or states in the U.S., and they are obtained directly from the Bureau of Economic Analysis (BEA).

normal benefits, profits, and returns on equity. In short, we can describe value added as returns to workers, returns to the owners of industrial capital, and returns to governments.[3] An even simpler measure of value-added is the gross output of a firm (as measured by sales, gross receipts, and other operating income plus inventory change) minus intermediate inputs (the consumption of other goods and services that are purchased from other industries)[4].

Determining value-added in the recycling industry may appear to present some difficulties, although in practice should not. Recalling the simple definition of value-added above, we know that the sale of a recycled commodity minus its intermediate costs will yield a measure of value-added. The challenge for studying value-added in recycling is identifying the overall cost of intermediate inputs. The challenge is heightened by an absence of information on whether the collection and processing of different recyclable commodities entails significantly different inputs. The challenge is further heightened when we realize that in some instances in the recycling industry the gross output as measured by sales do not exceed intermediate costs when all public and private investment in the activity is considered.

Value-added is sometimes misunderstood; it represents no more than the potential amount of money or realized wealth that finds its way into the economy as a result of some commodity production process. Accordingly, it is a reasonably good measure of productivity because it demonstrates the overall payments to the primary factors of capital and labor relative to the sector's gross output. Value-added is sometimes characterized as a measure of economic benefits of an industrial activity in a particular region. In the main, however, caution should be used when interpreting value added and net regional economic gain: gains in one sector, like recycling, can always accrue at the expense of another, like mining or refining; gains in one region may come at the expense of another.

Focusing on total value-added also detracts from the more important elements of determining the values. The key to value-added and the potential total worth of an industrial activity is detailed analysis of the intermediate inputs necessary for the production of a particular good. In so doing we understand not only the types of industrial inputs necessary for production but also the value and regional strength of those linkages. Stated differently, when we know the intermediate linkages to a particular recycling industry, we then know that increased value-added in one sector entails additional value-added in other sectors of the economy. The additive impacts

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[3] **We include indirect business tax payments to state, local, and federal governments as components of value-added, but we exclude income taxes and taxes on profits. These taxes consist primarily of excise and sales taxes paid, usually, by individuals to businesses as a part of the normal operation of a business.**

[4] **This definition borrowed from the Bureau of Economic Analysis, U.S. Department of Commerce.**

regionally represent the full economic value of an industrial activity to an economy.

In general, the determination of total value-added within the collection/processing dimensions of the recycling industry is straightforward: gross marketings minus the cost of inputs equals the industry value-added. Unfortunately, we often must calculate the values with the costs of inputs as unknowns. Surveys often tell us the value of sales and payroll costs. We apply rule-of-thumb estimates to profits or returns on investments and tax payments to arrive, circuitously, at an estimate of total value added. We are further confounded in the recycling sectors because of the nearly total absence of good information on the economic performance of recycling firms. Finally, we are stymied on the collection side because we have difficulty differentiating private transactions from public transactions: Households and firms generally pay to have their refuse removed. The intermediate costs of removal include tipping fees in the case of landfilling or the costs of sorting, shredding, crushing, baling, or otherwise processing in the case of collection and processing. At the local level, the increment to value-added attributable to recycling may be only marginally more than had been the case historically when recycling was less prevalent and most recyclables were landfilled.

In a study done with R.W. Beck in the state of Iowa[5] we were very careful to begin our determination of value-added and economic impacts at the processing level. Our reasoning was that on a local basis the labor and capital necessary for collection represented only a minor change if any from the labor and capital necessary for landfilling. This reasoning assumes that solid waste management whether for households or industries is a desirable and necessary social good that in and of itself is subsumed within all social costs paid in a region. Stated differently, mere collection *and* **landfilling was with regard to a regional economy undifferentiated from collection** *and* **storage for processing and therefore no additional or meaningful value-added was generated. Value-added activity began once the waste commodity was purchased for processing and re-introduced as an intermediate commodity. Thereafter, the recycled commodity became a substitute for some other intermediate commodity in the industrial process. It had a market value at that point.**

Reuse industries present no particular problems with regard to determining their unique value-added given the definition listed above and the characterization of these firms in the main study. Remanufacture and wholesaling all yield straightforward economic information in that they purchase recyclable products of some form, add value to them either through remanufacture or selective salvage, and then resell the goods. In analysis, however, we must either know these firms' intermediate costs along with sales or we must know these firms' labor costs, profits, and returns on

[5] "Economic Impacts of Recycling Study," for the ReCycle Iowa Program. R.W. Beck, Ames Economic Associates, and Andrew Reamer and Associates, January 1997.

investments. To each must be added some estimate of indirect tax liability.

A practical guide to determining value added by industry type may in fact be impractical. Each industry's production functions are somewhat different. Failure to acknowledge those differences will result in averaging the impacts across industrial sectors and regions that in fact may not have been affected by the presence of a recycling firm or by industrial or household demand for a recycled product. Through careful use of census of industry data collected by the U.S. Department of Commerce, analysts may be able to determine some prototypical industry types that reasonably approximate the industrial processes associated with recycled goods processing or reuse. Some industries such as paperboard manufacture, metals recovery, wood pallet manufacture, tire retreading, and used merchandise stores have distinct SIC codes for which good economic data exist for determining the characteristics of value-added. Use of the 1992 census of industry information will readily yield much of the value-added for some recycling and reuse industries. For other types of recycling activities, economic analysts must either rely on reasonable estimates of value-added or they must rely on the spattering of economic survey information available about firms that are involved with recycling.

Without recycling industry-specific information, however, analysts will necessarily rely on indirect, incomplete, and potentially misleading measures of value-added. Estimating value-added this way will involve imputing gross output, average employee compensation, returns on investments, and indirect taxes from more readily collected values, such as the numbers of employees that a firm has. A more reasonable and short term approach to the problem would be the administration of a survey of selected recycling industries to provide the necessary detail that would allow for adjustments to the direct requirements of these firms and the re-estimate of the input-output accounts for a particular region. The survey would give valuable information on the returns to capital and returns to labor expectations for these industries, and would allow planners and decision makers to more reasonably determine expected value-added per type of recycling firm.

II. The Appropriateness of Using Fixed Multipliers to Estimate Recycling Industrial Impacts

Part II deals with the appropriateness of using RIMS II or other industrial multipliers for a region to determine the total economic impacts of a recycling activity considering either support firms (intermediate input suppliers) or manufacturing firms (end users). It is relatively common to use RIMS II type multipliers to estimate the expected economic impacts of particular types of industrial growth. It is further possible to apply these multipliers in an additive fashion to estimate the impacts of one firm's output on the output of firms that supply commodities and services to the

primary firm under study. In doing this we are measuring the total indirect impacts of a firm's presence in the region and within a particular economy. By adding up all of the direct and indirect employment and earnings impacts we can then apply household spending multipliers to arrive at the induced or household effects of a particular type of firm. The sum of the direct, indirect, and induced effects constitute the total economic impacts of a firm in a region. These effects can be stated in the forms of industrial output, income and its components, total value-added, and jobs.

Imagine a firm that builds dining tables out of oak. To make its product it needs oak lumber, other products necessary for carpentry of the tables, labor, equipment, and capital goods. For every $1 of gross sales we can estimate how many direct requirements are needed to manufacture tables and chairs. We may know that $.35 goes to the purchase of lumber, $.30 goes towards the purchase of all labor, $.15 goes towards the purchase of all other remaining inputs to production, $.05 goes towards indirect business taxes, and the remaining amount, $.15, constitutes profits and returns to investors. Because $.35 of every dollar in sales is paid to the lumber industry we must then look at its inter-industrial relationships. We would do the same with all other inputs to find out which industries in the region were stimulated when their sales increased. We would keep doing this until (1) we had not double counted any of the values in the region of study and (2) we were satisfied that we had captured as many of the regional effects as were practical. Provided that all of the input firms were relatively clean or pure types of industries that were captured regularly by the quinquennial economic censuses, then using standard industrial multipliers to determine regional impacts is a valid approach to compiling economic impacts.

Now imagine a firm that reprocesses recycled plastics and manufactures outdoor tables and chairs. The type of product produced may not be qualitatively or functionally different than the fine oak dining table listed above, but most of the constituent inputs to manufacture the product are significantly different. Without knowing details of the firm's inputs we would need to look at both the furniture and the plastics manufacturing sectors to elicit clues about the general inputs of the firm. We would further need to know the relationship of the firm to the suppliers of the recycled plastics and, further, those firms' relationships to their suppliers of inputs and demands for labor. This whole process breaks down over and over again because there are no reliable U.S. data on the gross output of recycling industries nor are there reliable U.S. data on the commodity demand for recycled content by traditional and not-so-traditional U.S. industries.

Inter-industrial commodity production and demands are contained in the "Benchmark Input-Output Accounts for the U.S. Economy, 1987,"[6] which are

[6] **1992 figures are scheduled to be released sometime in early 1998.**

compiled and maintained by the BEA. These accounts are based significantly on the economic censuses that are conducted every five years plus a host of other data that are collected by federal agencies. The key components of input-output tables are the "make" tables and the "use" tables. These tables identify which industries *make* **which commodities and which industries** *use* **which commodities in their production processes. All commodities produced equal all commodities demanded. In a static environment, then, when we alter demand for a particular commodity, that change ripples through industrial relationships and influences the overall demand for other commodities, which in turn influences demand for labor and household consumption. This is the crux for I-O tables and the basis for RIMS II multipliers.**

In the U.S. at present, we do not include most recycled goods processors or firms as specific industries or commodity suppliers. Accordingly, we do not know what inputs these firms depend on for the manufacture of their commodities nor do we know the indirect effects on these firms as they may relate to upstream users of their products. The problem is further complicated in some industries because there may not be much overall outward difference in manufacturing processes of one industry that makes a product from natural resources versus one that does so from recycled products. An accounting of the inter-industrial linkages for these sub-sectors has, of course, also not been done. Therefore, recycling impacts on support industries or the impact of end-users on recycling processors can only loosely be estimated from existing, broad industrial-average multipliers.

In the two examples above we do not know whether any recycled-content products are included in the manufacture and distribution of the oak tables and the overall value of the outdoor table manufacturer's linkages to other firms in the U.S. economy including its economic linkage to the supplier of the recycled plastics. Because we do not know these indirect relationships, any impact assessments would be incomplete and inaccurate.

III. Methods for Applying Multipliers for Determining the Economic Impact of Recycling

Measuring economic impacts has become a commonplace form of economic analysis over the past decade. Much of the demand for economic impact assessment stems from regional or structural economic changes. Decision makers are interested in the dollar and human impacts of the economy's ebbs and flows. A reliable method for measuring economic impacts requires the use of national and regional input-output accounts. The strength of I-O analysis hinges on both the flexibility and the logic of its design. I-O measures the value of transactions for all consumption in a study region for a specific period of time. I-O analysis is similar to classical financial accounting in that the economic accounts track industrial purchases of commodities and, simultaneously, industrial production of commodities. The power of this method

is that it is an economy-wide measure of change; it measures the ripple through the economy, both positive and negative, when output in one sector changes.

Input-output analysis also has its detractors. For one, an I-O model represents just one point in time. Unless the data comprising the model, and all of the underlying econometric assumptions, are current, the model may not reliably describe some industrial changes well, especially those that have undergone rapid technological change, like the printing industry. There are, too, a host of other assumptions that must be accepted when using most I-O models: (1) industrial expenditures, a firm's production functions, are assumed to be constant irrespective of the scale of production; (2) there are no supply constraints, and output is determined only by demand; (3) a fixed commodity input structure does not allow commodity substitution – that is, as the price of inputs change the models can not assume the introduction of substitutions; and (4) output in each sector is homogeneous – an increase in the production of one good will lead to an increase in all other goods that the industry produces.

These are not insurmountable restrictions for most I-O accounts because the flexibility of I-O allows you to compile industries and commodity production into finer and finer subdivisions. To accomplish this, I-O practitioners utilize non-secondary data sources, usually survey information, to determine production functions much more finely than may be the case in standard I-O models. RIMS II is a type of I-O model that is not readily amendable in that purchasers of the model receive the mathematical findings of the I-O process and not the means of determining the findings, which is not usually the case with other I-O systems that applied economists utilize. RIMS II type multipliers whether compiled with regional sensitivity or with industrial sensitivity are normally used by planners and program development groups who are mandated to consider the broad potential economic impacts of a particular course of action, like a base closing or the construction of a hydro-electric facility.

Ideally, analysts of the recycling industry interested in testing potential economic impacts considering different structural or industrial growth scenarios would utilize an I-O model that was reasonably current and able to accept modifications. Most commercially available I-O impact assessment models allow for significant revisions of several of the above-mentioned limitations. These revisions are made when new information is gathered about the direct requirements of an industry. The new information is usually gathered because of some dissatisfaction with the aggregates that are compiled by the BEA and Census Bureau in their respective surveys of business. To compile the data a survey is administered that goes beyond the traditional questions of sales, employment, and payroll. The ideal survey asks in as much detail as possible all of the costs of production for the firm. By so doing, more sensitivity to inter-industrial linkages can be established. Once the data are apportioned appropriately, the I-O accounts can then be re-run and a re-balanced regional model

is then produced. Once done, very reliable economic impacts can be compiled of the industries of interest as we model simulated or actual changes in their output or their respective manufacturing requirements.

A properly fashioned input-output model containing detailed information about the recycling industry would produce much more valid representations of the worth and economic impact of recycling than would existing models or standard industrial multipliers, as evidenced by RIMS II tables. Advocates of this approach to developing hybrid I-O tables that combine secondary and primary information indicate that it is not necessary to compile an exhaustive set of inputs; instead, analysts need to focus on the key input sectors that are distinguishable from other kinds of firms,[7] recognizing that most of the others are quite typical or comparable to nearly all other similar firms. RIMS II does not allow you to modify the direct or total requirements characteristics of your industries.

Commercial models or models that are manufactured by economists out of the national input-output benchmark tables are, however, very amenable to modification. Commercial models usually produce all of the information that RIMS II models produce. In addition, the commercial models produce all of the "assumption" tables; that is, all of the assumptions and factors used to generate the regional model are in evidence. This eliminates the "black box" characterization of these models and the common belief that they are primarily stylized mathematical systems that have only an indirect relationship to a region's economy. Commercial models or models manufactured by economists will give information on direct, indirect, and induced impacts associated with industrial output, several components of income, value-added, and jobs. By so doing, these models also produce the appropriate multipliers to be applied for determining the total economic effects of a firm. The difference between these multipliers and those produced by RIMS II are not of method; instead, they have been produced with increased sensitivity to the inter-industrial linkages of the industries under study.

The rules of impact assessment with regard to industrial output in the recycling industry and the outcome from the assessments are no different than would be the case for a non-recycling industrial assessment. A change scenario must be specified taking into consideration either a direct change in regional production by an industry, changes in the factors of production, changes in household consumption, or changes in taxes. Next, the analyst must specify a cogent region for analysis. If the region is too small then the full impacts will not be identified. If the region is too large too many impacts may be inferred in the primary impact community. Finally, the analysts

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[7] See for example the work of Geoffrey Hewings, as in his "Design of Appropriate Accounting Systems for Regional Development in Developing Counties."" Papers of the Regional Science Association, 7, 1983. pp 179-96.

must adjust the model to reflect actual inter-industrial linkages in the region. For example, the opening of a meat packing plant in a county may not yield meaningful increases in meat production in a particular region nor will it lead to increased local consumption of meat. The opening of a plant that uses recycled content in a community will not likely increase the amount of regionally-collected recyclables. Accordingly, if linkages like this were established in the original I-O tables, they would have to be offset in the scenario development and subsequent analysis.

A significant problem emerges when analysts or policy makers infer economic benefits from regional economic impacts. Economic benefits and economic impacts are two quite distinct economic outcomes.[8] Economic impact refers more properly to the overall role that a particular industry may play in a region's economy. It measures the relationships and linkages among institutions, regional commodity production and supply, regional propensities to purchase locally manufactured goods and services, along with households and institutions.

Economic benefit is a different measure altogether. Economic benefit accrues when some change in government activity or in industrial technology allows for the accumulation of consumer surplus in the economy relative to some base condition. For example, if a government builds a road that allows for a significant reduction in the transportation costs of goods and services between two regions, then, in general, a consumer surplus is generated in the form of lowered costs for goods destined for intermediate and final demand. Because costs are lowered, households can consume more of a good without sacrificing consumption of any other goods.

When impacts are measured in the several types of industries that constitute recycling in the United States, several issues need to be addressed before any economic benefits can be inferred:

Are the benefits regional or ubiquitous? Any recycling firm with a positive margin will appear to generate value-added locally. A much more important question remains as to whether the overall effort of collection and processing is economically efficient absent the hidden public subsidies associated with recycling.

A much larger concern involves the economic impacts of the substitution of a recycled commodity for one that is produced from virgin stock. In economic development parlance, the production of any good in any region that substitutes for imports generally results in localized economic gains. In the instances of imported oil to manufacture plastics and of bauxite to make aluminum, it is clear that increasing

[8] See, for example, Stephen C. Cooke, "The Problem: Using Value-Added Information in Benefit/Cost Analysis," in Daniel M. Otto and Thomas G. Johnson (eds), Microcomputer-Based Input-Output Modeling; Applications to Economic Development. Westview Press, Boulder, CO., 1993. Pp 47-56.

recycling makes tremendous economic sense. Reductions in the harvest of renewable resources versus recycling, such as might be the case in the production of papers and cardboards is an area that might require much more careful study. Another concern would involve the underutilization of efficiently-produced renewable resources in favor of recycled products. In the long-run, economic factors will determine which mix of recycled and virgin products are involved in the production of intermediate and final goods. Still, shifting from one input to another entails output gains in one sector and output losses in another. Unless all of the gains are offset with all of the losses, the potential economic benefit or loss of a course of action is not well understood. Gains in one region may come about as a result of losses in another.

Another concern is temporal. The slow and steady increase in recycling in the U.S. does not constitute a radical shift in industrial production. There is no before and after in a modern sense. Instead, recycling and reuse industries have emerged with socially separate identities than might have been the case in the past. We now have many more industries that amass and process recyclables as intermediate goods than we did in the past. We now have many more manufacturing firms that in varying degrees include recycled content in the production of their finished goods than was the case a decade ago. We now have wholesalers and retailers that redistribute salvaged items, though we have always had second-hand, consignment, and salvage dealers. In short, the impact of recycling is a function of the definition of what constitutes recycling and when the analysis is done. Much as in 2 above, however, it may be hard to "net" the temporal gains.

In summary, were input-output models employed in determining recycling economic impacts in the U.S. and within its several regions, significant survey information would need to be collected so that the industrial production characteristics of specific types of recycling activities were better known. This survey would not necessarily need to differentiate spatial differences, but it would have to be of sufficient size so that critical differences among the various types of collectors/processors and users of recycled products were well documented. Given the willingness of the U.S. Department of Commerce to include recycling industry questions in their upcoming surveys, it may be also possible for a special survey of at least a critical subset of recycling firms in the U.S. Perhaps an appropriate way to determine this critical subset is by both total value and the mass of product recovered. In so doing, a hierarchy of industries will emerge that can be surveyed over time.

Input-output models are not value-neutral nor fail-safe. They are very much dependent on the skill of the analyst involved and the quality of the research scenarios that are developed. Still, I-O models could be used very effectively to study national and regional economic impacts and net economic benefits associated with the emergence of a recycling economy. By combining established U.S. input-output tables with a survey of recycling industries in the U.S. we:

- determine the true industrial requirements for producing recycled commodities,

- establish the actual inter-industrial production linkages associated with the production of recycled commodities and the use of recycled commodities in the production of final goods,

- increase our ability to calculate net benefits, especially as technology changes and as input levels change among industries producing and demanding recycled commodities, and

- will understand, ultimately, the internal economies associated with various aspects of recycling in the U.S.