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Overview of Existing Studies on Community Impacts of Land Reuse

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Overview of Existing Studies on Community Impacts of Land Reuse

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Abstract: The productive reuse of properties that are contaminated by hazardous substances has been increasingly emphasized by the U.S. Environmental Protection Agency and state and environmental agencies. As reuse on contaminated sites has grown, the documentation and analysis of the beneficial effects of such reuse also has expanded. This paper reviews the existing literature on the effects of reuse—summarizing the principal studies, measures of beneficial effects, and associated data—and discusses conceptual issues and difficulties that need to be addressed when estimating the beneficial effects of reuse. Studies included in the review represent a range of scales from the national to the local level and four different methodological approaches (routine data collection, case studies, survey-based methods, and analytical approaches). Directions for improving estimation of the beneficial effects include a wider variety of metrics for capturing the effects, an increased emphasis on the distribution of these effects, and a more rigorous economic accounting perspective.

Keywords: Land reuse, community impacts, hazardous substances

Subject area classifications: (8) Hazardous waste; (59) Economic impacts

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1. INTRODUCTION

The reuse of sites that are contaminated or are thought to be contaminated is not a new phenomenon in the U.S. In the last several years, however, such reuse has garnered significantly more attention from the U.S. Environmental Protection Agency (EPA) and state environmental agencies, most strongly from federal and state brownfields initiatives but also increasingly from other regulatory programs dealing with underground storage tanks, federal and state Superfund sites, and facilities under the Resource Conservation and Recovery Act. At the federal level, interest in reuse is illuminated perhaps most sharply by EPA's Land Revitalization Agenda, which seeks to integrate reuse into the remediation process across all EPA cleanup programs.

As reuse has expanded—both driven by EPA and by state and local efforts—the effects of reuse have become more visible. Documentation of these effects is still a relatively nascent endeavor, however. Data collection and analysis are inconsistent across federal and state agencies, across programs in a single agency, and even within individual programs. Few data on the effects of reuse are available since most federal and state programs neither document baseline conditions nor routinely and systematically collect and record complete information on reuse activities. Even more rarely do formal studies critically analyze the positive effects or examine the costs as well. In addition, EPA and other federal and state agency staff are sometimes not familiar with the studies that have been done.

In this paper—which was commissioned as a background document for an EPA-sponsored workshop on estimating community economic impacts from the reuse of

contaminated properties (www.rff.org/sitereuse)—we aim to make the lay reader familiar with data on and studies of the effects of reuse. Specifically, we seek to 1) summarize available data and studies pertaining to the effects of the reuse of contaminated land; and 2) briefly present some of the conceptual issues that need to be addressed when estimating these effects; and 3) outline the major practical problems that the studies have encountered. As we describe below, we include in our discussion and analysis a range of effects, some that are typically thought of as economic benefits and others more loosely defined as impacts.

The paper's organization is as follows. In section 2, we provide background on terminology used in the paper as well as delineate the range of studies that the paper covers. The background section also contains a discussion of the context of the data collection and studies and how such information can be used. We then discuss some of the conceptual difficulties faced in these and other studies in section 3. In section 4, the central part of the paper, we describe each study or data collection effort. This description includes the universe of contaminated sites examined, scale at which reuse is examined, the effects, and methods. In section 5, we offer concluding comments.

2. BACKGROUND

As noted at the outset, despite widespread and increasing interest in the reuse of contaminated sites and in measuring the effects of such reuse, there is a paucity of information on this topic. This includes some ambiguity on what is meant by "reuse" as well as a relative dearth of raw data on reuse and little analysis of these data. Yet, even

with (or perhaps because of) relatively limited experience with reuse information, a wide range of metrics has been used to track the effects of reuse. Among others, they include:[2]

- number of short-term and long-term jobs associated with business enterprises that are created or expanded at contaminated sites that are redeveloped
- wage income from short-term and long-term jobs
- number of business establishments created or expanded on contaminated sites that are reused
- sales from business establishments at redeveloped contaminated sites
- sales, business, and income taxes generated by activity from business establishments at redeveloped sites
- changes in property values that are associated with reuse (on-site and off-site)
- changes in local property tax revenues from property value appreciation associated with reuse
- acres of land that are preserved by redeveloping contaminated sites
- number of new housing units constructed on redeveloped contaminated land

We generally include as many examples of these measures as appear in the studies, referring in this paper to them collectively as "beneficial effects." This is an umbrella term, in principle capturing both economic benefits as an economist might evaluate the effects of reuse (net changes in social welfare) as well as more loosely defined impacts that typically do not represent net changes to social welfare or even necessarily use monetary metrics. In reality and as the above list hints, however, most of the data

[2] See, for example, a recent report from the International City/County Management Association (2002,

collection efforts and studies we review have focused on impacts rather than changes in social welfare.[3]

In total, we review 14 different studies that have been undertaken to document the beneficial effects of reuse. These 14 represent a cross-section of different approaches and constitute all the relevant work that we have been able to find, subject to the limitations we detail below. The studies include a number of efforts that entail only data collection and involve no analysis of the collected information, as well as investigations that provide analysis of reuse data. In this paper, we separately discuss databases from other types of analyses, although we refer to both these types of effort as "studies" for expository convenience.

In the remainder of this section, we touch briefly on several factors that constrained the set of studies that we review and on the purpose of the beneficial effect studies themselves.

Limitations on Selection of Studies

The number of studies that touch at least in part on beneficial effects of reuse is relatively small. Nonetheless, to keep our review manageable and focused on description and review of reuse rather than remediation and other aspects of redevelopment we have limited our choice of studies in several additional ways.

Appendix A)

[3] Examining the list of beneficial effects in the text, for example, the economic literature has focused primarily on property value enhancement in estimating changes in social welfare. Wage income as a component of value added also could be included, although the inclusion of such income will depend on the degree to which labor and other resources are pulled or transferred from other economic activities in which they are employed. We discuss this further in section 3 in the text.

First, we do not review studies that emphasize the direct environmental effects of cleanup (the value of cleaner water for a community, for example, or non-use values from the preservation of healthy wildlife habitat), although such effects may contribute valuable reuse benefits. Nor do we review studies that have examined impacts and economic benefits of environmental management at large contaminated federal sites owned by the Department of Energy or Department of Defense, many of which are being downsized, cleaned up, and/or managed for their environmental values.[4] We also do not cover studies that may examine negative aspects or costs of reuse such as increased congestion. The relatively new interest in reuse benefits by EPA's Office of Solid Waste and Emergency Response (OSWER) and state programs means that we currently lack the necessary data on the full social costs and benefits to place reuse activities in a cost-benefit framework for evaluation.[5]

Second, we review only those studies that deal specifically with reuse of contaminated sites. This may seem obvious, but one of the commonly touted beneficial effects of reuse is that it may offer an alternative to sprawl into greenfields (suburban or

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[4] See, for example, studies done by the National Center for Neighborhood and Brownfields Redevelopment at Rutgers and affiliated researchers (Frisch, Solitare, Greenberg, & Lowrie, 1998; Greenberg, Lowrie, Solitaire, & Duncan, 2000; Solitare et al., 2000). Also see the MIT (Frieden & Baxter, 2000) report on base closures.

[5] We know of only two studies that examine both costs and benefits in a brownfields setting for a variety of goods and services. DeSousa (2002) compares the environmental, social, and economic costs and benefits of developing brownfields sites for residential and industrial uses versus the costs and benefits from developing these uses at greenfield sites. Public benefits in his hypothetical scenarios appear more favorable with brownfield redevelopment than with greenfield development, although residential redevelopment at brownfield sites still imposes a net cost relative to doing nothing. Industrial redevelopment of brownfield sites yields a small positive public benefit. Persky and Wiewel (1996) examine the social benefits and costs of central city vs. fringe development, focusing on the benefits and costs of congestion, accidents, air pollution, loss of open space, abandoned dwellings, and the mismatch between residential location and workforce skill sets. They find that deconcentration of development to outer suburban areas brings limited net gains at best. Benefits may be high for some parties such as private firms locating in suburban areas, but public costs also are high and the deconcentration may impose significant inequities in the distribution of costs and benefits to city residents, commuters, and taxpayers.

rural areas that are not yet developed) and be a key element of smart growth strategies. The literature on infill and smart growth is burgeoning and policies to promote infill and smart growth practice at redeveloped sites certainly may yield beneficial effects. However, we do not include studies that examine these effects unless they are motivated principally by the reuse of contaminated land. Similarly, although a number of rigorous economic studies have examined changes in the values of properties that surround a contaminated site undergoing cleanup, we do not review these. Unfortunately, none of the studies have differentiated the effects associated with reuse from those associated with site remediation.

Third, we generally limit our studies to empirical investigations of a relatively large number of sites. Thus, we do not include work designed principally to develop theory, policy, or methodological guidance, except to the extent that the work is based on actual data. In addition, while many states routinely describe "success stories" of individual sites in their annual reports, newsletters, and on their websites, we do not discuss these here.[6] We also do not include the wide range of case studies in the literature that may discuss beneficial effects of reuse but only in a non-systematic fashion or only for a very limited number of sites. These principally include studies of Superfund sites (see, for example, Glaser, 1994; Kiel & Zabel, 2001; Wernstedt, 2001) and brownfield properties (Bartsch, Collaton, & Pepper, 1996; Howland, 2000; Pepper, 1997; Schoenbaum, 2002). In addition, while we know of one important study that has focused on the Underground Storage Tank (UST) pilot grant program (Northeast-Midwest Institute and National

[6] For example, see:
California (http://www.dtsc.ca.gov/SiteCleanup/Brownfields/SMP_Brownfields_Brochure.pdf);
Michigan (http://www.deq.state.mi.us/cmis/);
Minnesota(http://www.pca.state.mn.us/cleanup/vicstories.html); and

Association of Local Government Environmental Professionals, 2002), the study emphasizes the barriers to UST site revitalization and factors that influence its success and provides less than a handful of numerical estimates of beneficial effects.[7] Further pointers to this broader literature appear in Wernstedt, Meyers, and Yount (2003, pp. 87-88).

Finally, the majority of the reviewed studies focus on brownfield sites. This in large part reflects the fact that at these sites reuse goals traditionally have been encouraged—it is a defining feature of brownfield programs—more than at sites with contamination covered under other federal and state cleanup programs.

Purpose of Reuse Studies

As noted earlier, we do not aim to evaluate whether reuse efforts are successful and make good use of public funds. Rather, our charge is to examine studies that document the beneficial effects of reuse. To this end, however, the purposes of the studies are relevant to our examination, since the many different contexts or reasons for documenting the beneficial effects of reuse may influence the information that is collected (*e.g.*, the effects that are measured, the frequency of measurement, and the methods and data used in their measurement).

For example, a study of reuse effects may be undertaken to yield information that can help target limited funds and attention to those types of policy initiatives or redevelopments that generate the most beneficial effects. If a reuse program aims to

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Wisconsin (www.dnr.state.wi.us/org/aw/rr/rbrownfields/bsg/RR5228.pdf).

[7] The UST study does present a simple cost-benefit calculation to describe the beneficial effects of a state-run reimbursement fund that supports UST cleanup. In this example, the state intervention reportedly added over $130,000 of value to the site by covering investigation and remediation costs. This represents a

efficaciously allocate resources to increase jobs, then features such as the nature of the jobs (*e.g.*, short-term jobs vs. long-term jobs) and the beneficiaries of these jobs (*e.g.*, held by neighborhood residents vs. held by in-migrants) become relevant to our examination. Alternatively, an agency may collect data or commission a study to satisfy a legislative mandate or requirement for planning or technical review. In this case, an assessment needs to examine whether the agency met its requirements. A reuse study also could be a more academic account of beneficial effects of reuse, an undertaking divorced from immediate needs for information to shape decisions and one that is driven neither by budgetary considerations nor by formal requirements. The rigor and legitimacy of measurement concepts and methodologies may be a key focus in these studies. Or data may be collected on an individual site or for multiple sites in a local context simply to educate the reader about the reuse that has taken place. Perhaps data collection and analysis is simply part of a campaign to build interest in and awareness of reuse efforts.

In short, because relevant effects and methods by which they are measured may differ depending on the motivation behind efforts to collect and analyze reuse data, an assessment of the efforts should be cognizant of the underlying motivations. Understanding the motivations and contexts of a study allows a more credible assessment of whether the effects that the study gathers and analyzes make sense given its purpose. In addition, an awareness of a study's purposes is useful in its own right for realizing why program representatives and other individuals care about the beneficial effects that they have chosen to focus on.

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leveraging of resources rather than a direct contribution, however, since part of the added value derives

3. CONCEPTUAL ISSUES IN ESTIMATING ECONOMIC EFFECTS

We already have alluded to the fact that the studies included in our review emphasize impacts rather than economic benefits per se. To reiterate, by this we mean that the studies typically examine the gross visible effects of reuse that individuals or communities may experience rather than the net changes in social welfare that concern economists. Thus, for example, increased jobs and sales income for a new establishment created on a redeveloped contaminated site are impacts that many would associate with reuse and one or both of these are found in most of the investigations we review. An economic investigation in contrast, typically would include as relevant only the value added (*e.g.*, profits and wage income) at each stage of production of the final good. Thus, sales figures themselves would not constitute a measure of an improvement in social welfare nor would new jobs. Increases in labor income as a component of value added could yield a social welfare gain but this would have to be placed in a wider context that also examines whether the increased economic activity from reuse serves some of the demand for goods and services previously met by existing businesses or, as we describe below, transfers or draws away resources from other economic activities.

Similarly, secondary impacts—that is effects on businesses that provide inputs to the new reuse activity or those that purchase the outputs of the new activity—generally would not constitute an economic benefit since these secondary impacts require a reallocation of resources from existing production activities. In the same vein, increasing the availability of remediated land that is suitable for development and that has underutilized infrastructure in place may contribute economic value, but this is measured

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from additional support from both the town jurisdiction and the UST pilot grant.

as the cost savings compared to alternative land parcels, not as the market value of the remediated land per se. To the extent that resources have opportunity costs—a value in production that is foregone when they are diverted to alternative activities—the economic benefits should reflect only the difference in value between substituting a higher-and-better use of the resources for a lesser one.

From the perspective of the economy as a whole, this increment is likely to be very small; that is, resources already will be fully employed unless rigidities limit their mobility. Because of this, a national perspective—or national accounting stance in the parlance of project evaluation—generally will yield lower estimates of economic benefits from an action such as reuse of contaminated land than would a regional or local accounting stance. At the regional or local level, there may be slack in the system and chronically underemployed resources—at least in the short to intermediate run—that reuse efforts may gainfully employ, yielding true economic benefits for the region. On the other hand, as one takes a smaller scale, local accounting stance, beneficial effects are more likely to leak out of the area of interest. Even the identification of beneficiaries from reuse efforts can be problematic at local scales, since both labor and capital can move in and out of an area, the latter often with few constraints.

In the end, the appropriate accounting stance depends to a large degree both on the purpose of a remediation and reuse program and the purpose in analyzing it. For reuse studies that simply seek to document the range of beneficial effects that remediated sites can spur, the accounting stance may be of little importance. At the other extreme, if one wants to evaluate a program to target its limited resources more efficiently, the appropriate accounting stance demands greater attention. It still may be that a regional or

local accounting perspective is appropriate in this context, but in most cases the accounting stance should be consistent with the scale at which beneficial effects are measured and at which leakages are minimized. In addition, in situations where public investments are significant, the appropriate stance may depend significantly on whether the funds are federal, state, or local.

An additional concern embedded in studies to evaluate the beneficial effects of reuse relates to causal links. This has two elements. First, in most situations a number of forces will shape successful reuse of contaminated land, but only one may be of direct interest to those responsible for conducting the study. Obviously these other forces may need to be identified so that one does not inaccurately attribute all of the beneficial effects to a single intervention. In many reuse projects on contaminated land with which we are familiar, for example, public funding targeted to remediation or redevelopment at a site serves only as a catalyst at best, with other public outlays for infrastructure and other supporting investments, private investment, skillful management and promotion, understanding of the market, extensive planning, infrastructure, public involvement, local government support, secular trends in the local real estate market, *etc.* essential to the success of reuse.[8] Linking reuse successes only to the public funding element of the package of features that made reuse possible is misleading in evaluations that seek to improve targeting of public resources.

A second difficulty encountered in assessing the causality of beneficial effects centers on the recognition of baseline conditions. The gross effects of a reuse project

[8] Related to this, it may be extremely difficult to separate the beneficial effects of reuse from those of remediation, a problem in many studies but one that is particularly endemic to property valuation studies because of the internal logic of valuation methodologies.

may overstate the effects of interventions to promote reuse if possible alternative development of the parcel is not adequately considered. From the standpoint of project evaluation, the "without project" condition is an important baseline against which changes need to be measured. This "without project" baseline may not be as dire as doing nothing. At many parcels, assuming that less intensive land activities will take place if a concerted reuse project does not happen may be more realistic than assuming that the parcel will host no activities absent the project. This is particularly true with longer time horizons—looking at beneficial effects over a long time period rather than just on a one-time basis—since market and technological adjustments over time can lessen reuse barriers once seen as insurmountable absent public interventions.

These concepts are useful to keep in mind in considering the studies discussed below. Few if any of the studies have the rigor of a full blown economic analysis or are meant as a full blown program analysis to inform decisions on how to allocate resources. Consequently, the fact that many fall short on methodological grounds should not be surprising. The concepts nonetheless offer useful lenses through which to examine some features of the studies.

4. STUDY DESCRIPTIONS

The studies and data collection efforts that we include in our review do not exhaust the range of work that has been done to document the beneficial effects of reusing contaminated land. As noted above, we do not include property valuation exercises (see, for example, Gayer, Hamilton, & Viscusi, 2002; Ketkar, 1992; Kiel & Zabel, 2001; McCluskey & Rausser, 2003a; McCluskey & Rausser, 2003b) because they focus

primarily on environmental or health improvements and do not distinguish the effects of reuse from those of cleanup.[9] In addition, we discuss only a few of the state initiatives to collect data on beneficial effects to exemplify the major thrusts of state-led efforts. And finally, we simply may have missed some relevant studies in our literature review.

Our review of the data collection and studies proceeds in four categories. We start with four examples of routine data collection and reporting, then review four case studies, cover three survey-based approaches, and conclude with reviews of three analytical approaches. Within each of these categories, we start with the studies that are designed to inform broader scale interpretations (*e.g.*, national-level) and proceed to finer levels (*e.g.*, local-level). For each study, we discuss the universe of sites that is examined, the beneficial effects that are measured, the methods used to measure these effects, and the results of the study.

4.1 Routine Data Collection and Reporting

Various entities routinely collect information on the beneficial effects of reuse of contaminated properties. The information may come from grant and loan applications or as a result of reporting requirements that funding entities impose on their grant or loan recipients. Alternatively, in some cases the reporting may follow from statutory or regulatory provisions and the information may be used as performance indicators to justify program activities and/or guide future funding, or it may simply be to enhance understanding of the array of beneficial effects associated with reuse. Below we review

[9] Property value studies were covered in more detail in a different part of the workshop that this paper and accompanying presentation were part of (see www.rff.org/sitereuse).

three national-level efforts to collect data on beneficial effects, as well as touch briefly on two state efforts to collect such information.

Brownfields Management System Database, EPA

EPA tracks reuse information in its Brownfields Management System (BMS), a database of information constructed primarily from regular quarterly reports filed by its pilot grantees.[10] The universe of grants and properties in the database includes those supported under Brownfields Assessment Demonstration pilots, Brownfields Showcase Communities, Brownfields Cleanup Revolving Loan Fund pilots, and Brownfields Job Training and Development Demonstration pilots (U.S. General Accounting Office, 2000).[11] According to EPA, the data that the BMS collects help the agency respond to Congressional and budgetary requests, provide material for speeches and testimony, address requirements under the Government Performance and Results Act, improve the success of the Brownfields Economic Development Initiative, and create communication and outreach materials to convey brownfields program achievements. (U.S. Environmental Protection Agency, 2000)

Grantees must furnish information on redevelopment activities and other accomplishments leveraged by the EPA grant, with leveraging defined as grant funds and activities that the EPA grant catalyzed or those that were linked in some way with the EPA grant. Measures of accomplishments currently include whether redevelopment is underway at a pilot and associated properties supported by the pilot; acres of green space

[10] In addition, grantees must complete property profiles as cleanup and redevelopment activities proceed at specific properties. The BMS also includes information from grant applications and work plans, EPA regional reports, and interviews with pilot managers.

created (from property profiles); number of temporary jobs created (jobs lasting less than one year, typically those created during assessment, cleanup, and construction activities); cleanup dollars from other federal, state, local, and private entities linked to or leveraged from the pilot grant; number of longer-term jobs created (jobs associated with a new reuse); and construction and redevelopment dollars linked to or leveraged from the pilot grant. Only actual accomplishments and committed funding, rather than planned or anticipated ones, are included.

The U.S. General Accounting Office (2000, p. 31) reported a number of accomplishments from the EPA pilots through March 2000, including over 1,500 cleanup and construction jobs, more than 5,000 redevelopment jobs, and over $2 billion in construction and redevelopment investments leveraged. This has increased with more pilots. EPA (2003c) lists over 550 assessment and pilot grants since 1995, resulting in the assessment of more than 4,300 properties and over $5 billion in leveraged public and private funding. The most recent EPA data on job impacts of 437 EPA Brownfields Assessment Demonstration pilots (personal communication, EPA Office of Brownfields Cleanup and Redevelopment, January 22, 2004) indicate leveraging of over 8,000 cleanup and construction jobs and 17,000 redevelopment jobs since 1994. These figures should not be viewed as providing an overall estimate of the total, direct impacts of the grants, however. They rest on self-reported information from grantees and do not reflect other factors in addition to the EPA grants that may have contributed to redevelopment successes. At the same time, the grants have promoted many beneficial effects such as

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[11] Although part of the BMS database, EPA's job training and development pilots focus on providing training and expanding employment opportunities in environmental jobs in areas affected by brownfields. Beneficial effects of these pilots are not associated with reuse.

public health protection and other property and community enhancements that are not reflected in the estimates of resource leveraging and job impacts.

Superfund Redevelopment Database, EPA

As part of its Superfund Redevelopment Initiative, EPA has created the Superfund Redevelopment Database (SURE) to track characteristics of sites on the National Priorities List (NPL) that host or plan to host reuse. The evolving database currently contains site information from, primarily, EPA staff (remedial project managers, community involvement coordinators, on scene coordinators, and site assessment managers) and, secondarily, representatives of states and potentially responsible parties.

SURE currently contains information on 375 NPL sites in 46 states. Fields relevant to the beneficial effects of reuse include, among other variables, type of reuse, number of on-site jobs, income from on-site jobs, property values on-site and off-site and changes in these, state income tax revenues from permanent jobs in on-site business activities after cleanup, personal spending of income earned in these permanent jobs on goods and services, and state sales tax revenues generated by from these on-site activities. Information to populate the database comes from the EPA and other contacts and from estimates based on secondary data when primary sources are not available. The secondary data sources include a commercial building consumption survey conducted by the U.S. Energy Information Administration—used to estimate the number of jobs based on the type of business activity—and on hourly earnings data from the U.S. Bureau of Labor Statistics to estimate job income.

About one-third of the records in the database—121 sites in 33 states—are populated with data on the beneficial effects of reuse. Each of these 121 records has job

information and 51 also have data on personal spending, most with associated sales tax revenues. 44 of the 121 records have data on state income tax revenues from on-site business activities. The database currently contains almost no property value data and no baselines to calculate changes in on-site or off-site property values after cleanup.

The 121 records with job data indicate that reuse has brought nearly 79,000 jobs (average of 650 jobs/site), with total annual income from these jobs exceeding $2.8 billion ($23 million/site). However, a few records highly skew this data. The three sites with the highest number of jobs and highest income post cleanup contribute about two-thirds of their respective totals. Median values are 25 jobs/site and $836,000 income/site. A few outliers similarly skew state income and sales taxes. For the 44 sites with income tax data, the average income tax revenues are about $400,000/site. Four of the 44 sites account for two-thirds of the income tax revenues, however, and the median revenue is about $67,000/site. In the case of sales tax data, 2 sites that contribute over 85 percent of the tax revenues skew the average of nearly $1 million/site. The median is less than $34,000/site.

Even after mitigating the influence of the outliers with these various reuse measures, the median values likely still overstate the typical effect of post-cleanup reuse on jobs and income, for two reasons. First, the database does not consistently distinguish between sites with insufficient information to develop estimates and sites where feasible reuses do not yield any jobs or tax revenues. Including the latter types of sites in the estimates of beneficial effects would drive down both average and median summary statistics.

Second, some of the reuses identified in the database continue previous site activities; that is, in some cases the post-cleanup reuses perpetuate or at best broaden uses

in place before cleanup occurred.[12] For the 50 plus sites in the database that have new uses in place (rather than continuation of existing uses), each site has an average 181 jobs and $6.3 million in annual income. The median values for these sites are 43 jobs/site and $1.3 million income/site. These are higher median statistics than the analogous medians for the entire sample of 121 sites, but they also overstate the effects of cleanup and reuse activities if some use may have been in place or was likely to arise even absent cleanup at these sites.

Northeast-Midwest Institute, 2002

The Northeast-Midwest Institute (NEMW)[13] has published an annual review of state brownfield programs since the late 1990s, with the most recent report appearing in December, 2002 (Bartsch & Deane, 2002). Information in the review comes from telephone interviews, faxed responses, and email correspondence with representatives of each state's environmental and economic development agencies. Although the review has focused on program aspects since its inception—characterization of brownfield and voluntary programs, supporting statutes, and financial support and other incentives offered, for example—one element of the review explicitly addresses "reuse benefits."[14] The latter covers information related to the number of sites in state programs, businesses created, jobs created, housing units constructed, and local tax revenue additions.

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[12] For example, the Varsol Spill Superfund site at the Miami International Airport underwent extensive investigation after listing on the NPL. EPA, after concluding in 1985 that the site did not require additional action since it posed no public health or environmental threat, deleted it from the NPL in 1988. The airport remained open throughout the investigation, decision-making, and post-deletion. It provides nearly 34,000 jobs that generate nearly $1 billion in income. Such activity clearly constitutes a desirable outcome but it also points out that one must take care in using the SURE database not to uncritically attribute outcomes solely to cleanup and reuse activities.

[13] NEMW is a non-profit, non-partisan research organization focused on economic development, environmental quality, and equity within the Northeast and Midwest states.

While information in the reviews in principle is collected systematically from each of the 50 states and Puerto Rico annually, it can be idiosyncratic and inconsistent across the states and years. As the 2002 report notes, due to resource limitations that constrain data collection "[m]ost states have yet to gather hard economic information on their programs" (Bartsch & Deane, 2002, p. iv). Much of the data that are included rest on specific examples of success stories that interview subjects cite. Only a half-dozen states appear to systematically track jobs, housing units, or tax revenues associated with reuse, with several more indicating that they planned to do so in the future. In most if not all cases, tracking states recorded information for only a subset of their brownfield and voluntary cleanup programs. In addition, the self-reporting of the information means that the quality of the data may be uneven. For instance, different states may include jobs that are retained in a community when a contaminated site is reused as a job benefit of reuse, while others may only include new jobs. In addition, some states may count only permanent jobs as a job benefit of reuse while others may include temporary jobs (*e.g.*, in the construction industry) or even report job-years as a measure of job benefits (*e.g.*, report a job that has lasted five years as 5 jobs).

Fifteen of the states provide some information on jobs—the half-dozen with systematic tracking and another nine that estimated jobs based on sites with which they were familiar. Sites that have gone through the brownfield and voluntary programs in these fifteen states host more than 120,000 jobs in total, a number subject to the above caveats on data quality. Interviewees from five states reported residential reuse totaling 14,000 additional units of housing, although a number of others indicated that residential

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[14] Bartsch (1999) provides a summary of reuse benefits for the 1999 survey year, the first year in which

units were being built for which they interviewees could not provide an estimate of the number. Five states also reported increased tax revenues (income, sales, and property) from various kinds of site reuse, with total revenues across the five states exceeding $1 billion dollars.

Surprisingly little additional tracking has taken place at the state level over the last several years according to NEMW data from earlier reports. Some of the beneficial effects of reuse from the earlier Bartsch, Anderson, and Dorfman study (Bartsch et al., 1999) are identical to those cited in the 2002 report and few states not tracking reuse data in 1999 tracked it in 2002 (Massachusetts being a notable exception). This in part reflects resource constraints noted earlier, but it also reflects inexperience or even hesitation on the part of staff from environmental agencies (or the lack of a legislative or regulatory mandate) to track economic data. In addition, staff from several states have told us that grant recipients often resist the paperwork required to document the beneficial effects of reuse.

State-Level Collection

Our discussion of the Northeast-Midwest Institute's annual review obviates, to some degree, the need to cover the efforts of individual states to routinely collect information on the beneficial effects of reuse. The NEMW study in principle already captures such information. Moreover, additional state-by-state documentation of efforts to track beneficial effects lies beyond the scope of our resources. However, it is useful to note that some states may document in more detail both the process of estimating beneficial effects and a wider range of effects than is apparent in the Northeast-Midwest reports. In

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benefit information was collected.

addition to logistical limitations of coverage on a national basis, some state respondents to the Northeast-Midwest Institute's questions may not be familiar with or have the time to track down all of the documentation taking place across the range of agencies involved in their brownfield and voluntary cleanup programs. In some cases, state staff may produce estimates of beneficial effects on an ad hoc basis—often to bolster a case for support from state legislatures—and these estimates may not be regularly available.

In the State of Wisconsin, for example, estimates of the beneficial effects associated with the State's Department of Commerce brownfield grant program[15] come from the semi-annual reports that grant recipients must file. Jobs are verified through employer tax forms, non-grant project investments through invoices (to satisfy match requirements), and on-site property value increases through documents with information certified by local tax assessors. Final reports from grant recipients are examined by auditors.[16] In addition to this routine, the state and interested parties may provide additional examples of beneficial effects at certain junctures. For example, proposed cuts to several of Wisconsin's brownfield grant programs in the Governor's 2002-2003 budget motivated a letter from the state's Brownfield Study Group that argued for the efficacy of the grants. In addition to listing similar benefits as those listed in NEMW's 2002 report, the Study Group reported that brownfield grants run through the Department of

[15] Reuse benefits generated from grants run through Wisconsin's Department of Natural Resources—those associated with the state's Site Assessment Grant program, for example—are generally not systematically tracked except with respect to matching requirements. On occasion, staff in the Department of Natural Resources may contact developers and other site principals for information to advertise success stories, but this is not common. Little is known about the benefits from these sites, particularly if they are private.

[16] This emphasis on documenting the beneficial effects of the grants reflects the orientation of the grant program. In scoring applications for brownfields grants, anticipated economic development effects account for 50 percent of each application's score. These effects include factors related to property values, jobs, wages, measures of stress, local and private investment, commitment of funding, and impact on community. Another 15 percent of the application depends on the quality and quantity of funding matches.

Commerce have leveraged $14.50 for every $1 of grant money.[17] Citing specific sites, the Study Group also noted that over 450 housing units would be created through the grants. In addition, the letter points out that local governments have supported their own projects, with West Allis and Milwaukee—both located in southeastern Wisconsin—together generating 4,000 jobs, $2 million in annual property tax relief, and over $300 million in construction and renovation investment from brownfields reuse. The Study Group further claims that Milwaukee has leveraged $56 in tax base increase for every dollar invested in "environmental activities."

Other states may routinely record information on tax revenues associated with their redevelopment programs on contaminated land. For example, Michigan regularly tracks the tax and local tax revenues produced by tax increment financing under the state's Brownfield Redevelopment Financing Act. This mechanism allows eligible brownfield redevelopment authorities to capture new property tax value from a redeveloped site and use those captured funds to reimburse those who incurred environmental expenses on that site. The Department of Environmental Quality reviews annual work plans submitted by the relevant brownfield redevelopment authorities—environmental expenses must qualify as eligible for reimbursement—and the authorities are required to regularly report revenues and expenditures to the state's Department of Treasury.[18]

In New Jersey, the state tracks sales, corporate, business use, and other taxes paid by new activities that take place at sites enrolled in the state's Brownfield and Contaminated

[17] More recent personal communication from the Department of Commerce indicates a leveraging ratio of 16.75 to 1. Property values from these grants have increased an additional $250 million and 600 additional jobs have been created (above the $356 million in property value increases and 4,000 additional jobs listed in the NEMW report).

Site Remediation Reimbursement Program. Up to 75 percent of remediation costs incurred in redeveloping the site are reimbursable to developers who enter into a redevelopment agreement with the state's Commerce and Economic Growth Commission, Department of Treasury, and Department of Environmental Protection. The program thus provides a *defacto* mechanism to monitor beneficial effects of reuse, insofar as the Department of Treasury monitors the tax receipts of the participants even after the reimbursement is completed.[19]

4.2 Case Studies

Our four case study approaches range from a national-level study by the International Economic Development Council on the benefits of brownfields-to-open space conversions to a study of the benefits of brownfields redevelopment in the City of Toronto. Beneficial effects that are examined include the usual jobs, income, and property values, as well as housing units, greenspace, and looser concepts such as "economic revitalization."

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[18] The Downriver Area Brownfield Consortium and staff at Michigan State University have developed an Access database tool to facilitate reporting (http://35.8.121.138/vi/bfreporter.asp).

[19] Since 1998, more than 50 agreements have been signed. Expected reimbursement from these agreements—the share of eligible remediation costs that will be reimbursed from tax revenues collected from projects in these agreements—exceeds $170 million. Completed projects have a nearly 3 to 1 return in revenues to the state to date; that is, the amount the state already has received in revenues from these projects is more than 3 times the amount of reimbursement it is obligated to pay. This understates the gross beneficial effects from the reuse insofar as revenues will continue to grow over time while reimbursement is capped. However, although the program requires that the reuse activities be new activities (rather than the relocation of an existing business in the state), the net effects of the reuse are uncertain since the state does not track possible revenue decrements from competing establishments in the state that may lose business as a result of the new activity.

International Economic Development Council, 2001

The International Economic Development Council (IEDC), a Washington, DC based non-profit organization representing economic development specialists and organizations, received financial support under a cooperative agreement with the EPA to study the conversion of brownfields to green spaces. The purpose of the study was to document that such conversion "*does have* tangible economic benefits" (International Economic Development Council, 2001, emphasis in original, p. 1), and to provide insight into the feasibility of conversion and the process for accomplishing it.

The approach rested on a non-random selection across fifteen states of twenty-five projects. These projects are located in twenty different communities identified beforehand as being active in brownfield to green space conversions. For each site, study staff conducted telephone interviews of study participants familiar with the projects, with most participants adding additional details in written answers on an IEDC questionnaire sent to each participant.[20] The questions were open-ended and covered a range of issues including physical characteristics of the project (*e.g.*, acreage), remediation, funding, redevelopment process, alternative uses, and principal parties involved in the conversion.

Most importantly for our purposes, the questionnaire also instructed participants to provide the property assessments of nearby parcels (offsite properties) for both the period prior to the brownfield site reuse and the period after the conversion to green space.[21] For each city, changes in assessed values in other areas of the city where no conversions took place also were recorded to provide a control group. Seven of the twenty-five

[20] The IEDC report does not identify study participants by name or position.

respondents provided the necessary information to estimate the change in property assessments of the offsite properties, and across all land uses, the unweighted mean percentage increase in offsite property values from the seven conversions is 106 percent (median of 86 percent). Comparable figures for the surrounding control groups averaged 25 percent, with a median of 14 percent. Weighting these differences across the cities (by property values) yields an increase in the offsite properties that, in percentage terms, is more than 2.3 times the increase in the respective control groups. Annual percentage increases calculated from data in the report are 26 percent (mean) and 16 percent (median) for the surrounding properties and 6 percent (mean) and 7 percent (median) for the control groups. For 6 of the 7 communities, each of the individual land uses for which data are available also experienced higher percentage increases in the offsite property values than in property values in the surrounding cities.[22]

The offsite property values unfortunately generally do not control for capital investments in the properties, thus inflating the values that appear related to greenspace development. In one project, for example, the value of residential properties surrounding a contaminated site converted to greenspace increased from nearly $700,000 prior to conversion to over $17,000,000 after the greenspace was in place two years later. The text of the IEDC report notes that this in part reflected a $3 million investment in the residential properties, an investment that would drive land value increases independently of the greenspace development. It is impossible to say whether the greenspace

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[21] Offsite property values and taxes were broken into six different land uses (industrial, commercial, residential, recreation, institutional, and mixed). The time period between each pair of property assessments ranged from two to eight years.

[22] The exception was a greenspace developed in a depressed neighborhood of an otherwise hot urban real estate market. Using that neighborhood as the relevant control group, offsite property value increases near the converted greenspace exceeded those in the wider neighborhood control group.

conversion even motivated the investment. The causal chain may be reversed or both may have been simultaneously driven by market forces.

More generally, the study's use of arbitrarily defined control groups—the city jurisdictions where the greenspace projects are located—is problematic. One should not necessarily expect that aggregate property values in different districts of a city should rise and fall together. Not only will some districts be more desirable than others (or than the "average" district) at some times, but the different compositions of district in terms of land use mixes (both type and quality) imply that value may change unevenly. Moreover, from a statistical vantage, one would expect small areas to have greater fluctuations in property values than the urban whole that they are part of. Finally, the information on property values is a mix of self-reported and assessor data and is thus of uncertain quality.

OSWER Reuse Studies, 2003

In mid-2003, OSWER commissioned a private consulting firm to gather data on the local impacts of reuse in OSWER's brownfields, RCRA corrective action, and underground storage tank programs. The resulting draft December 2003 report (U.S. Environmental Protection Agency, 2003a) provides reuse data on twenty-five sites in twenty states—six sites in each of the three programs plus another seven Superfund sites that had been examined in a separate study. Reuse activities across the twenty-five sites and four cleanup programs range widely and in no predictable pattern and include, among others, housing, office, retail, restaurants, hotels, museums, recreational, parks, and transportation uses. At each of these twenty-five sites, the report includes the number of

on-site jobs, income from these jobs, property values at the site and in surrounding properties, and property tax revenues resulting from property value increases.

Analysts used several approaches to estimate these beneficial effects. For job impacts, nearly three quarters of the sites' employers reported the number of their employees. Published information and/or developers or building managers furnished estimates at seven sites, one site's employment was calculated based on the square footage of building devoted to different sectors and employee/square foot ratios, and four sites had no jobs.[23] Income estimates from these job gains were estimated by applying Bureau of Labor Statistics data on earnings by sector.

On the property front, study staff collected property value information for each site and for surrounding off-site properties (both the value prior to cleanup and the value after cleanup when reuse occurred). Unlike the IEDC study, which relied largely on self-reporting and self-identification of relevant off-site properties, the OSWER Reuse study included all properties within a half-mile radius for the brownfield, RCRA, and UST sites and those within a one-quarter mile radius for the Superfund sites. Local property tax rates were applied to the increments in property values to estimate the increase in property tax revenues resulting from reuse.[24]

Numerical estimates of beneficial effects range widely, on both job and property tax metrics. Sites with no current reuse or with reuse not generating employment (*e.g.*, residential and greenspace sites) have no reported job increases, while the median number of jobs at those sites with reuses that do provide jobs is 250. One site has yielded

[23] Study staff used more than one measure to estimate job impacts at some sites.

nearly 3,000 jobs. The median increase in property tax revenues is close to $1 million, although revenue increases exceed $20 million for one site.

The numerical estimates show that reuse can occur and that the reuse appears to have beneficial effects, a finding that is useful in public education efforts to demonstrate the range of properties involved in cleanup and the range of reuses and their beneficial effects. For evaluative purposes, however, differences in types of reuse at each of the sites and in site sizes yield a wide range of on-site job effects from reuse that do not lend themselves to comparisons. Similarly, differences in property assessment methods among jurisdictions, in the radius around each site in which off-site property values were measured, and in the years included in the estimates make meaningful comparisons across the twenty-five sites and the four OSWER programs problematic.[25] In addition, because the study does not report the cost side of reuse activities nor address whether the reuse activities would have occurred elsewhere, it is not possible to use the study to compare or assess the relative effectiveness of different reuse endeavors.

New Jersey Municipalities, 2000

Researchers at the National Center for Neighborhood and Brownfields Redevelopment at Rutgers University (Miller et al., 2000a; Miller et al., 2000b) intensively investigated twelve New Jersey municipalities, as part of a project examining

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[24] Past studies have indicated that sites with hazardous substances may affect property values at properties several miles distant. However, the high parcel density at most of the 25 sites investigated and resource constraints precluded property data collection beyond the ¼ to ½ mile limit.

[25] For example, the median number of jobs generated at the six UST sites is 6, while the analogous median at the six RCRA sites exceeds 1,000 jobs. Similarly, the UST sites yielded a median tax revenue increase of about $700,000/year, while the median RCRA revenue increases were close to $4 million/year. The RCRA reuses certainly appear as if they provide more economic stimulus, but differences in site sizes, contamination, location, and resource commitments make comparisons between UST and RCRA sites meaningless.

the potential for using brownfield redevelopment as an element of smart growth strategies. Project staff visited zoning and tax assessor's offices in each of the twelve municipalities as well as each of 89 brownfield sites and, in addition, interviewed municipal officials, developers, and architects associated with the sites and municipalities.

Study staff developed economic reuse information (jobs, property tax revenues, new residents) based on a combination of reuse plans, local assessment rates, expert opinion from the study's authors and two economic development experts, and, in the case of job estimates, extrapolation from similar facilities in New Jersey (based on square footage in the case of retail facilities). Using this combination of approaches, the authors estimated the creation of roughly 4,000 to 4,600 jobs at the sites over the next three to five years, annual property tax revenue increments to the twelve municipalities of roughly $13 to $22 million, and 3,000 to 5,000 new residents. Extrapolating these estimates to the entire state, they estimated 17,000 to 60,000 new jobs from redevelopment of brownfield sites, $55 to $287 million in annual revenue increments, and housing for 13,000 to 65,000 residents.[26]

The statewide estimates clearly are ballpark figures and depend critically on the representativeness of the sample municipalities of the state as a whole. The municipal sample covers all geographic areas of the state but, as the report notes, includes only small and mid-sized municipalities (and the municipalities included have more

[26] The number of brownfield sites potentially available statewide for development is unknown but a range was estimated by using two different statewide lists of brownfield properties, the larger one containing about three times as many sites as the smaller one. Similarly, the authors used two different likelihoods of development of the sites, one based on the ratio found in their study of the twelve municipalities and the other set at 100 percent. The combination of the two possibilities of site counts and two possibilities of the

brownfield sites and a high proportion of poor and minority populations relative to the rest of the state). Each of the 89 specific brownfield sites included in the sample was selected because it had received a grant from the state's Hazardous Discharge Site Remediation Fund (62 sites) or because officials in the municipality in which it was located identified the site as one that the municipality was seeking to develop (27 sites). In addition, even for the twelve municipalities studied in detail, the modeled revenue estimates likely are too high. Market demand is poorly represented in the study and the authors note that property tax abatements and other financial inducements probably will be needed to attract residents and businesses to many of the areas. Moreover, the upper ends of the statewide job, revenue, and housing estimates are based simply on the estimated acreage of reusable land that will be available. They do not account for whether there will be a demand for jobs and housing either because of an expanding national economy or through transfers from other parts of the country.

DeSousa, 2003

DeSousa's (2003) research of brownfield to greenspace conversions in Toronto provides our final case study example. Based on a review of ten such conversions and structured interviews with twelve stakeholders from the public, private, and non-profit sectors familiar with these efforts, the author examines physical characteristics of the conversions, planning processes, lessons from the conversions, and perceived impacts. The ten projects were not chosen randomly but rather were selected to be representative of conversions that have reached fruition or undergone extensive planning.

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likelihood of being developed yielded four scenarios, each of which was modeled to estimate statewide effects on jobs, property tax revenues, and residential housing.

The conversion benefits noted by the interviewees ranged over both "natural" and "human-oriented" impacts. Nine of the ten interviewees indicated the augmentation of ecological habitat was a key conversion project benefit—the most frequently identified benefit of the twelve discussed in the study—but most of the other identified benefits relate to human-oriented impacts. They included, in decreasing frequency of appearance, "public and community collaboration and involvement," "increasing areas for public recreation and use," "education," "flood control," "environmental renewal," "economic stimulation," and "improvement of neighborhood aesthetics."[27] DeSousa notes that many of the interviewees praised the social networks that emerged with the conversions, a creation of social capital that differs from standard economic development impacts such as jobs.

4.3 Survey-Based Approaches

Our review of survey-based approaches is limited to three studies. To some extent, our categorization of the three studies in this fashion is somewhat arbitrary, insofar as several of the studies discussed above (the BMS, SURE, NEMW annual review, and New Jersey examples) involve a survey or enumeration of sites or programs. In this section, however, we focus on less routinized, more irregular efforts that collect data by structured questionnaires (rather than interviews).

U.S. Conference of Mayors, 2003

The series of annual brownfield reports from the U.S. Conference of Mayors since 2000 provides an oft-cited source of brownfield information. The most recent version contains responses from nearly 240 cities in 37 states—plus Washington, DC and five

[27] See page 194 of Desousa (2003) for the full list of benefits and accompanying details.

cities in Puerto Rico and Guam—who noted that they had brownfields. It is based on responses to a four-page survey that consists of half open-ended and half closed-ended questions. Respondents could mail or fax completed questionnaires or complete the survey on-line (U.S. Conference of Mayors, 2003).

According to the survey responses, potential beneficial effects of brownfields are high. Growth in a city's tax base was the most often identified benefit of brownfields redevelopment, followed in order by neighborhood revitalization, job creation, and environmental protection. Actual reported gains among respondents were $90 million in additional tax revenues and 83,000 jobs. Based on those who responded to the question on potential tax revenues from brownfields redevelopment, additional aggregate revenues summed across the cities could range from $790 million to $1.9 billion annually. Those reporting potential job gains indicated that over 575,000 new jobs could be created on brownfields sites.[28]

Similar to the skewness in the Superfund database discussed earlier, the jobs and tax revenue data have a number of outliers with very high values. The average increase in jobs from redeveloping brownfields is nearly 3,900 jobs/city, while its median is 500 jobs/city. In addition, municipalities reporting on the actual jobs created neither distinguish between temporary and permanent jobs nor indicate the time period over which the job gains have occurred. For annual tax revenue estimates—where respondents where asked to provide both a "conservative" and an "optimistic" estimate of

[28] Responses to the Conference of Mayors survey suggested that over 4 million additional residents could be accommodated within the surveyed cities without overly burdening existing infrastructure. This is a potential beneficial effect rather than a realized gain, however, and it is best interpreted as an indicator of the surplus infrastructure that brownfield reuse could take advantage of. The phrasing of the question on

the tax revenues that would be generated if all of the brownfields in the jurisdiction were developed—the conservative "average" annual tax revenue increments in each city from redeveloping brownfields is over $5 million/city, while its median is about $640,000.

The skewness in the impact data is perhaps caused or exacerbated by respondents that provide overly optimistic potential benefits that don't relate to market conditions or even reasonable physical constraints. In a particularly egregious example, one city with an estimated 1,400 acres of brownfields available estimates that full development of this acreage would yield between $200 million and $600 million in annual property tax revenues.[29] Moreover, this city does not report (nor do the others) the level of public investment that would be necessary to promote and support such development, making the prospective net fiscal impacts of reuse unknown.

Council for Urban Economic Development, 1999

The purpose of the 1999 project conducted by the Council for Urban Economic Development (CUED)[30] was to "obtain direct, measurable data on a variety of brownfields redevelopment projects and to evaluate them through the lens of economic development" (Council for Urban Economic Development, 1999, p. 7). More than any other study that we review, the CUED effort clearly aims at systematically documenting the beneficial effects. Such documentation, the report's authors argue, is useful for

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the ability to support additional residents did not mention brownfields so it is not clear the extent to which brownfield acreage is available for housing.

[29] By comparing the estimates of future tax revenue and job gains with those that already have been experienced (based on the respondents' characterization of realized gains), we can see the uncertain nature of the estimates. The median ratio of actual revenue gains to conservatively estimated future gains from brownfields redevelopment is 0.28. The median ratio of actual job gains to possible job gains from brownfields redevelopment is even lower at 0.17.

[30] CUED merged with the American Economic Development Council in 2001 to form the International Economic Development Council. The IEDC authored the greenspace report discussed earlier.

helping decide how economic development resources should be allocated, showing legislators and other decision makers the benefits of brownfield programs, and determining whether brownfields redevelopment is an efficacious use of resources.

CUED's methodological approach rests on structured telephone interviews of a selected sample of project managers and others familiar with brownfield developments in 51 communities in 20 states.[31] These interviews are followed by (in most cases) participants' return of a completed survey instrument with more details. 107 brownfield redevelopments are represented in the study, all of them completed projects.[32]

Relevant measures for examining the beneficial effects of the redevelopments include on-site jobs and leveraging of private funding. All but a handful of the projects in the sample had some type of public funding, an average of $4.5 million/project when public debt and current public expenditures is included (median is $1.3 million). Across all projects with public and private funding, the average private investment is $12.7 million (median is $2.5 million). The average leveraging of private funds—the amount of private funding leveraged for each public dollar—is about $2.50.

The number of jobs associated with each redevelopment project site is quite variable, ranging from a low of 0 to a high of 2,300 at several sites. The study standardizes these figures by amount of public funding, reporting a median of $14,000/job. This includes newly created as well as retained jobs. When the latter is excluded, the median cost increases to roughly $24,000/new job.

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[31] The 51 communities were not chosen randomly but rather were selected for their active involvement in brownfields redevelopment.

[32] Using completed projects mitigates the problem of performance measures being based on projections rather than actual outcomes, although the study's authors note that some participants did provide such projections and estimates.

Michigan Department of Environmental Quality

Michigan's Department of Environmental Quality has conducted an irregular survey of 33 Michigan municipalities since enactment of provisions to reform the liability provisions and cleanup standards in the states' primary cleanup law. These reforms aimed at diminishing the barriers imposed by remediation costs—both their magnitude and the uncertainty of what costs might be incurred—on parties interested in cleaning up and reusing contaminated properties. The purpose of the survey—which has been carried out in 1996, 1997, and annually from 1999-2002—is to gauge the effects of the provisions. Legislative language in the amendments reforming the liability scheme and standards requiring the Department to regularly report to the legislature on the effectiveness of the amendments in restoring the economic value of sites with environmental contamination thus has resulted in a series of defacto studies of reuse impacts.

Results from the most recent survey indicate that, since their inception, the amendments have led to over $4 billion in private investment in development in the surveyed communities (Michigan Department of Environmental Quality, 2002). This represents a fifteen percent increase in investment over the results from the previous year's (2001) survey. In addition, survey results indicate that the amendments have led to the creation of nearly 12,000 new jobs, an increase of about 25 percent over the figures reported from the 2001 survey.[33]

[33] The representativeness of the results from the survey of 33 municipalities is unknown. At the time of this writing, we unfortunately have not had access to the actual survey instrument or to a list of the municipalities included in the study. The estimates of tax revenue and jobs gains appear to be self-reported in the survey and are of unknown quality. However, they likely overstate the effects of the changes in liability and cleanup standards insofar as the baseline against which they are compared appears to assume

4.4 Analytical Approaches

Our last category of studies fits under the title of "analytical approaches." Roughly speaking, this entails studies that use conceptual models to estimate the beneficial effects of the reuse of contaminated land, although the models may be based on empirical data. They include two national level studies and one local level example.[34]

Draft EPA Redevelopment Sector Report, 2003

EPA's Office of Policy, Economics, and Innovation has estimated beneficial effects of brownfield redevelopment as part of a study examining the broader effects of smart growth practices involving building rehabilitation, infill development, and brownfields redevelopment (U.S. Environmental Protection Agency, 2003b). The study, a national examination of the impacts of redevelopment mediated through the nation's construction industry, constitutes the most spatially extensive look at beneficial effects of all of the studies we review. It also includes two brief case studies of individual localities to provide more detail on the beneficial effects from redevelopment.

The study is not designed to provide estimates of net economic gains from redevelopment activities nor as a guide to allocating resources. As stated at the outset of the report, economic gains cited in the study might have occurred elsewhere and in different form if they had not been associated with redevelopment activities. The results thus serve best, perhaps, as gross estimates of activity. They also provide a public

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that no remunerative reuse at contaminated sites in the relevant jurisdictions would have occurred absent the statutory changes.

[34] We do not include in our discussion simple models commonly used by local economic development planners to gauge a proposed project's impact on a community. These are often based on spreadsheet calculations that estimate job and tax revenue impacts based on the acreage of a contaminated area (input variable) and given parameters of floor-area ratios, value of building per square foot, tax assessment rates, and jobs per square foot of building space (specific to type of reuse).

education function by highlighting the importance of redevelopment practices to the national economy and by identifying policies and incentives that may encourage such redevelopment.

The analysis itself uses a number of measures to capture the importance of redevelopment practices—expenditures, earnings, employment, tax revenue streams, and secondary impacts of spending—estimated over a ten-year period from 1990-1999. By necessity it involves a large amount of imputing. The basic logic is:

1) estimate the nationwide acreage of brownfields that have been redeveloped;

2) convert this acreage estimate to a building space estimate, based on established relationships between building floor area and land area;

3) estimate remediation expenses per acre;

4) estimate development costs per square foot of building space;

5) estimate building space/job ratios;

6) use the building space/job ratios and the standardized remediation and development costs to convert acreage and building space estimates to primary output/expenditures, jobs, and wages from remediation and redevelopment;

7) use multipliers estimated from the U.S. Bureau of Economic Analysis input-output model (RIMS II multipliers) to convert primary effects into secondary ones; and

8) estimate tax revenues based on average tax revenues per acre of brownfield redeveloped.

Many of the factors used in the estimation—brownfield acreage, floor/area ratios, remediation costs per acre, development costs, and tax ratios—are specific to brownfields and come from studies reviewed above or their earlier versions (Bartsch & Deane, 2002; Council for Urban Economic Development, 1999; U.S. Conference of Mayors, 2003).

Following the above procedure, the study estimates that brownfield remediation and redevelopment in the 1990s yielded nearly $400 billion in primary output and created nearly 4.5 million short-term jobs paying over $150 billion in wages.[35] Subsequent activity on the redeveloped sites generated nearly 2 million jobs paying $74 billion in wages. Secondary effects of spending by the new reuse activity on businesses furnishing inputs and by those buying the output of the new activity—estimated by using the input-output multipliers—added another 3 million long-term jobs and $140 billion wages. The study placed local tax revenues from activities at the site at $2 billion to $5.5 billion annually.

The report also provides estimates of outputs, wages, jobs, and tax benefits for the two case studies. Using a similar approach as the national analysis—but with information on property valuation and more specific data on building construction—the study estimates both short- and long-term effects from infill development.[36] For the first case—a New Jersey county—the EPA report estimates infill development has generated over 14,000 long-term jobs paying nearly $1.7 billion in cumulative wages. The second area studied—the City of Denver, Colorado—reportedly generated 8,000 long-term jobs

[35] All monetary measures are expressed in 2001 dollars.
[36] The analysis lumped together brownfield redevelopment and infill in the two case studies, although brownfield redevelopment is only a subset of the latter.

paying nearly $1.4 billion in cumulative wages. The authors did not report secondary effects for either local area.

George Washington University, 2001

The EPA OSWER office and George Washington University (GW) signed a cooperative agreement in 1997 to examine the interplay of development pressures on brownfields and greenfields, economic benefits induced by brownfields redevelopment, and federal, state, and local laws and regulations that influence brownfield redevelopment. As part of that cooperative agreement, GW researchers (Deason, Sherk, & Carroll, 2001) estimated the land area that would be required for various types of developments in inner city, brownfield areas as compared to suburban, greenfield areas. The metric used to gauge the beneficial effect of brownfields reuse is the ratio between the acreage required in each of the two contexts. The beneficial effect in this context is not a typical job or income impact from reuse, but rather the preservation of greenfields.

The basis for the land use comparisons was 48 brownfield projects identified across the Baltimore, Burlington (Vermont), Lowell (Massachusetts), Richmond (Virginia), Sacramento, and St. Louis metropolitan areas. These six study areas were selected by the research team to satisfy two criteria. First, each area included an EPA Brownfields Pilot program city. Second, each study area had a high negative population growth differential between the central city and the surrounding counties—that is the population growth in the central cities was significantly less than that in the surrounding counties—for the 1990-1994 period. This criterion reflected the researchers' interest in focusing on areas where central city growth pressures (and therefore demand for brownfield redevelopment) may be relatively low.

For each of the study areas, researchers interviewed individuals involved in brownfield projects and collected information on project characteristics such as site acreage, lot dimensions, number of floors, and specific reuse. The projects were assumed to have satisfied all relevant land use regulations in the central city jurisdictions. Researchers also identified three greenfield jurisdictions (towns and counties) in each of the six study areas. Based on published land use regulations for each of the greenfield jurisdictions—regulations that generally would require larger tracts of land for development than their central city counterparts—they estimated the acreage that each of the 48 brownfield projects would require if the projects were located in the surrounding greenfield jurisdictions.[37] In some cases, the research team had to make simplifying assumptions regarding requirements related to neighboring uses and setbacks, parking, allowable densities, and building heights (Deason et al., 2001, 5.2.1-5.2.5). For example, where building height regulations in greenfield communities precluded the construction of a tall structure that had been located on a brownfield site, the authors assumed the construction of lower buildings with bigger footprints on greenfield sites to accommodate an equivalent square footage.

The ratios of greenfield to brownfield acreage—that is, the acreage that a project would take on a greenfield site divided by the acreage that an equivalent project would take on a brownfield site—range from 0.4 to 60.5. The mean ratio across the 29 industrial projects in the study is 6.2; that is, on average, 6.2 acres of greenfields are required to site an industrial project that would take 1 acre on a brownfield site. Across

[37] Each of the 48 brownfield has three greenfield counterparts, for a total of 144 greenfield projects. Two of the greenfield projects would not have been possible to build due to restrictions, however, so the GW analysis includes 142 greenfield projects in total.

the 60 residential projects that are modeled, the mean ratio is 5.6, while for the 53 commercial projects it is 2.4. The overall mean across all projects and all uses is 4.5, meaning that a brownfield redevelopment needing one acre would prevent, on average, 4.5 acres of greenfield development. The different rules for lot size, building footprints, setbacks, *etc*. between central city and surrounding jurisdictions drive these differences.

The 4.5 ratio has received attention in the policy realm so it warrants some scrutiny. Similar to many of the other beneficial effects reviewed in this paper, the data in the GW study are skewed. The median value across all projects and types of reuse is 1.7 acres of greenfields developed for every acre of brownfields development. Similarly, the median ratios for industrial, commercial, and residential developments are 1.3, 1.7, and 2.1, respectively. All of these are much lower than their corresponding means. This is due in part to the influence of outliers,[38] such as those driven by height limitations that require ample greenfield acreage to host equivalent projects.

An additional difficulty in interpreting the results is that the study does not provide a sense of market demand for the equivalent projects in greenfield locations and the substitutability of developments in the two settings. To the contrary, it implicitly assumes that the market and developers are indifferent to brownfield and greenfield locations. Moreover, the fact that land use and zoning regulations in greenfield locations force different building designs suggests the study is comparing projects, which although having common reuses, may differ markedly in other dimensions such as footprint, building height, access to parking, setbacks from the street, *etc*. In short, it is not clear

[38] Eight projects have ratios that exceed 30.

whether the brownfield and greenfield projects irrespective of their locations are similar enough in physical traits to be considered substitutes.

Colorado State University and Development Research Partners

Under an award from the Economic Development Administration of the US Department of Commerce, researchers at Colorado State University and Development Research Partners used a case study approach to examine the beneficial effects of brownfields redevelopment in the Westwood section of Denver (Colorado State University and Development Research Partners, Undated). In particular, they constructed a hypothetical one-acre aggregated site from 3 smaller properties along the neighborhood's main thoroughfare and estimated the potential fiscal and economic impacts from redeveloping this property for retail use. These estimates rest on characteristics of comparable retail establishments in the area, local tax rates, local wages, and the application of Bureau of Economic Analysis RIMS multipliers to estimate secondary activity.

Compared to the baseline current use of automotive service and yard storage at the properties, development of the aggregated site for retail use would raise the assessed value of the property from nearly $800,000 to nearly $1.4 million. Employment would nearly double, although earnings would increase by less than fifty percent because of lower average wages in the retail sector. Tax revenues would increase by $36,000, a fifty percent increase from the current baseline of $72,000. Site investments (remediation, construction, and equipment) would increase by $2 million and more than 20 additional jobs would be created through secondary effects. These secondary effects as well as the primary job creation constitute valid impacts according to the authors—at least from the

neighborhood perspective—since the neighborhood is currently underserved by retail outlets and since its unemployment rate significantly exceeds the city wide average. The economic value of these effects depend on whether the resources employed in the economic activity at the site—and those employed in other activities that provide or use goods or services produced by the new retail activities in the case of secondary impacts—draw away resources from existing activities elsewhere.

Summary of Studies

Table 1 offers summary comparisons of the above studies along a number of dimensions. These include:

Purpose of Study: rational for conducting study (*targeting* resources or attention, meet program *requirement*, *education* about beneficial effects, *academic* undertaking)

Beneficial Effects: metric or units in which study measures beneficial effects

Secondary Effects: does study also include beneficial effects associated with activities producing inputs for or using outputs from the economic activity at the site

Type of Reuse: types of reuses examined in study

Geographic Range of Included Sites: spatial extent over which data are collected

Scale and Sample Size for Data Measurement: geographic scale/program home of reuse projects included in study and size of sample

Scale at Which Results are Reported: geographic scale at which beneficial effects are reported in study

Quality and Representativeness of Sample: degree to which sample of reuse projects in study represents the geographic range of the population of interest

Results: information on jobs, income, tax revenues, *etc*. provided by study

As the table makes clear, the 14 studies tend to examine a relatively narrow range of beneficial effects, most typically including economic development impacts such as jobs and income. Several more include effects of reuse on property values, both at the property being reused and in surrounding properties, and two report secondary impacts. Collectively they cover a wide range of scales—from national down to the neighborhood—both in terms of the data contained in the studies and in the spatial generalizations the studies make about the results. Finally, in most cases the sample sizes that the studies are based on are relatively modest and typically not random.

5. CONCLUSION

Each of the fourteen studies of the beneficial effects of reuse that we have reviewed uses simple metrics—such as jobs and property value enhancement—that are readily appreciated. At a minimum, these offer clear evidence of beneficial effects. Even when the same metric is used, however, the effects can vary widely across the studies, as well as among the sites and cities within a study. This follows in part from the skewness of many of the samples of sites where reuse has taken place. In many of the studies, such samples frequently have been constructed to showcase the reuse that has occurred on contaminated sites. In other studies, the sites may constitute a full enumeration of a population of interest—all sites receiving financial support under a specific program, for example. For both of these cases, outliers in the data suggest that medians more usefully summarize the data and that the arithmetic mean is a potentially misleading metric.

Overall, the studies are difficult to compare, both because of the different methods they use—routine data collection, case studies, survey, and analytical approaches—and because they have different purposes. Moreover, while a representative sample might seem an important attribute in any study no matter its purposes, across the fourteen studies as a whole, only EPA's Brownfields Management System (includes all brownfield pilot grantees) and possibly the US Conference of Mayors study (includes 240 municipalities) appear to have samples that are both large enough to be representative of their populations of interest and have sufficiently consistent reuse information. In addition, the different types of beneficial effects and cleanup programs that the fourteen studies target, as well as different scales and accounting stances, make comparisons difficult.

Given this host of differences, we caution the reader that it is not appropriate to compare beneficial effects across studies. Placing the beneficial effects of one site against those of another site is also difficult, even for any given study, given the great disparities in site sizes, reuse potential, contamination, and commitment to reuse. Furthermore, because most of the studies focus on brownfield sites, generalizing or extrapolating general lessons from our overview unfortunately also is problematic. However, our examination of the existing state-of-the-art in studies of the beneficial effects of reuse does identify several important directions for further work.

First, as noted above, the studies we reviewed emphasize a relatively narrow set of traditional economic development measures. These include jobs, income, property values, and tax revenues, with a few other metrics (*e.g.*, greenspace and social improvements) identified in a few of the studies. Yet, we have evidence from a number

of surveys that while public officials and other interested parties may in fact place the highest priorities on the traditional beneficial effects from economic development, they also may value a wide range of other types of effects not included in the studies we examined. These effects include community safety, improved health, reduced sprawl, removal of eyesores, infrastructure utilization, and provision of recreation, cultural and other community facilities (ECS and Council for Urban Economic Development, 2000; Greenberg & Lewis, 2000; Walzer, Duncan, & Sutton, 2001; Wernstedt, Crooks, & Hersh, 2003; XL International and International Economic Development Council, 2002). Further work is needed to examine such effects, both to ascertain whether they are desired and also to what extent they can result from reuse at contaminated properties. Ideally this work would go beyond simple enumeration of additional effects and begin to systematically collect primary data in different settings on the relative importance or value that the public puts on the beneficial effects associated with reuse.[39]

Second, none of the fourteen studies examines in any great detail the distributional effects of reuse with respect to different segments of a community. Yet, many contaminated properties lie in disadvantaged areas, where site reuse has the potential to address long-standing issues of local environmental and economic inequities. Future work to clearly identify the communities and subpopulations that are supposed to benefit from the reuse of contaminated land—and to assess where the beneficial effects of reuse

[39] A survey of public officials and/or private individuals would seem to be an obvious approach for providing such data but to the best of our knowledge no such study has been undertaken. This in part reflects the high cost of original survey work, as well as the difficulty of constructing a survey instrument that is applicable to a wide range of community settings and a wide range of beneficial effects. In a related project on the value of incentives for promoting reuse of contaminated land (EPA Star Grant R829607, at http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/2376), we use hypothetical redevelopment scenarios to frame choices of different incentive packages. A similar approach

actually go—could both make explicit what often appears to be an implicit objective of site reuse as well as improve program initiatives to accomplish this objective. Such work would require baseline documentation of the socio-economic composition of the communities hosting reuses and systematic tracking of changes in this composition and general community well-being.

Finally, none of the studies can be said to constitute a true economic analysis. The studies often look at gross rather than net gains and fail to identify the baseline conditions and trends at sites, for example, and describe what likely would happen absent site remediation. Most of them also adopt a local accounting stance and examine only the local effects experienced by individual communities—although they may aggregate these across communities—without taking into account possible displacement of existing businesses or leakages of the beneficial effects outside the community of interest. And perhaps most tellingly, none of the studies discuss the opportunity costs of the resources employed in reuse—the value of the resources if they remained in their prior use—and, therefore, they tend to overstate the economic value of reuse. Adding these features to a study of the beneficial effects of reuse would go a long way toward a more full and accurate picture of the economic value of the reuse of contaminated land.

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could be used to uncover preferences for different beneficial effects under different hypothetical reuse scenarios.

Table 1: Summary of Studies

	Purpose of Study	*Beneficial Effects*	*Secondary Effects*	*Type of Reuse*	*Geographic Range of Included Sites*
Routine Data Collection					
BMS	targeting, required, education,	jobs, income, greenspace, resources leveraged	?	various	national
SURE	education	jobs, tax revenues	?	various	national
NEMW	education	income, personal spending, property values	no	not tracked systematically	national
State-Level	various	new businesses, jobs, tax revenues, housing units	?	various	state-specific
Case Study Approaches					
IEDC	targeting, education	various	no	greenspace	15 states
OSWER Reuse	education	jobs, income, property values, tax revenues	no	various	20 states
New Jersey	education, academic	jobs, tax revenues, housing	no	various	12 municipalities in state
DeSousa	academic	habitat, recreation, public involvement, and others	no	greenspace	1 city (Toronto)
Survey Approaches					
US Mayors	education, academic	jobs, tax revenues	no	various	national (37 states)
CUED	targeting, education, academic	jobs, resource leveraging	no	various	20 states
Michigan	requirement, education	private investment, jobs	no	not specified	state
Analytical Approaches					
EPA Sector	targeting, education	sales, jobs, income, tax revenues	yes	various	national (and two local case studies)
GW	education, academic	acres of greenfields preserved	no	residential, commercial, industrial	6 metro areas in 6 states
Denver	targeting, education	property values, jobs, tax revenues	yes	retail	Denver neighborhood

Table 1: Summary of Studies (continued)

	Scale/Sample Size of Data	*Scale of Reporting Results*	*Quality/Representativeness of Sample*	*Results*
Routine Data Collection				
BMS	EPA Brownfield Pilots (457 projects)	pilot to national	full enumeration of pilot population	17,000 redevelopment jobs, $5 billion in leveraged funding
SURE	375 Superfund sites	Superfund site to national	351 Superfund sites with planned or actual reuse	median 43 jobs, $1.3 million income at 54 sites with new reuse
NEMW	50 states	state	incomplete and inconsistent responses across states	120,000 jobs, 14,000 housing units
State-Level	various	generally state	generally includes success stories	N/A
Case Study Approaches				
IEDC	25 brownfield to greenspace conversion	local	non-random sample of places w/ greenspace conversions	% ? offsite property values > 2 times % ? in control group values
OSWER Reuse	25 sites of OSWER interest	local	non-random sample to highlight different reuses	median 250 jobs/site and $1 million/site in tax revenues
New Jersey	83 sites	municipalities, extrapolated to state	excludes large cities, biased toward distressed cities	4000+ jobs, $13 million + tax revenues, 3000+ residential units
DeSousa	10 greenspace conversion projects	city	non-random selection	ecological habitat key benefit, various human oriented benefits also
Survey Approaches				
US Mayors	244 cities	city, national level	survey administered nationwide, no info on return rates	83,000 jobs,$90 million tax revenues, median 500 jobs/city
CUED	107 brownfield projects	local	non-random	median of $2.5 million private investment leveraged, $14,000/job
Michigan	33 Michigan municipalities	state	not specified	$4 billion private investment, 12,000 new jobs since 1995
Analytical Approaches				
EPA Sector	various scales depending on different	national	N/A	$74 billion income, 2 million jobs, $5.5 billion tax revenues
GW	142 sites (3 sites each of 48 brownfields)	local to national	unknown	median of 1.7 acres greenfield saved/acre brownfield developed
Denver	property	neighborhood	N/A	75% increase property value, 50% increase tax revenues

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