REVERSING URBAN SPRAWL: A RECLAIMABILITY INDEX APPROACH FOR REVIVING DOWNTOWN BROWNFIELDS

Final Report

CTLS 08-03

by

Maria Chrysochoou, Norman Garrick, Kathleen Segerson, Amvrossios Bagtzoglou, Geeta Dahal, Kweku Brown and Catalina Granda-Carvajal
University of Connecticut

for
Center for Transportation and
Livable Systems (CTLS)
270 Middle Turnpike
Storrs, Ct. 06269

March 2011

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CTLS 08-03	N/A	N/A

4. Title and Subtitle	5. Report Date
Reversing Urban Sprawl: A Reclaimability Index Approach for Reviving Downtown Brownfields	March 2011
	6. Performing Organization Code: CTLS 08-03-2

7. Author(s)	8. Performing Organization Report No.
Maria Chrysochoou, Norman Garrick, Kathleen Segerson, Amvrossios Bagtzoglou, Geeta Dahal, Kweku Brown and Catalina Granda-Carvajal	CTLS 08-03

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Center for Transportation and Livable Systems (CTLS) 270 Middle Turnpike Unit 5202 Storrs, CT 06269-5202	N/A
	11. Contract or Grant No.: N/A

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S Dept. of Transportation 1200 New Jersey Ave, SE Washington DC 20590 202-366-4000	Final
	14. Sponsoring Agency Code: N/A

15. Supplementary Notes

This study was conducted at the Center for Transportation and Livable Systems (CTLS) http://www.ctls.uconn.edu/

16. Abstract

A key step to promoting urban revitalization is the reclamation of abandoned or underutilized contaminated sites, also known as brownfields. Effective brownfield redevelopment approaches require environmental, socio-economic and urban planning dimensions to be integrated into policies. The most common approach to incorporate such dimensions is to evaluate specific redevelopment projects for a single site and decision support tools have been developed for that purpose. In this study, we present a decision support tool to prioritize brownfield redevelopment options based on their location characteristics as a basis for developing redevelopment priorities. This tool incorporates and aggregates location-specific variables into three indices: socioeconomic, smart growth and environmental. Its application to the city of New Haven, Connecticut as a case study demonstrates a general prioritization scheme that can be used by urban planners and public agencies to develop strategic plans for brownfield redevelopment, incorporating funding and local considerations.

17. Key Words	18. Distribution Statement
Brownfields, GIS, Smart Growth, Urban Sprawl	No restrictions. Copies available from CTLS: www.ctls.uconn.edu

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	123	N/A

ACKNOWLEDGEMENTS

This project was funded by the Center for Transportation and Livable Systems (CTLS). We thank Kweku Brown, Geeta Dahal and Catalina Granda-Carvajal for data compilation and analysis, set up of the GIS and assistance with writing this report.

DISCLAIMER

TABLE OF CONTENTS

EXECUTIVE SUMMARY **1**
1.0 PROJECT OVERVIEW AND SURVEY RESULTS **5**
1.1 INTRODUCTION 5
1.2 SURVEY SCOPE AND RESULTS 6
1.2.1 OBRD and DECD 7
1.2.1.1 Smart Growth in CT *7*
1.2.1.2 Brownfields in CT *7*
1.2.1.3 How Does Redevelopment Work? *7*
1.2.1.4 Pertinent Issues with Brownfield Redevelopment in the state of CT *8*
1.2.1.5 Recent Disbursement of Funds ($2.25 million) *8*
1.2.1.6 Funds *9*
1.2.2 Connecticut Brownfields Redevelopment Authority 10
1.2.2.1 Completed, successful projects *11*
1.2.2.2 Pending projects *12*
1.2.2.3 Archived projects *12*
1.2.3 City of New Haven 13
1.2.4 City of Meriden 15
1.2.4.1 Interaction with other agencies *16*
1.2.4.2 Barriers to brownfields revitalization *17*
1.2.5 Regional Growth Partnership 18
1.2.6 Valley Council of Government – Regional Brownfields Partnership of West 20
1.2.6.1 Barriers to brownfields revitalization *22*
1.2.6.2 Responsible Growth Agenda *23*
1.2.7 Survey Conclusions 24
2.0 LITERATURE REVIEW **29**
2.1 DEFINING BROWNFIELDS 29
2.1.1 Why Redevelop Brownfields? 29
2.2 FEDERAL AND STATE GRANTS FOR BROWNFIELD REMEDIATION AND DEVELOPMENT 29
2.2.1 Federal Programs 30
2.2.1.1 Assessment Grants *30*
2.2.1.2 Revolving Loan Fund (RLF) Grants *30*
2.2.1.3 Cleanup Grants *30*
2.2.1.4 Targeted Brownfields Assessment (TBA) Program *30*
2.2.2 Connecticut Brownfields Related Program 31
2.2.2.1 Connecticut Environmental Assistance Programs *32*
2.2.2.1.1 Brownfield Municipal Pilot Program 32
2.2.2.1.2 Special Contaminated Property Remediation and Insurance Fund (SCPRIF) 32
2.2.2.1.3 Urban Sites Remedial Action Program (USRAP) 32
2.2.2.1.4 Tax Increment Financing (TIF) 33
2.2.2.1.5 Connecticut Brownfield Revolving Loan Fund 33
2.2.2.1.6 Environmental Insurance Program 34
2.2.2.2 Local and Regional Brownfields Programs in Connecticut *34*

2.3 OBSTACLES FOR BROWNFIELD REDEVELOPMENT 36
2.3.1 Connecticut 36
2.3.2 Commonly Identified Obstacles in the Brownfield Literature 37
2.4 ENVIRONMENTAL LIABILITY AND BROWNFIELDS 40
2.4.1 Empirical Assessments on the Effect of Liability on Brownfields 42
2.4.2 Federal and State Solutions 43
2.4.3 State of Connecticut 43
2.5 TOOLS FOR THE EFFICIENT ALLOCATION OF FUNDS FOR BROWNFIELD REVITALIZATION 45
2.5.1 A Review of Literature 45
2.5.1.1 Approaches Dealing with Environmental Remediation 46
2.5.1.2 Approaches Dealing with Environmental Conservation 46
2.5.1.3 Some Conceptual Background for the Index-Based Approach 47
2.5.1.4 The Index Approach: How it Works and its Cost-Effectiveness 48
2.5.1.5 USDA Conservation Programs 49
2.5.1.6 Conservation Reserve Program 50
2.5.1.7 Environmental Quality Incentives Program 52
2.6 BROWNFIELD REDEVELOPMENT, SMART GROWTH AND URBAN PLANNING 54
2.6.1 Smart Growth 55
2.6.1.1 Smart Growth Scorecards 57
2.6.2 Brownfields and Urban Planning 62
3.0 INDEXING APPROACH AND GIS TOOL 70
3.1 INTRODUCTION 70
3.2 METHODOLOGY AND DATA 72
3.2.1 Socio-Economic Index 73
3.2.2 Smart Growth Index 76
3.2.3 Environmental Index 81
3.3 RESULTS 84
3.3.1 Socio-Economic Index 84
3.3.2 Smart Growth and Environmental Index 85
3.4 CONCLUSIONS 91

APPENDICES

APPENDIX A: SURVEY QUESTIONS

APPENDIX B: CASE STUDIES

LIST OF TABLES

Table 1.1: Account of CBRA's Inventoried Brownfield Sites 12
Table 1.2: Summary of EPA Brownfields Assistance 14
Table 1.3: Summary of RGP's Financial Assistance 14
Table 1.4: Summary of RGP Financial Assistance for Brownfields 19
Table 2.1: Factors Generating Points for the CRP's Environmental Benefit Index 51
Table 2.2: Summary of EQIP Formula to Allocate National Program Funds to States 53
Table 2.3: Examples of State-Level EQIP Weights 54
Table 2.4: Main Elements of Smart Growth Policies 57
Table 2.5: Summary of Projects Specific Scorecards 58
Table 2.6: Summary of Case Studies 67
Table 3.1: Socioeconomic Variables - Classification, Scores and Weights 73
Table 3.2: Smart Growth Variables - Classification, Scores and Weights 76
Table 3.3: Environmental Index Score Variables - Classification, Scores and Weights 81

LIST OF FIGURES

Figure 1.1: Towns that Received a Total of $2.25 Million Funding in October 2008 9
Figure 1.2: Organization Framework of Brownfield Redevelopment in Connecticut 28
Figure 3.1: Socio-economic Index Mapping for Connecticut Municipalities 85
Figure 3.2: GIS Maps of Smart Growth Variables and Index in the City of New Haven 87
Figure 3.3: GIS Maps of Environmental Variables and Index Score in the City of New Haven . 89
Figure 3.4: Distribution of Environmental Index Score (EIS) for 61 Brownfield Sites in New Haven 90

EXECUTIVE SUMMARY

A key step to promoting urban revitalization is the reclamation of dilapidated or vacant contaminated sites, also known as brownfields, which are abandoned, idle or under-used industrial and commercial properties where expansion or redevelopment is complicated by real or perceived environmental contamination. Brownfields are commonly located in urban areas where basic infrastructure, workplaces and other amenities are already in place, thus their redevelopment aligns with principles of smart growth, such as promotion of walkable neighborhoods, urban revitalization and public transportation. Despite these advantages, brownfield reclamation faces significant obstacles due to high clean up costs, uncertain timelines and liability associated with contaminated properties As a consequence, over 450,000 brownfield sites in the United States remain underutilized, with social, health and environmental costs. The intervention of state and local authorities with financial aid and crafting of suitable policies thus is crucial to overcoming those obstacles. Given these circumstances, allocation of funds among contaminated areas to achieve multiple environmental and socio-economic objectives is one of the most important challenges facing brownfield program managers.

The objectives of this project were to: a) identify the primary challenges and existing decision support tools associated with brownfield redevelopment; b) document the state-of-the-practice for brownfield redevelopment in the state of Connecticut;, and, c) develop a decision support tool for state and local governments for prioritization of brownfield redevelopment and fund allocation. **This decision support tool departs from previous efforts in that it considers a strategic plan for redevelopment based on the location-specific attributes of brownfields, decoupled from their specific end-use.** The tool is also data-driven, utilizing data-sources that are generally available across the U.S. and does not require information obtained through formal environmental investigations.

A literature review was conducted to fulfill the first objective. While multiple decisions support tools exist for brownfield redevelopment, in all of the identified studies, the evaluation tool was designed to be used on a case-by-case basis. In particular, it either assumed that there is a potential developer with a set of criteria or that there is a specific private end use that is assessed, so that the brownfield is evaluated in a specific context. Importantly, these tools do not allow broad identification of areas or sites that might be targeted for re-use as part of an effort to promote smart growth, where the end use might, for example, involve open space or recreational or residential use rather than commercial or industrial development. Additionally, all of the proposed evaluation schemes require a wealth of information on the brownfield and the project, which is usually available only after the stakeholders have decided to take action on investigating a brownfield and spend money on it.

To fulfill the second objective, we performed a survey of existing brownfields in Connecticut and their management practices. There are approximately 300 brownfields in the two databases that are maintained by the Connecticut Department of Environmental Protection (CTDEP) and the Connecticut Brownfields Redevelopment Authority (CBRA). It is estimated that this number

grossly underestimates the true number of abandoned and underutilized sites with potential contamination (a.k.a. brownfields); even though no official estimation exists, the non-for-profit organization 1000 Friends of CT speaks of "thousands of sites across the states" in their blog (6/2/2009 entry). In April 2009, the state Task Force on Brownfields Strategies released their third report, re-iterating the need for more funding and for improved policies. The report cited the connection of brownfield redevelopment with the goals of creating green corridors, transit-oriented development and responsible growth as major incentive to enhance efforts and funding. We interviewed a variety of stakeholders involved in brownfield redevelopment at the state level, including representative from the Department of Economic and Community Development (DECD), from CBRA, from town authorities (Meriden, New Haven), the Regional Growth Partnership and the Regional Brownfields Partnership of West Central CT and we found all of them share the sentiment that funding is the No. 1 obstacle, followed by often rigid regulations on liability and remediation. A step forward was taken in the summer of 2009 with new legislation that targeted to limit liability and ease regulatory requirements for redevelopment.

Our review of the allocation of the available funds showed that, although smart growth principles are being considered through the use of a Responsible Growth evaluation card for state-funded projects, there is no overall strategic plan that aims at catalyzing urban renewal. Even though there are highly successful projects, e.g., the Occum park redevelopment in Norwich, which lead to an overall neighborhood revitalization, it appears that both towns and the state approach this redevelopment on a case-by-case basis. Balancing practical considerations such as availability of funding, liability, public perception, job and tax creation with longer term planning aspects tends to shift the focus into implementing immediate solutions to pressing problems. Shifting from the reactive mode to more pro-active paradigm of deliberate investing of funds to blighted areas will take both a significant funding commitment from the state, as well as the development of a strategy. This has been recently recognized by the state, and the Office of Policy and Management is currently developing a Conservation and Development Policies Plan for 2013-2018 that includes the prioritization of brownfields.

Based on the literature and survey findings, we established that the new decision support tool should: a) be location-specific and consider attributes of a brownfield site that are independent of a specific end use; b) be data-driven, with information that can be easily obtained from public sources without the need for site-specific investigations; c) consider variables in three dimensions, socioeconomic, environmental and smart-growth related. For each area, an index was created to summarize the redevelopment priority of different locations based on each of the three considerations. In the development of the three indices, we sought to organize and classify the data based on widely accepted standards when possible. For example, categories for transportation and land use data were selected using the LEED-ND Rating System as a guide.

For the socioeconomic index, the chosen variables were population density, unemployment rate, property values, and whether the town is designated as a Distressed Municipality or a Targeted Investment Community (TIC) in the state of Connecticut. For smart-growth, six variables from the LEED-ND systems were adopted: availability of utilities, job-housing balance, intersection density, bus and rail availability, and potential for additional rail transit. Finally, for the environmental index we chose seven variables that provide a rough representation of the three elements that are typically part of environmental risk assessment: source, pathway and receptor.

Additionally, all of these could be easily quantified and classified with available data sources. **This is the first brownfield environmental index created that can be obtained without the need for formal Phase I-III investigations.** The variables are: past use of site, proximity to surface water and groundwater, soil permeability, zoning of the site, proximity to sensitive receptors (protected habitats, parks, protected open space) and characterization as floodplain or wetland.

All aforementioned variables were mapped for the entire State of Connecticut for the socioeconomic and smart growth indices and for three major cities (New Haven, Bridgeport, and Hartford) for the environmental index. Application of this GIS-based tool to the City of New Haven with the available data showed that the tool was able to discern between sites of variable environmental sensitivity, yielding a normal distribution for the Environmental Index Score of 61 brownfield sites in the state inventory. The resolution of high versus low smart growth areas was lower because the City of New Haven is an area with high smart growth within the state of Connecticut; however, if an end user so desired, it would be possible to apply stricter criteria in order to achieve higher resolution. By applying a combination of these indices and maps with economic and local considerations, it is possible to come up with specific strategic plans for systematic remediation of brownfields, instead of the current approach which relies on private interest or public outcry in order to focus on a particular site.

1.0 PROJECT OVERVIEW AND SURVEY RESULTS

1.1 INTRODUCTION

A key step to promoting urban revitalization is the reclamation of dilapidated or vacant contaminated sites, also known as brownfields. The United States Environmental Protection Agency (2011) defines brownfields as abandoned, idle or under-used industrial and commercial properties where expansion or redevelopment is complicated by real or perceived environmental contamination. Brownfields are commonly located in urban areas where basic infrastructure, workplaces and other amenities are already in place. Therefore, their redevelopment can promote the creation of walkable neighborhoods, favor public transportation, and revive local markets.

Despite these advantages, brownfield reclamation faces significant obstacles —depending on the local legal and socioeconomic conditions— due to high clean up costs, uncertain timelines and liability associated with contaminated properties (O'Reill & Brink, 2006; Bacot and O'Dell, 2006; Heberle and Kackar, 2006; Siikamaki and Wernstedt, 2008). As a consequence, over 450,000 brownfield sites in the United States remain underutilized, posing health and environmental risks and impeding the revitalization of urban neighborhoods that once were important centers of industrial activity. The intervention of state and local authorities with financial aid and crafting of suitable policies thus is crucial to overcoming those obstacles.

Given these circumstances, allocation of funds among contaminated areas to achieve multiple environmental and socio-economic objectives is one of the most important challenges facing brownfield program managers. This issue acquires more prominence in view of the fact that, even with state and federal incentives, developers and economic development agencies still deal with many decisions about which sites to remediate, market, and/or purchase (Thomas, 2002a). In this regard, the lack of decision support tools for prioritization of brownfields for redevelopment has been recognized as one of the impediments to obtain maximum benefits from the available funding sources (Lange and McNeil, 2004).

In such a context, fund allocation for brownfield revitalization should be inserted in a development strategy popularly known in urban planning circles as smart growth. The concept of smart growth embodies principles seeking to maximize the use of an area's land resources by limiting outward growth, increasing residential densities, creating areas with mixed uses, deemphasizing car use, promoting alternate modes of transportation and creating pedestrian oriented environments. Thus, effective brownfield redevelopment approaches require environmental, socio-economic and urban planning dimensions to be integrated into policies.

Since the targeting instrument plays a crucial role in allocating funds efficiently, the goal of this study is to provide a decision support tool that government planning agencies, developers and other organizations can employ to initially identify which brownfields sites can be redeveloped

in compliance with smart growth principles, while also taking into account critical environmental and socio-economic factors. This tool incorporates and aggregates location-specific socio-economic, environmental and transportation and land use variables into a mapping index showing urban areas with the potential to support brownfield revitalization as a smart growth strategy. Our aim is that future users of this index and the associated maps can pin down those environmentally sensitive, distressed zones with the highest potential for smart growth in order to target brownfield redevelopment efforts towards these areas.

We focus our analysis on the state of Connecticut because its political leadership has been attempting to promote smart growth development patterns over the past decade (Connecticut Office of Brownfield Remediation and Development, 2006), and due to the absence of a clearly established framework for the evaluation and prioritization of brownfield sites at the state level and in cities actively pursuing redevelopment plans such as Hartford, Bridgeport and New Haven. The application of our proposed geospatial decision support tool to New Haven as a case study demonstrates a general prioritization scheme that can be used by urban planners and public agencies to pinpoint smart growth and environmentally sensitive locations that can be set as priority areas for funding.

The report is organized in three chapters: the first details the results of a survey conducted in Connecticut to document the current framework and state-of the-practice for brownfield redevelopment in the state. The second chapter covers the literature review on brownfield redevelopment issues and indexing schemes for smart growth and funding allocation, all of which are integral parts to the research. Chapter 3 then details the indexing approach developed in this research and demonstrates its application in the City of New Haven.

1.2 SURVEY SCOPE AND RESULTS

A number of surveys were conducted both at the State level and for individual cities, in order to identify the existing conditions and to understand the current framework in the state of Connecticut. The target audience for the survey included two member organizations of the Office of Brownfield Remediation and Development (OBRD), the Department of Economic and Community Development (DECD) and Connecticut Brownfields Redevelopment Authority (CBRA); two non-profit regional economic development organizations, the Regional Growth Partnership of South Central Connecticut (RGP) and the Valley Council of Governments (VCOG); and the cities of New Haven, Meriden, Hartford and Bridgeport. Of these institutions, only the latter two cities did not respond to our request. Therefore, organizations and cities involved in the survey were:

- Office of Brownfield Remediation and Development
- Department of Economic and Community Development
- Connecticut Brownfield Redevelopment Authority
- Valley Council of Governments
- City of Meriden
- City of New Haven

The survey was conducted by means of personal interviews with the officials in charge of brownfields issues in each of these organizations. As such, the interviews were informal and mostly took the form of open questions. They were attempted to address the agencies'

involvement in brownfields revitalization, their effectiveness and its interaction with other partner organizations (e.g., EPA). In addition, how agencies classify and select brownfields projects and/or sites for funds allocation and whether they consider Smart Growth and Transit-Oriented Development principles into their criteria is also tackled in the survey. Finally, we allowed the interviewees to express their perceptions about the barriers and challenges for the redevelopment of brownfields in Connecticut. The survey questionnaire is attached in Appendix 1.

The main findings of each interview are summarized for each target institution.

1.2.1 OBRD and DECD

Peter Simmons, DECD: Director of Office of Responsible Development;
Elizabeth Appel, Office of Brownfield Remediation and Development

The Connecticut Office of Brownfield Remediation and Development (OBRD) serves as the governing body for brownfields redevelopment in Connecticut. OBRD works in coordination with the Department of Economic and Community Development (DECD), the Department of Environmental Protection (DEP), and Connecticut Brownfield Redevelopment Authority (CBRA).

1.2.1.1 Smart Growth in CT

The responsible growth program is in its incipient stage in the state of Connecticut. A Plan of Conservation and Development (POCD) is being revised for the state where use of six smart growth principles would be incorporated. The POCD will have a ranking system for six principles and also a bonus point system.

1.2.1.2 Brownfields in CT

Brownfield redevelopment is conceived at the State level from two perspectives: Housing and Economic Development. For the DECD, brownfields are another type of real estate project; consequently, they work with real estate developers in what ultimately is “a question of scale”.

1.2.1.3 How Does Redevelopment Work?

- Developers come to DECD with a project. As clients, the DECD offers them with properties that meet their criteria in terms of size, location, infrastructure, etc.
- Developers approach the towns with their plans (as they but have no money); and then they request funding from the state.
- Continuous Application- This is a platform where towns approach the DECD with applications. This process would be preferred to be held twice a year but currently it is not so.

- Multi-town projects (towns working in collaboration) tend to be prioritized over single town projects. Also, the DECD collaborates with agencies that are involved in Transit-Oriented Development (TOD) projects.
- Some cities like Naugatuck and New Haven are working to rebuild their downtowns.

1.2.1.4 Pertinent Issues with Brownfield Redevelopment in the state of CT

- Taxes associated with abandoned properties. Back taxes on abandoned properties tend to be a stumbling block to redevelopment.
- Brownfield redevelopment on flood plains is a big issue.
- A steady source of funding is required. Current funding is intermittent, as it relies on bonds and the way the State Bond Commission functions.
- There are a lot of sites that require demolition for redevelopment, which increases the cost by a lot.
- The cost of cleanup and redevelopment is perceived to be much higher than the benefits after redevelopment.
- Time predictions- Most businesses, after acquiring a loan, have a six month window to start building or developing. However, the investigation and clean up of brownfields tend to take much longer.
- With all these constraints a sense of priority is lost. The state has not been able to target sites they would like to redevelop.

1.2.1.5 Recent Disbursement of Funds ($2.25 million)

In October 2008 five brownfield sites across the state (Figure 1.3) received a total of $2.25 million to assist in redevelopment efforts under a Pilot program.

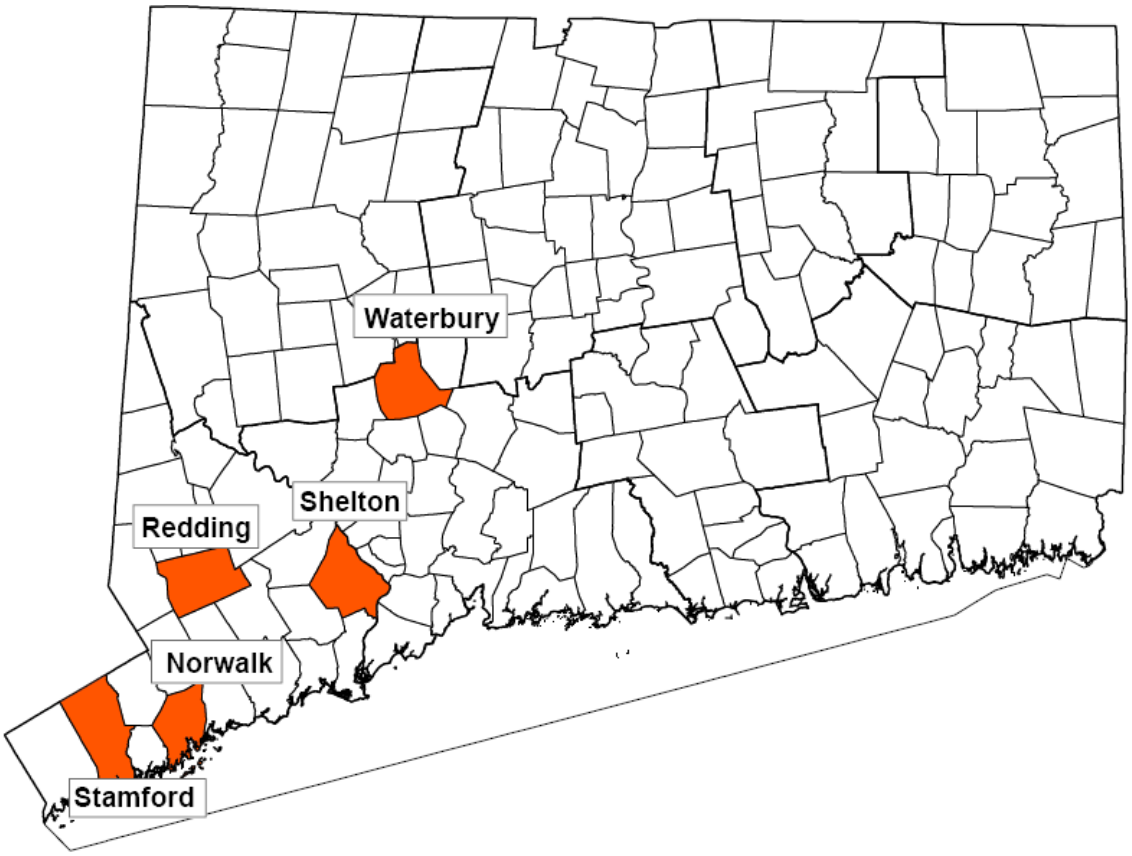


Figure 1.1: Towns that Received a Total of $2.25 Million Funding in October 2008

Letters were sent to all municipalities and16 came forward with proposals among which 5 were selected. This was the first time that redevelopment funds were allocated on a competitive basis.

The allocation of funds was done by assessing the viability of the proposed projects, as well as community impacts. Community Impact assessment involves the analysis of the influence of a project on its community and surrounding towns and cities in terms of generating employment opportunities, increasing the tax base, etc. In such a sense, the applications were ranked on the basis of whether they met Responsible Growth criteria (25 points), as well as readiness to proceed (25 points), demonstration of financial need (25 points) and benefits and impacts (25 points).

1.2.1.6 Funds

Most redevelopment funds come from the state, but some projects also get funding from EPA.

Ideal Case

Ideally, the State could assess the Brownfield sites and get them ready for site selectors. However, due to inadequate resources and funds, this is thought to be next to impossible.

1.2.2 Connecticut Brownfields Redevelopment Authority

Cynthia Petruzzello, Vice president

The Connecticut Brownfields Redevelopment Authority (CBRA) is a subsidiary of the Connecticut Development Authority (CDA). It functions as a bank, co-recycling monies through its various programs: direct, guaranteed and participating loans, and Tax Incremental Financing (TIF).

Financial assistance at CBRA is currently focused on brownfield remediation. In the past, CBRA used to provide funding for site investigations through the Brownfields Assessment Grants (BAG). Though this program was very successful, projects never moved past the assessment stage towards remediation. This motivated CBRA to switch its focus towards cleanup activities.

As an OBRD member organization, CBRA works together with DECD and DEP in providing assistance and financing to lower the financial risks and alleviate the legal, regulatory and environmental risks of brownfield redevelopment. CBRA works with DEP throughout the process of every project, as these all must be backed by environmental certifications under either the DEP or LEP (Licensed Environmental Professionals) programs. CBRA has also partnered with DECD in some projects, yet it has not taken any money from the State in about ten years.

CBRA is a self-sustaining, quasi-public entity, which means it has its own bonding authority. In fact, the CBRA Board meets once a month as opposed to the State Bond Commission, which authorizes DECD funding and meets every six months. This translates in that CBRA-funded projects are larger and move more straightforwardly than DECD-financed ones.

With the aim to encourage redevelopment, CBRA has identified a number of eligible brownfield sites. These comprise an unofficial inventory of municipally recognized priority sites to market for redevelopment. Table 1.1 below provides an account of the inventoried sites as currently reported in CBRA's website; yet Ms. Petruzzello recognized the available brownfields listing needs updating. In most cases, these are prime properties for commercial or industrial use that are located close to major highways and rail lines.

Some of the activities eligible for CBRA support include groundwater remediation, soil removal, installation of engineered controls, long-term groundwater monitoring, and off and on-site testing. CBRA assistance does not cover 'soft costs' such as Transfer Act filings, ELUR document preparation, legal fees, compilation of Remedial Action Plan, and assessment reports, among others (CBRA, 2009). The main criterion for project

screening is the viability of the project itself and of the developer. All of CBRA-approved brownfields remediation projects must have a developer attached, thus guaranteeing that the project will move forward. Despite considering mixed-use ends and the use of green technologies, CBRA does not seem to weigh Smart Growth principles into the evaluation of projects.[1]

For both loans and TIFs, the minimum amount lent is $250,000 ($400,000 for TIFs) and the maximum $10,000,000. The latter amount must be approved by the State legislature. Although CBRA has supported small scale projects, funding seems to be focused on large ones. Indeed, Ms. Petruzzello recognizes that small projects should get more financial assistance, but CBRA is constrained by law to meet the aforementioned disbursement limits. The same amount of paperwork is needed for the screening and execution of all projects, which becomes another comparative disadvantage of smaller-scale projects.

1.2.2.1 Completed, successful projects

Ms. Petruzzello defines these as projects for which the purpose of CBRA financial assistance has been accomplished. The following list is based on the current CBRA's website:

- Killingly Commons (Killingly): approx. 85 acres. Manufacturing and warehouse buildings were previously located there. CBRA approved $1.5 million in TIF for site remediation. Its development is intended for commercial use.
- Legion Square (Berlin): 8 acres. Former municipal solid waste disposal facility redeveloped for commercial use. CBRA provided $675,000 in TIF funds to assist in the environmental remediation of the site.
- Southington Remediation, LLC (Southington): 2 acres. Former sheet metal manufacturing facility. CBRA approved a $250,000 loan to assist the developer. An existing structure was refurbished, and is presently fully leased to a light manufacturing company.
- Goodwin College (East Hartford): Vacant property to be used for the expansion of an educational facility. CBRA provided support through a $3 million grant for environmental remediation.
- University of Hartford Center of Arts (Hartford): Former car dealership to be converted into a performing arts facility.
- Daticon (Norwich): Under-utilized site converted into a data/call center.
- Hudson Baylor Corporation (South Windsor): Abandoned building converted into state-of-the-art recycling center.

[1] When asked about her familiarity with Smart Growth principles, Ms. Petruzzello replied alluding to environment-friendly, energy-saving developments, yet she never mentioned elements such as compact building design, preservation of open space, variety of transportation choices, and encouragement of community involvement. In her view, most projects today incorporate Smart Growth principles, without stating what these principles are.

1.2.2.2 Pending projects

- Fairfield Train Station (Fairfield): Vacant property to be converted into a train station/multi-use complex.
- Retail Facility (Killingly): Former manufacturing facility to be converted into a big box complex.
- North Haven Commons (North Haven): Former scrap yard to be transformed for commercial use through a TIF grant.
- Georgetown Land Development Company (Redding): Former wire mill to be transformed into a mixed-use, transit-oriented center.

1.2.2.3 Archived projects

Ms. Petruzzello referred to these projects as properties for which the city is still seeking a developer. Two archived projects are reported on CBRA's website:

1. Steel Point Peninsula (Bridgeport): 52 acres. Former industrial site proposed for a mixed-use end.
2. 198 River Street (New Haven): 4.15 acres. A steam boiler complex previously operated there. Phase II environmental assessment of the property has been conducted on the site thus far. It remains to complete the environmental characterization of the site (Phase III).

Table 1.1: Account of CBRA's Inventoried Brownfield Sites

***County*/Town**	**No. of Brownfields**
Fairfield	
Bridgeport	27
Danbury	2
Fairfield	3
Newtown	1
Redding	1
Shelton	3
Stratford	7
Hartford	
Berlin	5
Bloomfield	7
Bristol	10
Canton	1
East Hartford	6
Glastonbury	2
Hartford	25
Manchester	5
Newington	1
South Windsor	1
Southington	1
Vernon	2
Litchfield	
Goshen	1
Harwinton	1
Kent	1

New Milford	3
Thomaston	1
Winchester	3
Woodbury	1
Middlesex	
Durham	1
Haddam	7
Westbrook	3
New Haven	
Branford	1
Derby	1
Hamden	3
Meriden	2
Milford	4
New Haven	12
Seymour	1
West Haven	5
New London	
Ledyard	3
Montville	1
New London	14
Norwich	5
Preston	1
Sprague	1
Stonington	1
Tolland	
Coventry	1
Hebron	3
Somers	2
Vernon	1
Windham	
Killingly	1
Plainfield	2
Putnam	1
Sterling	1

Source: CBRA (2009).

1.2.3 City of New Haven

Helen Rosenberg, Economic Development Officer

The current DEP inventory features 35 brownfields sites in New Haven (DEP, 2004), making this City the one with the largest number of brownfields statewide.

According to EPA's website, the City of New Haven has received EPA funding for assessment and remediation of hazardous substances in brownfields sites as detailed in Table 1.2.

The City has further received one grant from the State's Urban Sites Remedial Action Program (USRAP). Due to the characteristics of this program, the Responsible Party

committed to remediating the site.[2] However, this has not been done as yet, and thus remains a pending task.

Table 1.2: Summary of EPA Brownfields Assistance

Grant Number	Grant Type	Amount	Year Awarded	Status
V99183601	Assessment	$120,000	1996	Closed*
		$147,000	1998	
BF97131901	Cleanup of Brewery Building, 456-458 Grand Avenue	$200,000	2005	Active
BF97171801	Cleanup of 34 Lloyd Street	$200,000	2007	Active
BF97171901	Cleanup of 56 River Street	$200,000	2007	Active
Total		$867,000		

* Site assessment activities were conducted at the 112 Chapel St., 46 River St., 100 River St., and 39-49 Dixwell Ave. The grant was closed in September 2003.

Source: USEPA (2008).

In addition to Federal and State funding, the City of New Haven has received some grants and loans for assessment activities from the Regional Growth Partnership (RGP). Table 1.3 summarizes this financial assistance.

Table 1.3: Summary of RGP's Financial Assistance

Year	No. of projects	Funding type			Total ($)
		Loan	Grant	Fifty-fifty	
1997	5		5		80,178.76
1998	4		4		24,000.00
1999	2		2		19,550.00
2001	3		3		42,400.00
2002	4		3	1	82,048.00
2003	5	1	4		38,485.00
2004	3	1	1	1	102,550.00
2007	1		1		13,000.00
Total	27	2	23	2	402,211.76

Source: Own estimations based on Regional Growth Partnership (2009).

The rest of the financing for brownfields revitalization has been provided by the City's own funds. While the City of New Haven does not have a budget for brownfields,[3] the Economic Development Office main task is deemed to be the conduct of assessment and

[2] Under the USRAP, either the State or the Responsible Party conducts the clean up of the brownfield site at hand.
[3] The Economic Development Office is a commitment of the City's own funds.

cleanup activities for facilitating businesses to redevelop there. In this regard, most of the City's monies have been focused on site investigations.

The main criterion for the prioritization of brownfields sites in New Haven stresses economic development, so that properties that are most likely to foster job creation and tax generation receive support. Given that there are not too many large brownfields in New Haven, most of the projects promoted by the City involve small-sized sites. Furthermore, Ms. Rosenberg notes that small projects are easy to promote.

Regarding Smart Growth principles, the Economic Development Office considers that any brownfields revitalization activity conducted in the City of New Haven contributes to Smart Growth since brownfields sites are located within the municipality. None of the projects supported thus far involves Transit-Oriented Developments, though.

Besides economic issues, Ms. Rosenberg considers there are bureaucratic obstacles for brownfields revitalization in New Haven. It takes time, in particular, to get funding from both the Federal and State levels. Moreover, changes in the environmental certification and cleanup processes that are controlled by the DEP are often occurring during the projects, further slowing the redevelopment process.

1.2.4 City of Meriden

Peggy Brennan, Economic Development Director

The City of Meriden provides staff support to the Brownfields Program, is contributing funds to clean up the HUB site and does flood control work throughout the city. Its Economic Development Office manages the various brownfields grants the City has received from state and federal agencies and staffs the Blight and Brownfields Committee (City of Meriden, 2008?).

Meriden works hand-in-hand with the Blight and Brownfields Committee, which is committed to involving community residents and stakeholders in all phases of brownfields cleanup and redevelopment. The City initially compiled an inventory of contaminated sites for purposes of public intervention. This listing was subsequently shortened to two major brownfields properties, as the City of Meriden is not concerned with the revitalization of privately-owned contaminated lands. Thus, Meriden's Blight and Brownfields Committee is involved in the revitalization of the following properties (see City of Meriden, 2008?):

1. Factory H on Cooper Street: approx. 7.2 acres.
   Formerly housed Meriden's International Silver Company (Factory H), the City took title to this abandoned property for flood control work through condemnation in June 2007. A participatory reuse planning workshop in 2006 produced a redevelopment concept that includes the redevelopment of vacant commercial and office structures adjacent to Factory H, thus generating between 75 and 100 new jobs. Nonetheless,

marketability would be possible once the site is demolished since the structures are deteriorated, structurally unsafe and cannot be reused.
USEPA funded friable asbestos/lead removal from the structures under its hazards removal program ($1.5 million), yet contained asbestos has not been removed. Although the City received EPA commitments of $800,000 for testing and soil remediation, no funds have been committed for demolition.

2. HUB block in the downtown: 14.40 acres.
Previously a center of industrial and commercial activity in Meriden's downtown, the HUB consists of two tax parcels: 77 State Street and 50 East Main Street. The latter site consists of a grassed area comprising an interim site remediation area and paved parking areas with limited access. The City acquired title to the property in 2005, after determining it would be in its best interest to do so along with the implementation of a flood control plan.
The City has completed a Site Reuse Concept Plan that calls for the site to be transformed into a park that serves the dual purposes of providing public green space and flood storage downtown. It also calls for the development of over 150,000 sq. ft. of developable office and retail space, an intermodal transportation center and a parking area. This approach is consistent with both Transit Oriented Development (TOD) and Smart Growth principles due to the fact that the site is located in close proximity to existing transit facilities and within the Central Business District (CBD).
Preliminary cost estimates to implement the Site Reuse Concept Plan (excluding both contingencies and the transportation center component) include $940,000 for engineering work, $3.8 million for environmental remediation, $1.6 million for flood control work, and $3.9 million for park construction. The State legislature recently approved the authorization of $9 million in state bond funds for the implementation of flood control measures at the HUB site and up to $1 million for improvements to the transportation center. A full allocation of these funds by the State Bond Commission is considered critical to the continuation of the project.

1.2.4.1 Interaction with other agencies

Meriden has been fortunate to have the support of EPA's Brownfields Program. This program awarded the City a grant of $200,000 in 2004, which was used to further test Factory H and to support a neighborhood-based reuse planning effort for the site. Also, EPA has provided financial support to conduct environmental assessments at both the Factory H site and the HUB site downtown and awarded Meriden a $200,000 cleanup grant for the HUB site in 2006. This grant was used to stabilize and manage contaminants on an interim basis after the vacant, 150,000 square foot HUB building was demolished in June 2007. In 2007, EPA's Brownfields Program awarded three additional grants to Meriden –$200,000 for assessments targeting the Factory H site and other properties in the two neighborhoods bordering Factory H and $400,000 to help cleanup contamination at Factory H. Additionally, in 2008 EPA's Hazards Removal Division removed friable asbestos from the vacant and deteriorated Factory H buildings at the cost of $1.5 million (City of Meriden, 2008?).

While Ms. Brennan observes that Meriden's definition of brownfields slightly differs from DEP's concept, she recognizes that this agency has been very supportive of the City's brownfields program. Of the seven Meriden's sites featured in the current DEP inventory, the Department completed a one-million dollar trust clean up of hazards at Factory H and provided the City with financial support to do an environmental assessment at the HUB. In addition, DEP staff attends the Blight and Brownfields Committee meetings, public meetings and serve as technical staff support to the City of Meriden's brownfields initiatives.

Furthermore, DECD has been a strong supporter of Meriden's brownfields redevelopment efforts. In conjunction with DEP, DECD provided grant funds to clean up the former Meriden Rolling Mills site. Also, DECD has provided Meriden with a $2 million grant that supported the demolition of the vacant 150,000 sq ft HUB building downtown. Without their financial assistance, Meriden would not have been able to start redevelopment of the HUB site. DECD staff also provides technical help and expertise to Meriden's brownfields program (City of Meriden, 2008?).

The Regional Growth Partnership of South Central Connecticut provided an assessment loan for $15,039.5 to one private site in Meriden in 2003, as well as a small grant ($4,575) to the City for asbestos removal at the HUB building. By administering an EPA Revolving Loan Fund, it supplied a $500,000 loan to Meriden Enterprise Center, located at 290 Pratt Street, for the implementation of cleanup plans. This loan was closed in December 2006, when the borrower paid it back with the receipts of a contribution action imposed on a former property owner.

Ms. Brennan pointed out that, since Meriden has no means to pay off loans and the two sites described above will be used for purposes other than increasing tax revenue (flood control), the City does not have a close relation with CBRA.

1.2.4.2 Barriers to brownfields revitalization

Drawing attention to the importance of economic barriers to brownfields revitalization, Ms. Brennan indicates that 99 percent of contaminated lands exhibit lack of funding. In this regard, she stresses the fact that funding is usually focused on the brownfields character of these sites, thus overlooking other structural and environmental features that may strongly affect the remediation and redevelopment process such as geographical location (e.g. harbors) and type of terrain (e.g. flood plains). She further suggests taking a look at the realities of each site and accordingly considering its marketability and the kind of assistance needed.

1.2.5 Regional Growth Partnership

Peter Stein, Director
Stephen Beck, Brownfields Coordinator

The Regional Growth Partnership (RGP) is a non-profit regional economic development organization serving the fifteen municipalities comprised in South Central Connecticut. Founded in 1996, RGP's primary mission is to encourage cohesiveness between the public and private sectors in the development of policies and programs designed to make the South Central Connecticut region more competitive in the global economy.

RGP's running costs are supported by both associated members and USEPA. Operating costs are financed through contributions from the fifteen municipalities and the business community. In addition, RGP receives a small amount of money from EPA for staff.

Since its creation in 1998-99, funding to support the RGP Brownfields Program has come from two sources: CTDECD and USEPA. DECD provided funding to RGP in the early 2000s with the only proviso that the monies were used to promote assessment activities. Likewise, RGP currently administers two EPA grants: a one-million-dollar Revolving Loan Fund received in 2003 for the cleanup of contaminated sites,[4] and $200,000 from a Petroleum Assessment Grant (see EPA, 2009). Both RGP officials commented that they have no knowledge of CBRA's existence and activities.[5]

RGP has a very well-developed program for assisting towns and private developers with the revitalization of brownfield sites. It offers two types of funding assistance for these types of sites (RGP, 2007?):

- Assessment funds can be used to complete Phase I, Phase II or Phase III environmental site assessments, as well as some cleanup planning activities. Depending on the source of funds, these are structured as both loans and outright grants. While funding for towns takes the form of either grants or grants and loans, it consists of loans when the recipients are private owners.
- Remediation funds are structured as loans and can be used to support cleanup activities, demolition and site preparation, and ongoing site monitoring.

The RGP Brownfields Program operates on the basis of projects submitted by municipalities and developers. When a project involves a loan for its execution, the application must have the approval of the town. The Regional Brownfields Committee, composed by municipalities and people with experience on brownfields, decides on whether to fund projects based on their potential to create jobs and increase tax revenue.

[4] It is worth highlighting that the first RGP's EPA Brownfields Revolving Loan Fund (RLF) loan was made to the Meriden Enterprise Center, located at 290 Pratt Street in Meriden, for funding remediation of hazardous substances. This $500,000 loan was closed on December 27, 2006, on the grounds that the borrower paid it back with the receipts of a contribution action imposed on a former property owner. In this case, the remediation of the site was complete.

[5] Concerning this issue, Mr. Beck mentioned that he has had telephone contact with Cynthia Petruzzello in just one opportunity, and hinted that this contact has not transcended into funding or any sort of joint initiative benefiting RGP's town members.

Moreover, the main criterion for providing support for site investigations takes into account the meritness of the project rather than the creditworthiness of the owner.

The RGP Brownfields Program has secured over $2,000,000 in state and federal funding for brownfields assessment and cleanup and overseeing the investment of these funds in 76 different properties for more than 10 years. As seen in Table 1.4, most of the financial assistance has been devoted to site investigations, comprising 80 projects as compared to only two sites supported for remediation. According to the interviewees, funds have been more or less evenly distributed between small and large scale projects.

Table 1.4: Summary of RGP Financial Assistance for Brownfields

Year	No. of projects	Activity		Funding type			Total ($)
		Assessment	Remediation	Loan	Grant	Fifty-fifty	
1997	15	15			15		158,513.76
1998	14	14			14		143,654.00
1999	5	5			5		40,310.00
2001	5	5		1	4		86,055.21
2002	9	9		1	7	1	202,698.00
2003	12	12		4	8		110,701.75
2004	8	8		4	3	1	270,364.08
2005	1	1		1			29,525.00
2006	3	2	1	3			529,200.00
2007	4	4		1	3		124,000.00
2008	1	1			1		1,200.00
2009 & pending	5	4	1	1	4		533,500.00
Total	82	80	2	16	64	2	2,229,721.8

Source: Own estimations based on Regional Growth Partnership (2009).

Most of RGP-supported projects basically deal with commercial and mixed-use developments. RGP officials consider that, as stated in the 2008 Comprehensive Economic Development Strategy (CEDS), promoting both Smart Growth and Transit-Oriented Development principles constitutes region's communities goals to which the Partnership should aim through assistance in developing and implementing land-use policies. Whereas there has not been any big effort in the promotion of Smart Growth principles as yet, Transit-Oriented Developments have received more support.

While RGP compiled an inventory of brownfields sites ten years ago, this list seems to be of little use in the current performance of the Partnership's tasks. Although Mr. Stein and Mr. Beck define a successful project as one that has led to a redeveloped, operating site, both of them admit not being aware of how many successful projects RGP has funded thus far. They say nobody has conducted a follow-up of the projects in this regard.

Even though both Mr. Stein and Mr. Beck acknowledge that the biggest obstacle for brownfields revitalization is the economic one, they also take account of other types of barriers. In particular, getting funding for the so-called 'soft costs' (e.g. assessment reports, engineering work, legal fees, demolitions, etc.) and finding developers interested

in 'dirty' properties are among the major challenges facing the redevelopment of contaminated sites.

In a far-reaching attempt to address these non-environmental barriers to the revitalization of brownfields and other types of challenging urban properties, RGP has recently developed a proposal to expand its brownfields program into a Regional Predevelopment Fund. This proposal is stated in the 2008 CEDS, in which the redevelopment of properties that suffer from environmental contamination is regarded as a crucial strategy to face the limited amount of land for new development in the region. Particularly, RGP intends to provide financial assistance to 32 new sites by 2011 by putting this strategic plan into action.[6] Municipal, federal and private officials in the region have identified the Predevelopment Fund as a key tool for economic development (RGP, 2007?).

1.2.6 Valley Council of Government – Regional Brownfields Partnership of West

Central CT
Richard Dunne, Executive Director
Arthur Bogen, Environmental Planner

The Valley Council of Governments (VCOG) is a public agency responsible for planning and implementing economic and development activities which have a regional impact on the Lower Naugatuck Valley in Southwestern Connecticut. Their activities include the creating of a master plan for the entire region, administering state and federal grants, transportation planning, brownfields redevelopment, census information and aiding in the overall economic development of the region (VCOG, 2008).

The VCOG, through its Regional Brownfields Partnership of West Central Connecticut (RBP), oversees and conducts a range of assistance activities across a 25-town region for the identification, assessment and remediation of brownfields sites.[7] Formerly the Naugatuck Valley Brownfields Pilot, RBP was established through an EPA grant in November 1996. The purpose of the RBP is to provide brownfields management capacity and financial resources for its municipal members (VCOG, 2008).

Services:
1. Site assessment grants
2. Clean-up loans
3. Brownfields site evaluations at no direct charge
4. Consultation on tax foreclosure environmental considerations

[6] The 2008 CEDS aims to establish a multi-year funding commitment to support the implementation of its goals and objectives.
[7] Municipal RBP members are Ansonia, Beacon Falls, Berlin, Bristol, Burlington, Derby, Naugatuck, New Britain, Newtown, Oxford, Plainville, Plymouth, Seymour, Shelton, Southington, Thomaston, Waterbury and Watertown. Additionally, the Comprehensive Economic Development Strategy (CEDS) municipalities eligible for funding are Bethlehem, Cheshire, Middlebury, Prospect, Southbury, Wolcott and Woodbury. The RBP also provides administrative services to the City of Danbury Revolving Loan Cleanup Fund.

5. Low cost site assessment management
6. Community outreach and educational seminars: Non-point source pollution reduction, developer requirements, site reuse insurance options
7. Regulatory interface and coordination
8. Information on and access to DEP, DECD, and US Department of Housing and Urban Development related brownfields programs
9. Links to developers
10. Anti-blight management assistance on abandoned sites

Members are eligible to access funding from any of RBP's various programs, including EPA site assessment grants and economic development loans for investigation and remediation for both public and privately-owned sites. VCOG also manages revolving loan funds in conjunction with the state and federal governments, potentially providing large amounts of money for difficult site cleanups (VCOG, 2008).[8]

Member municipalities pay an annual $800 dues fee. This income provides for quarterly EPA reports, preliminary site research, community outreach, and liaison for developer and community inquiries, among other activities. In addition, each community pays fees equal to 10% of the value of an assessment grant. These monies are used to pay for the staff and supplies needed to conduct calls for proposals and to serve as liaison to regulatory agencies in the process (VCOG, 2008).

Since 1996, RBP has assessed over 80 sites, provided educational outreach, and received support from different federal, state and regional organizations. According to the RBP's website, the following are some of the activities that have received additional resources:[9]
• Original EPA grant to establish the Naugatuck Valley Brownfields Pilot, $90,000
• Supplemental EPA grant to expand and continue RBP activities, $110,000
• Community Foundation of Greater New Haven for outreach and education, $50,000
• Community Foundation of Greater New Haven for regional economic redevelopment of brownfields sites and an application for a Revolving Loan Fund, $50,000
• EPA Showcase grant to develop inter-RBP regional assessment protocols
• Matthies Foundation to institute best management practices for non-point pollution at Seymour and RBP Brownfield sites in partnership with the UCONN NEMO Project, $15,000
• RBP receives management fees for developing and administering the $500,000 Danbury Revolving Loan Fund
• Revolving Loan Fund: the RBP anticipates fees for loans to be provided for cleanup
• The City of Derby is paying the RBP to manage the environmental assessment of the Downtown Revitalization District, $14,800
• Jobs Training Grant in partnership with Naugatuck Valley Project, TEAM, Inc., the WorkPlace, Inc. and several corporate partners, $200,000.

[8] Each Partnership member has access to $350,000 of short-term, low-cost cleanup loans. The objective is to make no interest bridge loans to member municipalities and qualified individuals and companies. Expanded funds are possible after the successful implementation of the program.
[9] It is worth noting that, as the interviewees admitted, the website has not been updated in about two years.

As a component of the foundational EPA grant, RBP conducted to some extent an inventory of brownfields sites.[10] Rather than choosing among projects, VCOG has always moved along a timeline.[11] Furthermore, the interviewees indicate the infeasibility of developing projects with CBRA even though they have had contact with this quasi-public organization regarding implementing TIFs on a couple of contaminated properties.

Mr. Bogen defines a successful brownfield project as one that increases public awareness about the issues that need to be addressed in the remediation of the corresponding contaminated site and about where to go in the pursuit of solutions to those issues as well.

1.2.6.1 Barriers to brownfields revitalization

The interviewees mainly focus on legal and economic obstacles for the revitalization of brownfields in Connecticut.

Legal

The interviewees highlight that environmental problems oftentimes come from the way governments have structured the laws. As regards brownfields remediation, they emphasize legal issues, rather than technology, as elements making the cleanup of contaminated lands costlier, and pointed to several issues arising from laws at both the State and the Federal level:

- CERCLA: Mr. Bogen stresses the Superfund Act is a very inefficient way to deal with site remediation and afterwards brings in, among others, the following reasons:
  - The current legal framework does not allow RBP to intervene in some types of properties, such as Superfund sites,
  - The continual character of joint-and-several liability makes access to cleanup funding difficult,

  Finally, he mentions the great expectations arisen from the upcoming new Federal brownfields law introducing changes in CERCLA.

- Other legal and regulatory issues:
  - Costs increased due to specific methodologies stated in the regulations,
  - The interpretation of regulations varies from person to person at the DEP level, and
  - That private information in the hands of a public agency becomes public information makes private owners/developers reluctant to disclose information, and thus hinders the remediation and redevelopment of private properties

[10] EPA provided $417,000 for the foundation of RBP through an assessment grant for hazardous substances. Subsequent EPA funding for the VCOG include a Revolving Loan Fund ($850,000) with Danbury in 2000, a Petroleum Assessment Grant for $200,000 in 2004, and a $200,000 Assessment Grant for hazardous substances in 2005 (EPA, 2006).

[11] Mr. Bogen notes that, when assessing a brownfields project, RBP takes into account the possibility of increasing public awareness on brownfields revitalization and of improving the interaction among the agencies involved in this process, in addition to economic criteria.

Economic:

Mr. Bogen points out the following economic barriers to brownfields revitalization:

- Restrictions to get back taxes in municipalities with vacant (abandoned) sites;
- Both public and private owners have to compete for assessment resources;
- Many brownfields programs do not provide funding for administrative and soft costs;
- Difficulties to remediate a site when there is not a good deal in place, i.e. when a specific end use has not been defined;[12]
- Compared to other states, CT has disadvantages in attracting brownfields developers due to its legislation, limited space, high tax rates, and costly electricity; and

1.2.6.2 Responsible Growth Agenda

The VCOG has developed a Responsible Growth Agenda that will encourage development patterns at the municipal and regional levels with the aim to foster (VCOG, 2008):

- Preservation of greenspace,
- Economically feasible redevelopment of infrastructure-rich brownfields,
- Sustainable development practices that both conserve energy and protect the environment,
- Planning and construction of new commuting options that reduce community's carbon footprint and allow commuters to give up their motor vehicles for convenient and efficient public transportation, and
- Coordination of all of these aspects of Responsible Growth to assure the state and federal governments that their investments in the growth and development of the Valley region meet established criteria in order to target funds for uses that are consistent with VCOG shared goals for responsible growth.

The Responsible Growth Agenda is part of the 2008 Comprehensive Economic Development Strategy (CEDS), which reflects a pragmatic view of the future of the Lower Naugatuck Valley.[13] Among the goals of this Agenda are the following (VCOG, 2008):

Land Use

- Open Space: Develop model regulations that preserve greenspace through sensible densities that provide incentives for the recycling of brownfields and existing infrastructure.

[12] In this sense, Mr. Bogen remarks that end uses should be not only revenue generating, but create lifestyle amenities as well.

[13] As the VCOG seeks support for accomplishing the 2008 CEDS, some of the objectives of this strategic plan may have been included just to increase the chances of obtaining funding. Mr. Bogen notes that this is especially the case as TOD districts concerns.

Transportation

- Transit-Oriented Development Districts: Identify likely sites with developed and underutilized infrastructure, current and future commuter opportunities and possibilities for more dense mixed-use development.

Brownfields (Assessment, Remediation, Low-Impact Development)

- Develop/Implement planning models for Sustainable Development
- Human health risk abatement
- Define sites aligned to Transit-Oriented Development priorities
- Define sites aligned to Plan of Conservation and Development, Aquifers
- Define multiple funding resources for assessment, remediation and development
- Link to economic development
  Create information sheets on sites
  Connect with National Brownfields Association and other groups
- Identify housing reuse of sites where possible
  Link to alternative energy for funding and economic leverage to offset assessment, cleanup and inherent timeline costs

1.2.7 Survey Conclusions

The main survey findings are summarized as follows:

On the Agencies Status and Interaction

This survey allowed us to have a better idea of how the different institutions and programs at the local, regional, Federal and State levels are organized to provide funding solutions and liability protection to municipalities and developers pursuing the revitalization of specific brownfields sites. Such organizational structure is presented in the diagram below, and the interaction among the different entities is described in detail in the summary of each stakeholder. Particularly in relation to our previous knowledge of this structure, it is worth noting that the survey enabled us to clarify that:

- CBRA provides financial assistance for brownfields remediation by co-recycling monies through its various programs: direct, guaranteed and participating loans, and Tax Incremental Financing (TIF).
- Since the creation of the regional economic development entities (henceforth Partnerships), funding to support their brownfields programs comes primarily from USEPA. Indeed, one of their main activities concerns the administration of EPA site assessment grants and of both Federal and State Revolving Loan Funds for difficult site cleanups.

It is also noteworthy that some partnerships and municipalities stressed the infeasibility of developing projects with CBRA support. On the one hand, the Partnerships barely have had contact with CBRA, and so they have not partnered in providing financial solutions to any Southern municipality in Connecticut as yet. On the other hand, some municipalities (e.g. the City of Meriden) have no means to pay back any type of loan

and/or aim to redevelop brownfields sites for purposes other than increasing tax revenue, both of which situations making them ineligible to receive funding from CBRA.

On Brownfields Classification and Prioritization

While all the surveyed organizations have compiled sites inventories in their respective jurisdictions sometime in the past, these listings seem to be of little use in the current performance of their tasks. In any case, these institutions do not exhibit a common approach to intervention on brownfields, which is reflected in the diversity of procedures and criteria for the classification, prioritization and ultimate selection of contaminated lands, even within a specific type of stakeholder. Thus, for instance, CBRA's main criterion for project screening takes account of the viability of the project itself and of the developer,[14] just like any bank. This results in that CBRA's eligible brownfields sites are primarily properties for commercial or industrial use.

Like CBRA, the RGP Brownfields Program operates on the basis of projects submitted by municipalities and developers. In contrast, the VCOG goes beyond such modus operandi to offer consultation services, community outreach, regulatory interface and coordination with other agencies and developers, among many other activities. Even with these differences, both Partnerships have in common not receiving any application from a private owner unless it has the endorsement of the concerned municipality.

Moreover, while the RGP Brownfields Committee decides on whether to fund projects based on their potential to create jobs and increase tax revenue, RBP takes into consideration the possibility of increasing public awareness on brownfields revitalization and of improving the interaction among the agencies involved in the process, in addition to economic criteria. Despite these methodological discrepancies, the main criterion for both of the Partnerships to provide support for site investigations deals with the contribution of the brownfield in question −once hypothetically redeveloped− to the community's benefit rather than with the creditworthiness of the owner, resulting in an overall favorable reception of these initiatives and/or requests.

The discrepancy between economic and other objectives is also present in the decision-making of the cities of New Haven and Meriden: Whereas New Haven prioritizes economic development (i.e. job creation and tax generation) in the evaluation of brownfields projects, Meriden stresses the possibility of public intervention in the revitalization of floodable contaminated areas.[15] Similarly, CBRA and the City of New Haven do not seem to ponder Smart Growth principles when assessing projects, which contrasts to the Partnerships' and the City of Meriden's sheer emphasis on promoting those principles, and especially Transit-Oriented Developments.

Barriers to brownfields revitalization

[14] Recall that all of CBRA-approved brownfields remediation projects must have a developer attached, thus guaranteeing its moving forward.

[15] In this regard, it is worth noting that the City of Meriden is not concerned with the revitalization of privately-owned brownfields sites.

Though all of the interviewees point to economics as the biggest obstacle for brownfields revitalization, they also take into account other types of barriers. A number of related challenging issues are described in what follows:

Economic

The interviewees in general focus on the economic obstacles for the revitalization of brownfields in CT. Some of the most frequently mentioned economic barriers are:

(a) Getting funding for 'soft costs':

Many Federal and State brownfields programs do not provide funding for administrative and so-called soft costs (e.g. assessment reports, legal fees, compilation of Remedial Action Plans, among others). For instance, none of CBRA programs finance such types of costs (CBRA, 2009).

In an attempt to overcome the difficulties that this situation poses, the Partnerships provide direct and indirect assistance to cover administrative and soft costs. This does not seem to be enough, though, as these economic development organizations themselves recognize the need for more resources.

(b) Finding developers interested in 'dirty' properties:

Connecticut faces difficulties in attracting brownfields developers because, in addition to the environmental and legal issues attached to contaminated sites, its legislation, limited space, high tax rates, and costly electricity bring about comparative disadvantages.

(c) Focus on brownfield character:

Funding is usually focused on the brownfields character of the sites, thus overlooking other structural and environmental features that may strongly affect the remediation and redevelopment process such as geographical location (e.g. harbors) and type of terrain (e.g. flood plains).

(d) Difficulties to remediate a site when there is not a good deal in place, and particularly when a specific end use has not been defined.

(e) Getting funding for small projects:

CBRA funding seems to be focused on large scale projects. In this regard, Cynthia Petruzzello recognizes that small projects should get more financial assistance, yet CBRA is constrained by law to meet certain disbursement limits. This is not the case with the Partnerships, which have provided small grants for particular brownfields sites several times in the past.

Another comparative disadvantage of small projects, as highlighted by Ms. Petruzzello, deals with the fact that the screening and execution of both small and large scale projects requires the same amount of paperwork.

(f) Other economic barriers:

- Restrictions to get back taxes in municipalities with vacant (abandoned) sites.
- Both public and private owners have to compete for assessment resources.

Legal

The interviewees emphasize legal issues, rather than technology, as elements making the cleanup of contaminated lands costlier, and point to several issues arising from laws at both the State and the Federal level:

(a) CERCLA:

- The current legal framework does not allow institutions involved in brownfields revitalization to intervene in some types of properties, such as Superfund sites.
- The continual character of joint-and-several liability makes access to cleanup funding difficult.

(b) Other legal and regulatory issues:

- Costs increased due to specific methodologies stated in the regulations.
- That private information in the hands of a public agency becomes public information makes private owners/developers reluctant to disclose information, and thus hinders the remediation and redevelopment of private properties.

Bureaucratic

- It takes time to get funding from both the Federal and State levels.
- Oftentimes projects find changes in their processes, especially concerning DEP. In this regard, it has been noted that the interpretation of regulations differs among DEP experts, thus resulting in seemingly inconsistent procedures and changes along the way.

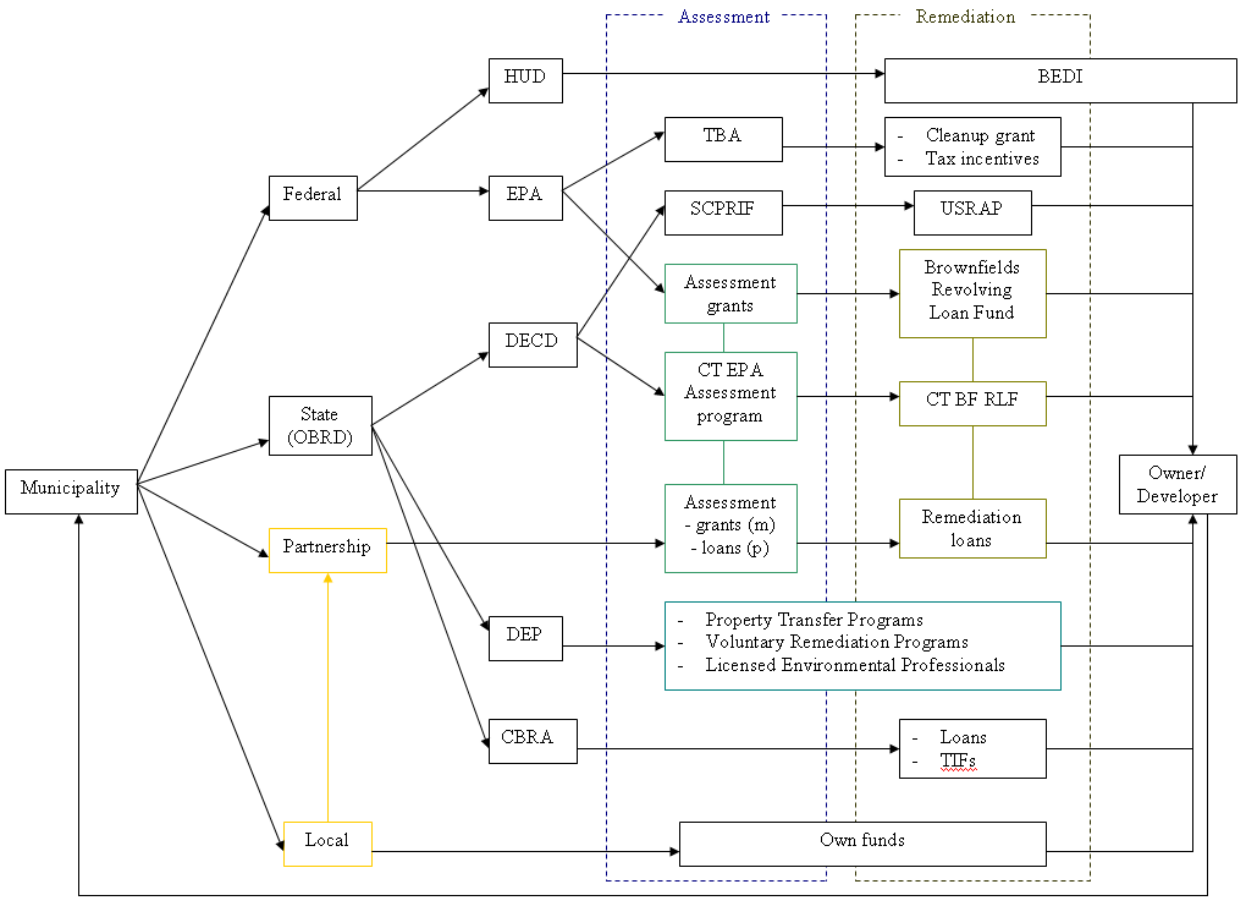


Figure 1.2: Organization Framework of Brownfield Redevelopment in Connecticut

2.0 LITERATURE REVIEW

2.1 DEFINING BROWNFIELDS

The United States Environmental Protection Agency (USEPA) identifies brownfields as "real property, the expansion, redevelopment or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant." Another definition further specifies brownfield properties as "abandoned, idle or underused industrial and commercial properties". The lack of specific details in the definition itself contends that brownfields can be of different size, shapes and can contain variable extent and nature of contaminants. The definition of brownfields has, however, eliminated the negative connotations associated with contamination and superfund sites, and helped brownfields to be seen as counterpoint of Greenfields (Howland, 2007).

The EPA estimates there are approximately 425,000 brownfield sites in the U.S. Brownfields were initially regulated by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 1980. At present brownfield redevelopment is guided by the Small Business Liability Relief Act, 2002 (Bacot & O'Dell, 2006).

2.1.1 Why Redevelop Brownfields?

The cleanup and reuse of Brownfield is attractive to communities and policy makers for three reasons. First, they reduce the adverse effects of the site's soil and water pollution on human health and ecological systems. Second, they help stop the conversion of agricultural land and rural sites to urban uses and other development patterns that generate environmental problems, congestion and sprawl. Third, they promote revitalization in inner cities and are, therefore, potentially important components of sustainable economic growth.

While the private sectors are provided with opportunities for profit through Brownfield redevelopment, the public benefits indirectly from creation of job opportunities and tax base (McCarthy, 2002). Also, most of the Brownfield are located in distressed neighborhoods representing an eroded industrial base and lack of services. Remediation of Brownfield in such areas becomes essential to address environmental and social justice issues (Greenberg, 2000). Brownfield redevelopment is ultimately smart development, as both smart growth and Brownfield redevelopment share an ultimate common goal – namely, revitalization of the urban cores.

2.2 FEDERAL AND STATE GRANTS FOR BROWNFIELD REMEDIATION AND DEVELOPMENT

The US EPA, the State of Connecticut and some programs that serve specific towns and regions of the State provide many sources of financial assistance for Brownfield redevelopment projects, with different eligibility and funding criteria. Some of the funding sources that are available at the state and federal levels are:

2.2.1 Federal Programs

As part of the Small Business Liability Relief and Brownfields Revitalization Act, EPA has designed programs for municipalities and eligible non-profit organizations that provide direct financial assistance for brownfields assessment and cleanup, as well as revolving loans and environmental job training. These grants may be used to address sites contaminated by petroleum and hazardous substances, pollutants, or contaminants (including hazardous substances co-mingled with petroleum), as described below. In addition, EPA provides technical information on brownfields financing matters.

2.2.1.1 Assessment Grants

These grants provide funding to inventory, characterize, assess, and conduct planning and community involvement related to brownfield sites. Eligible entities may apply for up to $200,000 to assess a site contaminated by hazardous substances, pollutants, or contaminants (including hazardous substances co-mingled with petroleum) and up to $200,000 to address a site contaminated by petroleum. Applicants may seek waivers based on the anticipated level of hazardous substances, pollutants, or contaminants at a single site. The performance period for these grants is two years.

2.2.1.2 Revolving Loan Fund (RLF) Grants

These grants allow their recipients (States, political subdivisions, and Indian tribes) to provide subgrants (i.e. low interest loans) to carry out remediation activities, and thereby encourage stakeholders to leverage the resources needed to clean up and redevelop brownfields. When loans are repaid, the loan amount is returned into the fund and re-lent to other borrowers, providing an ongoing source of capital within the community.

2.2.1.3 Cleanup Grants

These grants provide funding to carry out cleanup activities. Applicants must own the brownfield site or demonstrate the ability to acquire title. Eligible entities may apply for up to $200,000 per site, and should not apply for funding at more than five sites. These funds may be used to address sites contaminated by petroleum and hazardous substances, pollutants, or contaminants (including hazardous substances co-mingled with petroleum). These types of grants require a 20 percent cost share –which may be in the form of a contribution of money, labor, material, or services– for certain activities excluding administrative costs. Applicants may request a waiver of the 20 percent cost share requirement based on hardship. The performance period for these grants is two years.

2.2.1.4 Targeted Brownfields Assessment (TBA) Program

This program is designed to help states, tribes, and municipalities –especially those without EPA Brownfields Assessment Pilots/Grants– minimize the uncertainties of contamination often associated with brownfields. TBA assistance is available through two sources: directly from EPA, and from state or tribal voluntary response program

offices. TBAs supplement and work with other efforts under EPA's Brownfields Program to promote the cleanup and redevelopment of brownfields.

Also, the Housing and Urban Development Department (HUD) has a ***Brownfields Economic Development Incentive (BEDI)***, which is a competitive grant designed to assist cities with the redevelopment of brownfields. BEDI grant funds are primarily targeted for enhancing the security or improving the viability of economic development projects financed with Section 108-guaranteed loan commitment.[16]

2.2.2 Connecticut Brownfields Related Program

The Connecticut Office of Brownfield Remediation and Development (OBRD) in partnership with the Department of Economic and Community Development (DECD), the Department of Environmental Protection (DEP), and Connecticut Brownfield Redevelopment Authority (CBRA) serve as the governing body for Brownfield redevelopment in Connecticut. OBRD is the primary assistance office, created by the General Assembly in 2006, as an operating office located within the DECD. OBRD has been assigned the responsibilities that include

- providing assistance to developers,
- streamline the development process,
- identifying sources of funding, size, state-wide Brownfield,
- developing procedures for expediting the application of funds,
- identify and prioritize development opportunities,
- provide assistance and information concerning the state's technical assistance, funding, regulatory and permitting programs,
- develop a communication and outreach program to educate municipalities, property owners, economic development agencies and other organization on the state's Brownfield program

The designated partner agencies of the OBRD have entered a Memorandum of Understanding (MOU) in 2007. The MOU has been established to delineate each partner agency's responsibilities with respect to the OBRD, foster cooperation among such agencies to create a process for the remediation and redevelopment of Brownfield on an expedited basis, promote OBRD as the institutional focal point to address Brownfield issues in Connecticut. Although establishment of OBRD is an important initiative towards working on Brownfield for the state of Connecticut, the Taskforce Report on Brownfield (2008) contends that CT is, in fact, lagging behind other states in terms of funding available to Brownfield. The new programs created are subjected to the availability of funds; and the lack of tools needed to fuel Brownfield redevelopment further make matters worse.

In Connecticut, eligible applicants for financial assistance for Brownfield redevelopment are defined under Public Act as "any municipality, a for-profit or non-profit organization, or entity acting on behalf of a municipality or any combination thereof" (State of Connecticut, Substitute House Bill No 7369). Eligible applicants are required to submit an application for financial

[16] Section 108 is the loan guarantee provision of the Community Development Block Grant (CDBG) program. CDBG entitlement communities and non-entitlement communities are eligible to receive loan guarantees. BEDI funds minimize the potential loss of future CDBG allocations.

assistance to the Commissioner of DECD on standard forms. An eligible applicant is at minimum required to provide adequate information that provides a detailed description of the project, the expected benefits of the project, information pertaining to the financial and technical capability of the applicant, information that depicts the conditions of the property in concern along with environmental assessment results, and names of individuals liable for the remediation of the property.

2.2.2.1 Connecticut Environmental Assistance Programs

The State of Connecticut offers a wide range of programs dealing with funding the assessment, remediation and development of Brownfield areas. Although not a comprehensive list, the programs described below attempt to provide a synopsis of the most important State initiatives:

2.2.2.1.1 Brownfield Municipal Pilot Program

This is a competitive program for municipalities with projects that have been "complicated by Brownfield but may on completion make a significant economic impact." Last year, five municipalities and municipal entities were granted funds for environmental investigation and cleanup taking into account population criteria.[17] Applications were ranked on the basis of Responsible Growth (25 points), Readiness to proceed (25 points), Demonstration of Financial Need (25 points) and Benefits and Impacts (25 points). It is also worth noting that the Commissioner considered location in *Priority Funding Areas* in the *Conservation and Development Policies Plan for Connecticut.*

2.2.2.1.2 Special Contaminated Property Remediation and Insurance Fund (SCPRIF)

It is a low-interest loans program that provides financial assistance to municipalities, developers or owners for environmental investigation, remediation and other activities that aim at encouraging property redevelopment.
Since the creation of the program in 1995 until February 2007, seventeen projects had been approved for funding totaling $ 1.9 million. The Task Force on Brownfields Strategies (2007) reports that the SCPRIF program has an unallocated bond fund balance of approx. $400,000.

2.2.2.1.3 Urban Sites Remedial Action Program (USRAP)

This is the State's flagship, and the oldest Brownfield specific redevelopment program. It provides seed capital to facilitate the transfer, reuse and redevelopment of Brownfield sites located in distressed municipalities. There are two types of USRAP projects: those covered under the Economic Development Initiative (Type 1), and those where the property owner is unwilling or unable to

[17] OBRD (2008) highlights that bond funds authorized in Public Act 07-233 provided grants according to the following criteria: two municipalities with populations > 100,000; one municipality with population > 50,000 and < 100,000; one municipality with population < 50,000; and one municipality selected by the Commissioner without regard to population.

perform the remediation (Unwilling or Unable Party, Type 2). Whereas eligibility for Type 1 projects is statewide, only projects in Distressed Municipalities[18] and Targeted Investment Communities[19] can apply for Type 2 funding. The Task Force on Brownfield Strategies (2007) cites a 2004 report prepared by the Office of Legislative Research (OLR) stating that this program has a current unallocated bond fund balance of $6.7 million. Also, OLR reported in 2006 that only 19 sites had been redeveloped and approximately $38.5 million had been spent since the creation of the program in 1992. During 2005 and 2006, no sites were funded through this program and, although other sites remain within the contours of the program as the site work has not yet been completed, no pending applications were registered in those two years.

2.2.2.1.4 Tax Increment Financing (TIF)

Initially called the Connecticut Solution, this program was the first of its type in the country to be used for Brownfield redevelopment (Paul & Petruzzello, 2004). It provides up-front cash to developers/owners for Brownfield remediation of residential, retail, commercial and/or mixed-use projects. TIF funding is repaid to the Connecticut Brownfields Redevelopment Authority (CBRA) by municipalities based on the increased tax revenues resulting from future higher property values. As of February 2007, five brownfields TIFs had been approved by the CBRA Board (Task Force on Brownfields Strategies, 2007).

Paul & Petruzzello (2004) describe the workings of the program as follows: Initially, developers propose a real estate project for a Brownfield property to municipality officials. If the proposal meets the objectives of the town plan of development, the developer and the municipality present the project to the CBRA for consideration. Upon approval, the municipality and CBRA quantify the future incremental tax revenues to be generated by the improved property and the percentage of those funds to be remitted to CBRA over a specified number of years. Bonds are then sold, with the principal amount based on the repayment period and prevailing interest rates. After that, CBRA provides the developer with the up-front cash grant representing the bond proceeds to fund a portion of the project. CBRA's share of the incremental tax revenues is used to repay the resources that CBRA used to support the grant.

2.2.2.1.5 Connecticut Brownfield Revolving Loan Fund

This recently created program assigns EPA funds for the remediation of environmental contamination located in non-residential properties in any Connecticut town, with priority to distressed municipalities. Eligibility requires, among others, enrollment in the CT Voluntary Remediation program.

---

[18] Hartford, New Britain, Bridgeport, Waterbury, New Haven, Windham, East Hartford, New London, Meriden, Ansonia, West Haven, Winchester, Derby, Torrington, Naugatuck, Bristol, Norwich, Plainville, Killingly, Plymouth, Sprague, Putnam, Enfield, East Windsor and Stafford.

[19] Bridgeport, Bristol, East Hartford, Groton, Hamden, Hartford, Meriden, Middletown, New Britain, New Haven, New London, Norwich, Plainfield, Plainville, Putnam, Sprague, Stratford, Thompson, Torrington, Waterbury, Winchester, Windham and Windsor Locks.

2.2.2.1.6 Environmental Insurance Program

Provides loans and grants to subsidize the cost of Environmental Insurance Premiums. This program is described in the section related to liability issues.

Additionally, the State of Connecticut has designed the ***Urban and Industrial Sites Reinvestment Tax Credit*** as a tax incentive aiming "to drive investment to the state's urban centers and other economically distressed communities without depleting valuable state bond dollars." (OBRD, 2006) Under the program, the State may provide up to $100 million in corporate tax credits over a ten-year period to support projects in eligible urban and industrial sites. The Department of Economic and Community Development determines the amount of credits to be offered based on a comprehensive financial review and an impact analysis using the REMI econometric model.[20] However, the commissioner must submit any requests for credits over $20 million to the legislature for their review. No brownfield project had used this program since its creation in 2000 until February 2008. For further details and analysis, see Department of Economic and Community Development (200?) and Task Force on Brownfields Strategies (2007).

2.2.2.2 Local and Regional Brownfields Programs in Connecticut

The following communities and organizations have received state and/or federal EPA funds:

- Regional Growth Partnership (RGP): has a program for assisting actual and potential property owners with the redevelopment of brownfields sites in South Central Connecticut municipalities. RGP offers two types of funding assistance for these types of properties: assessment funds and remediation funds. Assessment funding can be used to complete environmental site assessments, as well as some cleanup planning activities. These funds are structured as both loans and outright grants, depending on the source of funds. Remediation funding is structured as loans and can be used to finance cleanup activities, demolition and site preparation, and ongoing site monitoring.

- Regional Brownfields Partnership of West Central Connecticut (RBP): formerly the Naugatuck Valley Brownfields Pilot, it oversees and conducts a range of assistance activities across twenty five municipalities for the identification, assessment and remediation of brownfields sites. For further details regarding the history, town members and activities of RBP, see Valley Council of Governments (2008).

[20] The REMI model is a dynamic forecasting and policy analysis tool that integrates several methodologies (input-output analysis, computable general equilibrium models, among others) in order to conduct simulations and provide response estimations to intended economic policies. REMI Policy Insight is used by government agencies (including most US state governments), consulting firms, non-profit institutions, universities, and public utilities to estimate comprehensive economic and demographic effects in a wide range of initiatives such as regional economic impact analysis; policies and programs for economic development, transportation, infrastructure, environment, energy and natural resources; and state and local tax changes. For further details, see Southwest Florida Regional Planning Council (2009).

Allocation of funds among different geographic areas in order to target multiple environmental benefits is perhaps the most important issue facing program managers. As regards the allocation of funds for brownfields projects in Connecticut, there are a number of issues that need to be addressed in order to attain higher efficiency.

Even with the existence of the wide range of funding programs mentioned above, there is much uncertainty as to whether financial support is truly available. Very little utilization of state grants is documented as already seen; and, overall, only those projects that are better known in the major urban areas actually receive funding. The Task Force on Brownfields Strategies (2007) has diagnosed, based on a significant amount of evidence, that programs in the State are "excessively cumbersome, limited in scope, applicability and geography." Moreover, "State programs currently do not fill funding gaps in the often rapid time frame involved with development." (p. 5)

While State-level funding for remediation and redevelopment activities is insufficient, funding for brownfields assessment raises more than an issue.[21] According to Paul & Petruzzello (2004), "tight town budgets prohibit payment for environmental assessments. Developers are unwilling to pay for the assessments because the project's financial feasibility cannot be determined. The result is an impasse that can seriously delay or end plans for site redevelopment." (pp. 317-318) Recognizing the serious nature of this impediment, CBRA created the Brownfields Assessment Grants (BAG), which was an innovative program to completely and/or partially fund site assessments. BAG provided reimbursement to developers, investors and municipalities for Phase I (up to $3000) and Phase II (up to $10,000) site assessment and investigations. In spite of the amount of interest in the BAG program, the Task Force on Brownfields Strategies (2007) informs that CBRA has discontinued it because the small amounts involved in these two types of investigation phases were insufficient to move projects along and used significant staff resources to process. This amalgam of conditions –inadequate funding available only for big remediation and redevelopment projects– leads to a contradictory situation as, without assessment and subsequent remediation, the sites remain of little interest to developers, who may then focus their developmental intentions on nearby greenfields.

In addition to these concerns, some of the underlined programs still aim at a single objective. One significant limitation of the ***Urban and Industrial Sites Reinvestment Tax Credit***, for instance, is that it stipulates that any development has to be revenue neutral. This implies that the total credit cannot exceed anticipated local and state tax revenue from the completed project, which may likely not be the case for brownfields sites –much more costly to redevelop. According to the Task Force on Brownfields Strategies (2008), the REMI model that performs the projections neglects the benefits of brownfields development and the spin-off investment that occurs once a brownfield site is revitalized. "This presents a serious obstacle to utilization of this tax credit for brownfields properties when many of the benefits are not as readily measured within the confines of a myopic, single purpose model." (p. 17).

[21] This problem is not exclusive of Connecticut, as some studies have pointed at lacking funds for assessment in other US localities. See, for example, Schoenbaum's (2002) study for Baltimore.

Given these limitations, a major challenge in the design and implementation of an index-based, multi-objective budget allocation tool for brownfields revitalization programs is to ascertain and quantify the value of alternative environmental and socio-economic benefits associated to the remediation and development of contaminated sites, as well as tangible tradeoffs between these various benefits. Although the criteria to be used and the weights attached to multiple objectives will ultimately be determined by the public authorities and related stakeholders, there is no doubt that research providing information on society's preferences for alternative benefits is needed for devising more efficient brownfields policies.

2.3 OBSTACLES FOR BROWNFIELD REDEVELOPMENT

2.3.1 Connecticut

The nature of the obstacles in Brownfield redevelopment varies with individual states along with the Brownfield regulations, programs, available funding. State specific obstacles for Connecticut include lack of adequate staff at OBRD, lack of funding, liability issues, and lack of clear, meaningful regulations. As of February 2008, OBRD was run by one full time staff person form DECD, with the assistance of a designated liaison from DEP. According to the Brownfield Taskforce Report (2008) the state's Brownfield programs have not been working successfully due to the lack of funds. The proposed funds for Brownfield redevelopment was 75 million dollars; with an additional 25 million per year to be available for the next five years. However the entire state's Brownfield program is funded at 2.5 million which apparently is not adequate to even fund the remediation of one site. (Brownfield Taskforce Report, 2008). Despite of Connecticut having several sites worthy of remediation, the funds designated to them are too low. This level of funding has led to serious questions regarding the state's commitment to Brownfield redevelopment.

Although environmental legislation holding specific parties liable for the cost of Brownfield cleanup reflects societal concern for the risks that contamination poses on human health and urban sustainable development, it has also created disincentives for stakeholders to take part in the Brownfield revitalization enterprise. Not only do current owners leave contamination on site because of their reluctance to invest in or sell contaminated properties –in what amounts to a risk-based cleanup strategy, but municipalities do not find enough of an incentive to remediate Brownfield and to recover cleanup costs from responsible parties as well (Dixon, 2003; Whitney, 2003).[22] Consequently, the threat of liability claims constitutes a significant barrier to Brownfield cleanup and development both state- and nationwide. Creating a successful Brownfield remediation program thus requires such 'draconian', discouraging liability policies to be changed. In this regard, the DEP is said to be reviewing the states remediation program (State of Connecticut Task Force on Brownfield Strategies, 2008).

[22] Whitney (2003) argues that CERCLA's treatment of municipalities as private actors for cost recovery purposes prevents a city from recovering all of the costs of investigating, acquiring, and remediating a Brownfield site.

2.3.2 Commonly Identified Obstacles in the Brownfield Literature

Although Brownfield legislation has been introduced to "assign responsibility for cleanup" it has provoked "unintended consequences" of increasing the difficulties in redeveloping Brownfield (Leigh & Coffin, 2000). The most common obstacles for Brownfield redevelopment as mentioned in Brownfield literature are

- Liability concerns
- Complex confusing and ambiguous environmental regulations
- Lack of guidelines
- Costs associated with redevelopment
- Size
- Multiple actors
- Lack of innovative technologies
- Lack of decision support tools
- Competition from Greenfields
- Ownership

The obstacles associated with Brownfield are not uniform, but rather site specific. Different problems are associated with different types of Brownfield as they have different owners, size, shape, contaminants, and location. Several of the main obstacles will be considered separately:

- Liability: Despite the fact that the federal and state governments have clarified the rules regarding liability issues to protect landowners and developers from liability claims, as well as to a certain extent offered solutions to private organizations through environmental insurance, the stigma surrounding liability issues still exists and developers and the Brownfield literature continue to mention liability and costs issues as barriers to Brownfield redevelopment (Bacot & O'Dell,2006; Lange& McNeil, 2005, Heberle,2006; Siikamaki& Kris,2008, Lange 2004). This is apparently an indication that there exists an information gap and the policies concerning liability still remain complex and unclear to the developers. Lange and McNeil (2005) used a logic model to differentiate "successful" from the "not so successful" Brownfield redevelopments, concluding that for successful Brownfield redevelopment lenders and financers should be educated about liability issues and policies that limit lender liability should be supported.

- Ownership issues associated with Brownfield are another spectrum of the Brownfield problem. Establishment of ownership and whether the owner is ready to pay becomes a concern as it can cause time delay and the redevelopment process cannot move fast enough to attract investors.

- Complex, confusing, ambiguous regulations and inconsistent cleanup standards are another set of obstacles to Brownfield redevelopment (Davis, 2002). Different regulatory clean programs are required depending on factors including the date a contaminant was released or discovered and the location where contamination occurred. Davis (2002) argues that the reason for these differences are not necessarily related to the science of remediation but are created by the bureaucracies to support the regulatory program.

- There is a lack of a consistent redevelopment framework and of clear and coordinated federal and state guidelines for developers. The lack of guidelines could apparently be a consequence of unclear legal policies, complex and confusing environmental laws and contradictory environmental standards.

- Cost concerns are associated with assessments, remediation, redevelopment, unexpected costs due to contamination, costs due to delays, availability of state funds, operating and maintenance costs, and expected profits to the developer. Funding for Brownfield redevelopment is limited. The $200,000 two-year grant provided under the Brownfield Economic Redevelopment Initiative is the only source of federal funding. All the state programs have obtained their funds of funds this program. Since 1995, the USEPA has awarded these Brownfield Assessment Demonstration Pilot grants to more than 200 local governments (McCarthy, 2002). Limited tax relief for Brownfield redevelopment does not necessarily help attract developers either.

- Size: Case studies conducted in 48 Brownfield redevelopment projects in four different states showed that size does matter, and larger scale developments were more likely to obtain public funds and be financed by lenders, and were able to attain "public actor facilitation" over small scale development. The study found out that majority of the small scale projects were self-funded by developers (Yount and Meyer, 1999). Scale of Brownfield projects is defined in terms of the transactions involved. Davis (2005) identifies a large scale transaction as the one that involves $100 million- plus and a small transaction involves 1 million. Comparatively, larger transactions have a greater potential for profit, can produce future tax increases, attract investment capital better absorb the risk of clean up costs and have a greater flexibility of employing cost controlling tools like environmental insurance. (Davis, 2005).As far as Connecticut is concerned; the funding available for the entire state is equivalent to a small scale transaction for a redevelopment project.

- Multiple actors- Brownfield redevelopment involves too many parties- property owners, lawyers, environmental consultants, real estate brokers, economic development representatives, insurance specialists, lenders and regulators. This leads to lack of coordination and cooperation between involved parties. Involvement of multiple actors creates a lack of concentrated expertise due to communication and information gap.

- Use of Innovative Technologies- US conference of Mayors report on Brownfield (Murno and Tzoumis, 2000) have identified that apart from liability concerns and funding problems, the need to determine the extent of contamination is also a major concern. Uncertainties regarding the presence and extent of contamination can be addressed though the use of innovative environmental assessment technology long with regulatory reforms. A need for the technologies to be accessible to developers and communities to help them understand the extent and distribution of contamination; and sample a number of sites within a short period of time and prioritize them accordingly has been emphasized. Conventional soil sampling techniques are time consuming and expensive. A survey conducted on 39 EPA funded Brownfield sites found of that only six responded

that they were using innovative technologies for Brownfield redevelopment, and those innovative technologies were confined to the use of GIS (Murno and Tzoumis, 2000).

- Lack of adequate decision support tools based on empirical analysis for Brownfield redevelopment is another concern (Lange and McNeil, 2004). A few available support tools are confined to regression models, GIS, and project specific scorecards. However, the extent to which these tools are actually implemented in the actual Brownfield redevelopment process needs to be documented. Thomas (2002) mentions that "for decision support system to be effective, designers must understand the human choice process as well as the needs of the user information, the abilities of the users to process and understand that information and the ultimate endpoint of how and why the information will be used". The need of a decision support system in Brownfield redevelopment cannot be stressed enough because even when redevelopment incentives are available, making decisions regarding what site to "remediate, market, and purchase" can be difficult due to the lack of appropriate decision support tools (Thomas, 2002).

- Competition and development pressures from Greenfields are another obstacle for Brownfield redevelopment. The nature of present development practices is such that zoning and government policies and regulations, and taxpayer subsidies encourage Greenfield development. Greenfields are easily accessible and attractive to developers for construction, as they are obtained at lower costs, and there is a potential for aggregate land parcels, compared to scattered Brownfield plots. Also Greenfield development does not face as much opposition from the public as Brownfield do. Further the cost of Greenfield development tends to be subsidized by the public sector through the provision of utilities and transportation-road, sewer and water networks (University of Louisville, 2006)

These impediments combined with other obstacles such as public opposition and limited demand of the redeveloped sites, make Brownfield redevelopment complex and time consuming. Lange and McNeil (2004) emphasize that much of the Brownfield literature is confined to "anecdotes and qualitative descriptions of experiences" which is in fact the case because a lot of Brownfield literature are based on the results obtained through interviews and surveys. There are no available databases for tracking comprehensive information on policies, economies and outcomes of Brownfield redevelopment. Bacot and O'Dell (2006) contend that standards for assessing the vitality of Brownfield redevelopment are lacking. Assessments are difficult because of "intergovernmental nature of the program- implementation and records are locally based, contracts are executed at the state level and program parameters are established at the national level- program impacts social, environmental, and planning policies." This reiterates the need for the establishment of performance indicators to evaluate the outcomes from Brownfield redevelopment. It is important for the government to assess whether the existing Brownfield policies work or not, and assess the implication of Brownfield redevelopment for the local communities so that when and where interventions and incentives are necessary can be determined (Lange and McNeil, 2004).

2.4 ENVIRONMENTAL LIABILITY AND BROWNFIELDS

While brownfield remediation and redevelopment is desirable for city governments and communities, attracting individual developers to these sites is not an easy task. Indeed, brownfield reclamation faces significant obstacles, depending on the legal and socio- economic conditions in every locality. As a consequence, over 500,000 brownfield sites in the United States remain underutilized and ignored,[23] posing health and environmental risks and impeding the revitalization of urban neighborhoods that once were important centers of industrial activity.

Brownfields redevelopment is a costly and risky activity, especially for the legal and regulatory aspects to which stakeholders are subject of. The mere presence of contaminated lands encourages investors to move elsewhere, as the fear of becoming liable for the cost of cleanup under the Superfund law deters the acquisition of brownfields for reclamation and development. In response to these claims, the federal government and states have adopted programs to protect real estate developers from liability. This protection would be unnecessary, however, if sellers could simply adjust property prices downward to compensate purchasers for this liability.

The 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) imposes liability on previous and current owners of contaminated property. Specifically, CERCLA requires federal and state governments to locate potentially responsible parties (PRPs) –those statutorily responsible for the contamination– to pay for cleanups. These PRPs may include any person who had any responsibility for creating, transporting, or disposing of the waste, in addition to the current owner and/or operator of the site.[24]

Courts have uniformly interpreted that liability is joint and several if two or more persons have contributed to a single indivisible harm, in which case each PRP can be held individually liable for the entire cost of the cleanup. Then, he may sue any remaining liable party for the share of the harm for which they are responsible. Once the federal government or a state agency has incurred cleanup costs, it brings a cost recovery action against a PRP. CERCLA treats these PRPs aggressively, in an attempt to put the 'polluter pays' principle into practice.

In addition to the federal Superfund law, each state has its own laws governing the cleanup of contaminated sites. Many state rules imitate the CERCLA liability provisions, including joint and several liability for owners and a broad set of other parties, but some states use different rules. As a response to the alarming rates of land being converted to urban use and realizing that the major obstacles to brownfields revitalization come from economic and liability issues, Michigan has implemented legislation that provides economic incentives in the form of tax recapture and reimbursement of cleanup costs, and legal incentives in the form of suspension of retroactive liability (Thomas, 2001). Likewise, Whitney (2003) discusses the provisions contained in California's Polanco Act, as well as some of the advantages and shortcomings derived from its implementation. Other states have similar statutes.

[23] According to EPA (2009) estimates, this amount may be as high as 1 million sites.

[24] While those who owned or operated the site at the time the waste was deposited in there are liable, some current owners and/or operators of such a contaminated site are subject to certain exceptions. For further details and legal interpretations, see Whitney (2003).

Many commercial real estate developers and observers have severely criticized both the federal Superfund and state law counterparts for hindering redevelopment of potentially contaminated sites. Some analyses underline that owners are often reluctant to sell, fearful of their own liability for as yet undetermined cleanup costs (Dixon, 2003; Whitney, 2003). Such brownfield owners often deem cheaper and less risky to 'mothball' a site –fencing it off, paying the property taxes, and trying to forget about it. Many owners who only suspect contamination dodge potential liability by completely removing their property from the market rather than performing site assessments, which must be reported if positive for contamination.

On the flip side, Superfund liability may discourage buyers from purchasing sites. But, as Chang & Sigman (2007) explain, the reasons for such an effect are more subtle than they might first appear. "If the liability rules merely forced the buyer to accept some share of a fixed expected liability that they would otherwise impose on the seller, then … the parties would simply adjust the price of the property downward to reflect the transfer of liability from seller to buyer, and this discount would ensure that economically efficient transactions go forward in spite of this transfer of liability." (p. 365)

Notwithstanding, joint and several liability may raise expected liability for developers and thereby prevent them from purchasing brownfields. Chang & Sigman (2007) identify four different deterrent effects of joint and several liabilities under Superfund. These effects all arise from the increase in the number of liable parties with sale of the property, regardless of their solvency level. First of all, a sale may increase the share of liability that a seller and a buyer may expect to pay as a group. Secondly, a sale may increase the amount of damages that the government can expect to recover at trial. Thirdly, a sale may increase the total litigation costs that a buyer and a seller may face as a group. Lastly, a sale may increase the amount that the government can expect to extract in a settlement from PRPs.[25] Each of these effects may interfere with the efficient revitalization of contaminated sites.

The previous analysis finds support in many other studies (Dixon, 2003; Whitney, 2003, to name a few), who argue that liability provisions under CERCLA make purchasers, developers, and lenders wary of property suspected of contamination, and thereby prevent brownfields from being redeveloped even under favorable market conditions. Investors might shy away from properties believed to be contaminated for fear of potential liability, and because the associated costs –which include assessment, remediation, third-party damages, and litigation fees– may prove too high for the development project to be viable.

Furthermore, banks may deny financing for brownfield projects to avoid possible involvement in liability over contamination, or undervalue the property as collateral for the loan. In the past, lenders have been held liable for clean up under CERCLA if the lender "participated in the financial management of a facility to a degree indicating a capacity to influence the corporation's treatment of hazardous waste." This is why lenders hesitate to loan money to potential developers, in fear of being held liable (Davis, 2002). Although recent reforms have been made to protect the lenders (see Subsection 4.2), the stigma still exists.

[25] CERCLA authorizes EPA to enter into settlement agreements with PRPs in those cases where negotiations have a 'reasonable chance of success' (Sherk, 2001).

Other key aspects in the debate over CERCLA's joint and several liability rules deal with who should bear the costs of tracking down and collecting from all the parties who had contributed to contaminating a site (Whitney, 2003) and who should bear the costs of 'orphan shares' –those shares of cleanup costs for which the responsible parties have neither assets nor insurance (Sherk, 2001; Whitney, 2003). All these elements make joint and several liability under Superfund Act an ongoing moot issue.

2.4.1 Empirical Assessments on the Effect of Liability on Brownfields

Despite claims about the effects of liability on the acquisition and development of brownfields, little empirical work has been done to assess the existence and magnitude of these effects, and the impacts, if any, of government incentives to developers for cleanup and development of brownfields. Sigman (2006) studies the effects of variations in state liability regimes –specifically, strict liability and joint and several liability– on prices and vacancy rates of reported brownfield acreage in a panel of cities across the United States. She finds that joint and several liability has a negative effect on land prices and a positive effect on vacancy rates in central cities. Yet the results are inconclusive on the question of substitution of greenfields for brownfields. Furthermore, no significant effect of strict liability[26] on either prices or vacancy rates can be inferred from her study.

Robertson & Reichert (2000) conducted a survey of Northeast Ohio businesses that had decided, since the enactment of Ohio's brownfields law, either to move to a new location or to expand at an existing location. The results highlight that while environmental liability has a high priority in the initial screening stage, it does not appear to be an important factor in the final site-selection decision. This suggests that liability issues are so critical in the screening process that all environmentally risky properties are screened out early in the decision-making process. Hence, the final short-list of potential properties includes only environmentally clean sites, which explains why this factor is not relevant in the final selection decision. Furthermore, firms that are more concerned about potential liability are more likely to be in the service industry; more expense conscious; and more likely to have encountered environmental or brownfield issues, have visited contaminated sites and be subject to environmental regulation.

Finally, two recent studies use stated-preference analysis to explore incentives to promote brownfields revitalization. In a survey of developers and real estate professionals attending an international trade fair in France, Alberini *et al.* (2005) studied how liability reduction, regulatory relief (improved speed and flexibility in approving cleanup), and direct subsidies affect redevelopment decisions. The respondents in general indicated less interest in contaminated sites than greenfields, although they were willing to undertake the former with financial incentives, especially if they had prior experience with contamination. Those less experienced with contamination placed a higher value on liability relief, fast track permitting, and flexible cleanup standards than they did on financial assistance. Using a rather similar

[26] Under strict liability, any action that causes contamination may give rise to liability. In contrast, negligence rules trigger liability only if precaution falls below some legal standard of care. Strict liability should increase expected private cleanup costs by expanding the set of sites at which private parties may be held liable. Also, the government may find it less costly to bring suits because its information requirements are lower, reinforcing the incentives from its higher expected awards.

approach in a mail survey of US land developers, Wernstedt *et al.* (2006) found that respondents place a fairly high value on liability relief from both cleanup costs and claims by third parties. It is particularly worth noting that developers place a different weight on the two types of liability protection, with third-party liability reduction being more appealing. Like the previous study, this result appears to be driven by developers who are not specialized in contaminated sites.

2.4.2 Federal and State Solutions

In response to the environmental liability problem, many states and the federal government have explored different ways to allay these fears and reduce the risk of liability. By means of the Asset Conservation, Lender Liability, and Deposit Insurance Protection Act of 1996, the federal government amended the Superfund Act to reduce the liability of institutions that make loans to brownfields redevelopment projects. These amendments "clarify the types of actions that constitute lender's participation in management and specify the steps a lender must take to foreclosure without losing liability protection" (Yount & Meyer, 1999). Later in 2002, Congress passed the Small Business Liability Relief and Brownfields Revitalization Act −or so-called 'Brownfields Law'− adjusting CERCLA to provide conditional liability relief to contiguous property owners (CPOs), bona fide prospective purchasers (BFPPs), and innocent landowners (ILOs). EPA has further issued guidance clarifying some of the conditions that these and other parties involved in brownfield properties must meet to qualify for the liability limitations provided in the Brownfields Law.

Additionally, most states have implemented their own brownfields redevelopment programs. Usually, these feature a Voluntary Cleanup Program (VCP) that offers prospective purchasers or property owner of a polluted site release from state liability in the form of 'comfort' or 'no further action' letters, certificates of cleanup completion and covenants not to sue, provided the remediation be done in accordance with state cleanup laws.[27] This does not remove the threat of federal liability and third-party legal actions. EPA, however, has generally respected state VCP agreements and rarely has taken action against such sites. Also, many state VCPs include technical assistance and financial resources.

2.4.3 State of Connecticut

As regards Connecticut's Voluntary Remediation Program, the Connecticut Office of Brownfield Remediation and Development (OBRD) has worked jointly with EPA and the Connecticut Department of Environmental Protection (DEP) to offer various liability protection programs and options to developers. According to OBRD (2007), currently these programs and options are:

Covenants Not to Sue with prospective purchasers and current owners of contaminated sites, as well as with lending institutions to whom such prospective purchasers or owners have conveyed a security interest in such properties. These covenants can be extended to successors of the holders of a covenant previously issued.

[27] Typically, state cleanup requirements are risk-based standards linked to the expected future use of the site under consideration.

CERCLIS 'Comfort Letter' and Archive Policy: It stipulates the elimination (archive) of any active federal Superfund site from the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) at the request of the DEP, provided that remedial action through one or more DEP Remediation Programs has been completed. If remedial action has not been completed, yet an interested party makes the commitment to remediate the site through a DEP Remediation Program, the Department might be willing to recommend EPA to issue a 'comfort letter' stating that it will not take further action to register the site on the National Priorities List.

Third Party Liability Protection: This program provides property owners with statutory protection regarding costs or damages to third parties –not including governmental bodies– exposed to pollution that existed prior to the landowner's taking title to the property.

Environmental Land Use Restriction (ELUR): It is a binding agreement between a property owner and the DEP with the purpose of minimizing the risk of human exposure to pollutants and hazards to the environment by preventing specific uses or activities at a site or a portion of a site. An ELUR is a tool that permits the remedial goals for a property to be dependent on the exposure risk associated with its use.

Along with these programs, the State of Connecticut has implemented an ***Environmental Insurance Program*** since 1990 with the aim to facilitate the quantification and transfer of risks related to brownfields cleanup costs and liability from project stakeholders to insurance companies. By means of this program, the Department of Economic and Community Development (DECD) provides loans and grants to subsidize the costs of Environmental Insurance Premiums, and OBRD offers technical assistance to developers on choosing the proper coverage for their projects.

There exist several types of environmental insurance policies, with three types specific to brownfield remediation: Pollution Liability, Cost Cap, and Secured Lender. Barrett (2008) describes these types of policies as follows:[28]

- Pollution liability policies insure against on-site cleanup costs of unknown, pre-existing pollution and current pollution from ongoing operations, and third-party claims arising from pollution conditions (e.g., bodily injury, property damage). It is the oldest and most widely used insurance product, commonly underwritten in CT.
- Cost Cap policies protect against cost overruns on planned remediation due to newly discovered contaminants both on site and off site.
- Secured lender policies protect a lender in the event that a borrower defaults on a loan and the default is associated with a pollution condition.

The Environmental Insurance Program is a fairly novel tool to shield participants from the risks that accompany brownfields reclamation and to expedite the process. As of 2008, only Connecticut and three other states (Massachusetts, New York, and Wisconsin) have state-run insurance programs specific to brownfield remediation, with varying degrees of success (see

[28] For further details as to the insurance programs currently in order in Connecticut, see State of Connecticut Task Force on Brownfields Strategies (2008).

State of Connecticut Task Force on Brownfields Strategies, 2008). Barrett (2008) notes that the number of policies issued ranges from zero to 320 within the four states.

2.5 TOOLS FOR THE EFFICIENT ALLOCATION OF FUNDS FOR BROWNFIELD REVITALIZATION

Allocation of funds among contaminated areas to achieve multiple environmental and socio-economic objectives perhaps is the most important issue facing brownfields program managers. As regards Connecticut, this subject acquires more prominence in view of the absence of a clearly established framework for the evaluation and prioritization of sites at the State level and in cities actively pursuing redevelopment plans such as Hartford, Bridgeport and New Haven.

Given that the targeting instrument can and indeed plays a crucial role in allocating a fund efficiently, designing a decision support tool that can be used by public planners to prioritize brownfield development options based on a consideration of overall social and environmental benefits relative to costs is the main task we face in the undertaking of this research project.

Some of the researches on the efficient allocation of funds for environmental protection have focused on US agricultural land conservation programs, which use an index approach to prioritize objectives and rank program applications. This approach has the advantages of keeping program objectives distinct and enabling program managers to use weights to determine the relative importance of each objective. Thus, environmental indicators can be used to target public programs to provide a variety of benefits.

As we consider this indexing approach susceptible of successful extension to the brownfield revitalization context, so that potential sites can be ranked aiming to maximize environmental and social gain given the available (limited) funds, the present report provides a conceptual and practical overview to this indicator-driven methodology and highlights some of its advantages and limitations. Also, we consider the potential challenges of the application of this methodology to the design of programs offering financial support for the remediation and development of brownfields in Connecticut and its municipalities.

2.5.1 A Review of Literature

The problem of allocating a given budget when multiple environmental and socio-economic benefits exist becomes increasingly important as funding for brownfield revitalization projects is relatively scarce. As a consequence, selection of a targeting tool for allocating limited funds among several objectives has important implications for the total level of benefits that can be obtained from a limited budget.

According to Baumol & Oates (1988), the standard definition of cost-effectiveness involves achieving an environmental goal at the lowest cost to society. This implies, in a context of limited funds, that its allocation should maximize the associated benefits. It also suggests that

understanding the relationship between environmental benefits and costs is critical in establishing cost-effective programs.

There is a substantial literature in areas related to environmental remediation and agricultural land use that develops principles for 'targeting' limited resources in order to achieve environmental and other objectives. In what follows, we summarize some of the approaches proposed in this literature, with a brief comment on its advantages and caveats.

2.5.1.1 Approaches Dealing with Environmental Remediation

Concerning groundwater contamination issues, Wang (2006) devises an environmental management strategy in order to maximize resource utilization, minimize adverse impacts on the environment, and pursue sustainable development. This management strategy can be implemented through a stepwise procedure whereby a given budget is optimally allocated to select sites intended for taking groundwater prevention and restoration measures within a certain time frame. The screening process is followed by several year-by-year optimization steps in which optimal distributions of the available yearly funds within those selected sites are determined. Although the application of this strategy seems feasible to deal with groundwater contamination, it requires too much information that might not be available or would be too costly to collect if we were to extend this approach to brownfield remediation.

Carlon *et al.* (2008) propose a methodology for the formulation of remediation plans that encompasses hazard assessment, exposure assessment, risk characterization, uncertainty assessment and allocation of risk reduction measures. This methodology has turned out to be the core module of a spatial (GIS-based) decision support system aiming at providing foundations for the risk-based remediation and redevelopment of megasites.[29] More specifically, this spatial decision support system supports the formulation and comparison of alternative remediation scenarios, where risk mitigation is related to the technical feasibility and costs of remediation interventions and to social and economic benefits after the re-use of the site. The issue with this methodology is that it involves the prioritization of specific sites within a wider contaminated area, not being suitable to address the remediation of 'small' brownfield properties.

2.5.1.2 Approaches Dealing with Environmental Conservation

Using an interdisciplinary approach, Johst *et al.* (2002) present an ecological-economic procedure to ascertain the optimum spatio-temporal allocation of a given budget for species protection. The suggested procedure seems appropriate for designing compensation payments for the protection of endangered species and, more generally, for the development and assessment of conservation programs. However, this study deals

[29] According to these authors, the term 'megasites' refers to large (km^2 scale) contaminated or impacted areas, like industrial harbors, petrochemical districts and mining areas. These areas are characterized by unacceptable costs for complete clean-up (within currently used regulatory timeframes) due to political, economic, social or technical constraints; having multiple owners and stakeholders, and the need for an integrated risk-based approach at a regional scale.

with hypothetical landscapes and does not explicitly consider spatial configurations and landscape heterogeneity.

In response to these claims, Holzkaemper & Seppelt (2007) employ a spatial optimization approach to identify land-use patterns that represent optimum trade-offs between ecological improvements and economic requirements. This optimization model can be applied to a chosen set of smaller sample sites in the study area, and the results used to derive a target- and site-specific cost-benefit function that in turn can be utilized to predict ecological enhancement as a function of costs and local conditions on a large spatial scale. As a result, it is possible to identify areas where certain management actions are most efficient with respect to a certain conservation goal without having to apply the optimization model to the whole region. This approach could be applied to a variety of landscape planning problems dealing with the effective allocation of management measures, such as identifying optimum areas for management actions or the design of compensation payment schemes.

Some of the research on budget allocation tools for environmental protection has focused on agricultural land use under the USDA's conservation programs, particularly the Conservation Reserve Program (CRP). These programs use an index-based approach to rank parcels, which are then selected for conservation payments. Before we examine the functioning and cost-effectiveness of these programs, let us consider some concepts that underlie this approach to the allocation of limited funds. More theoretical insight can be found in the Appendix.

2.5.1.3 Some Conceptual Background for the Index-Based Approach

By comparing among distinct targeting criteria, and specifically between maximization of environmental benefits and acreage maximization, Babcock *et al.* (1996, 1997) found that there may be significant tradeoffs between alternative environmental benefits when different criteria are targeted for conservation practices. This means, explicitly, that one may have to give up some of one benefit to obtain more of the other benefit.

Likewise, Babcock *et al.* (1997) argue that the magnitude of the losses from targeting least cost land and environmentally sensitive land instead of land that offers the highest ratio of benefits to cost depends upon the joint distribution of costs and benefits. The amount of spatial variability in costs relative to benefits and how benefits and costs are correlated are the primary factors influencing the magnitude of these efficiency losses.

By drawing upon Babcock *et al.*'s approach, Wu & Boggess (1999) show that the efficient spatial allocation of conservation funds must take into account the specific shape of the ecological benefit function. In particular, they point at two important 'pooling' effects: cumulative (watershed) effects and interrelationships among alternative environmental benefits (ecosystem effect). Cumulative effects are present when a significant environmental improvement (e.g., water quality becomes suitable for fish reproduction) can be achieved only after conservation efforts reach a certain threshold. Interrelationships exist either because environmental benefits interact with each other (e.g., water quality and fish habitat) or because they are jointly produced by the same

resource or conservation practice. The latter type of interrelationship is of particular interest as, for example, the CRP reduces soil erosion and provides other environmental benefits such as groundwater quality and wildlife habitats by retiring lands from crop production.

Wu & Boggess (1999) argue that the two pooling effects mentioned above have tended to be ignored by traditional resource-specific conservation programs,[30] thus leading to a number of negative consequences. "Ignoring the cumulative effects of environmental benefits may cause conservation funds to be overly dispersed geographically and, as a result, may result in minimum environmental benefits when the budget is small. Ignoring the interrelationships among alternative environmental benefits may result in not only misallocation of conservation funds among geographical areas, but also incorrect resources being targeted for conservation practices." (p. 302) For these reasons, traditional conservation programs have misallocated funds even if they have attempted to maximize the value of environmental benefits.

2.5.1.4 The Index Approach: How it Works and its Cost-Effectiveness

From the previous concepts, it can be inferred that implementing a multi-objective program efficiently requires that policy makers balance different environmental and cost objectives. In an attempt to do so, managers of multi-objective programs are increasingly using an 'index' as a means of aggregating a variety of indicators into a single measure. The index is typically constructed by multiplying indicator variables (e.g., physical measures), which are correlated with environmental concerns (i.e., program objectives), by a vector of weights –where the weights reflect program manager perceptions of relative importance. Hence the single summary score that is calculated for each program applicant allows program managers to rank and select applications based on their potential contribution toward achieving the program objectives.

Once objectives are defined, whatever they are, maximizing the extent to which these objectives can be achieved entails designing cost-effective programs. In comparing the advantages and shortcomings of single- and multi-objective programs, Cattaneo *et al.* (2006) remark that "while multi-objective programs may be more efficient than single-objective programs, they are more complicated to administer. With single-objective programs, simple rules (such as cost minimization) can guide program decisions. With multiple objectives, such simplifications are not possible because objectives are not typically perfect complements and they cannot all be maximized at once." (p. 31) With this view in mind, Claassen *et al.* (2008) argue that benefit-cost targeting using environmental indices aims at enhancing cost-effectiveness.

As environmental cost-effectiveness has been an important criterion in the development of US agricultural land conservation policy since the early 1990s, Claassen *et al.* (2008) state that "maximizing benefits per dollar of expenditure implies (1) targeting payments

[30] US conservation programs have historically been designed to protect specific resources. These resources have been targeted on the basis of onsite, productivity related criteria such as soil erosion rates, rather than on the values of environmental benefits obtained.

to those combinations of specific practices and tracts of land that yield the greatest environmental benefit per dollar of cost, and (2) making payments in amounts that equal the minimum necessary to encourage producers to adopt the desired practices on the targeted tracts of land, as additional payments would dissipate resources that could be spent on leveraging additional environmental gain." (p. 738) In the following section, we will take a look at how the ideas highlighted above are intended to be put into practice in the largest USDA conservation programs.

2.5.1.5 USDA Conservation Programs

Over the last twenty years, the US has established a number of agricultural land conservation programs. While these programs do not seek the exact same types of environmental improvements, they all have in common the goal of achieving multiple objectives within the confines of a single program. Multi-objective programs include the Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP), which seek environmental improvements by retiring farmland; the Environmental Quality Incentives Program (EQIP) and the Conservation Security Program (CSP), which are designed to improve environmental outcomes on 'working' agricultural lands; and the Farm and Ranch Lands Protection Program (FRPP), which aims to prevent the loss of environmental resources to non-agricultural uses.

Implementing multi-objective programs efficiently requires balancing different environmental and economic objectives. Federal conservation programs are typically implemented using indices to rank applications for enrollment submitted by potential participants in terms of environmental gain and cost. The importance of each environmental and economic objective is expressed in its relative weight within the index. Furthermore, the elements of each index can vary according to the purpose of the program in question[31] (Cattaneo *et al.*, 2006).

It is worth noting that differences in program structure can give rise to the use of several indices within a single program. Thus, for instance, the CRP is centralized, and all applications nationwide are prioritized and chosen on the basis of a single index. However, decentralized programs such as EQIP and FRPP use indices in a two-step process where, once Federal funds are disbursed to the States (typically using an index type of mechanism), State or local governments make decisions about applications to accept using State or locally developed indices. As Cattaneo *et al.* (2006) note, this approach accommodates heterogeneity in local objectives as well as in the relative importance of the objectives.

As the CRP and EQIP are the largest US agri-environmental programs and because of their differences in objectives and structure, we will describe the main features of the index approach used in these two programs as well as their operation as follows.

[31] While several programs focus on the same type of environmental resource (improving water and soil quality, for example), some have standards for reducing environmental degradation while others (i.e. the CSP) seek improvements beyond those standards.

2.5.1.6 Conservation Reserve Program

The Conservation Reserve Program (CRP) is the largest US agricultural conservation incentive program in terms of acres enrolled and Federal outlays. Since its introduction, it has been used on as many as 36 million acres (about 10% of US cropland) at any one time to prevent soil erosion and degradation of water quality, preserve wildlife habitat and provide other natural resource benefits.

First implemented in 1985, the CRP provides participants (farm owners and operators) with an annual payment and cost-sharing for establishment of permanent land cover (usually grass or trees) in exchange for retirement of highly erodible land and/or environmentally sensitive cropland from production for ten to fifteen years. Although the program originally focused on enrolling low-cost land, it has evolved into a multi-objective program that yields environmental benefits beyond the traditional concern for soil conservation (Claassen *et al.*, 2008). Currently, the bulk of enrollment occurs under a competitive-bid process, whereby offers are ranked according to the expected environmental benefits and cost to the government.[32]

The Environmental Benefits Index (EBI) was adopted in 1990 as a tool to assess the multiple environmental benefits and the costs of implementing conservation practices on tracts of land offered for the program and to target enrollments of tracts on this basis. It is a national index with a uniform set of objectives and weights that essentially balances the benefits of reducing negative environmental impacts of agricultural production against the costs of retiring the land and installing conservation practices (Cattaneo *et al.*, 2006).

Benefit-cost targeting, as implemented through the EBI, shifted emphasis from enrollment of highly erodible low-cost land to obtaining a wider range of environmental gains while considering cost (Cattaneo *et al.*, 2006; Claassen *et al.*, 2008). Although the structure of the EBI has changed slightly over time, EBI points have been assigned based on four to six categories of environmental benefits and a cost factor. Program managers determine the relative importance of addressing these categories (i.e. the implied weights) by establishing maximum attainable scores for each environmental and cost concern. As Table 2.1 shows, three major environmental factors – wildlife habitat, water quality, and soil erodibility (i.e. potential for soil productivity damage) – each have usually received 100 of a total of about 400 possible environmental points. Although the number of points given to the cost factor can vary between sign-ups, 150 points has been the norm in recent enrollments. For any factor, any number of points between zero and the maximum can be assigned to a specific offer. The decision process that determines the land to enroll involves selecting the tracts of land with EBI scores above a cutoff level chosen for each sign-up period after bids are received.[33]

[32] For further details about the history of the CRP, see Ribaudo *et al.* (2001), Cattaneo *et al.* (2006) and Claassen *et al.* (2008).

[33] Also, to help decide which contract offers to accept, CRP program managers estimate the distribution of index scores among producers who may apply for CRP enrollment at a later date. Based on this distribution, program managers may decide to reject some current applicants (even if they could be accommodated under the acreage cap) in the hope that producers who can deliver greater benefits per dollar of cost will apply in the future.

Table 2.1: Factors Generating Points for the CRP's Environmental Benefit Index

EBI factors	Definition	Features that increase points	Maximum points
Wildlife	Evaluates the expected wildlife benefits of the offer.	·Diversity of grass/legumes ·Use of native grasses ·Tree planting ·Wetlands restoration ·Beneficial to threatened/endangered species ·Complements wetland habitat	100
Water quality	Evaluates the potential surface and ground water impacts	·Located in ground-or surface-water protection area ·Potential for percolation of chemicals and the local population using groundwater ·Potential for runoff to reach surface water and the county population	100
Erosion	Evaluates soil erodibility	·Larger field-average erodibility index	100
Enduring benefits	Evaluates the likelihood for practice to remain	·Tree cover ·Wetland restoration	50
Air quality	Evaluates gains from reduced dust	·Potential for dust to affect people ·Soil vulnerability to wind erosion ·Carbon sequestration	45
Cost	Evaluates cost of parcel	·Lower CRP rent ·No government cost share ·Payment is below program's maximum acceptable for area and soil type	Varies

Note: This table includes the most common and highest scoring practices.
Source: Claassen *et al.* (2008, p. 743, Table 2).

The EBI was meant to be a flexible index that can be adjusted over time and improved as better information on its various components becomes available and the goals of the CRP change. In this way, as Ribaudo *et al.* (2001) notes, this indicator reflects "both the science of the problem and a complex web of social values." (p. 12)

Several studies have concluded that the use of the EBI has improved the environmental performance of the CRP, though the cost-effectiveness of the program has been subject of moderate debate. Concerning this issue, Claassen *et al.* (2008) points out that not all the information needed for effective benefit-cost targeting can be obtained from applicants or existing data. Likewise, Ribaudo *et al.* (2001) argues that the cost-effectiveness criteria adopted for the CRP bid assessment process (EBI/government cost prior to the 15th sign-up, cost as a weighted factor starting with the 15th sign-up) do not provide objective enough cost-benefit measures to judge whether the program is efficient at delivering desired benefits.

Cattaneo *et al.* (2006) examine the environmental and cost tradeoffs of different index weighting schemes under the CRP. This analysis takes into account both land characteristics and how changes in the EBI objectives' weights affect the economic and environmental benefits of the program. They conclude that small changes in the CRP objectives' weights affect program costs more than environmental outcomes.

Finally, another issue refers to the effectiveness of the EBI in terms of actual improvements in environmental quality. This topic has been assessed to only a limited degree. In this regard, Ribaudo *et al.* (2001) highlights that one shortcoming of the EBI is that it "… reflects expected environmental benefits, but whether the EBI of a specific bid reflects actual benefits has yet to be determined. Nor is there any follow up to monitor whether environmental quality has improved." (p. 17)

2.5.1.7 Environmental Quality Incentives Program

Another program that, like CRP, has multiple environmental objectives extending well beyond soil erosion is the Environmental Quality Incentives Program (EQIP). This program was created in 1996 through consolidation of a number of programs. It currently is the most important USDA program providing financial assistance for conservation on working farms and ranches.

EQIP provides cost-sharing and incentive payments to producers who adopt environmentally friendly practices on working lands. This program seeks three of the four environmental objectives sought by the CRP: reduction in soil erosion and water pollution from agricultural non-point sources, and habitat conservation. In addition, it seeks the reduction of emissions of particulate matter, nitrogen oxides, volatile organic compounds, and ozone precursors and depleters. EQIP is also meant to help producers comply with regulations. While not an environmental objective, this does play a role in terms of the resource concerns addressed.

Eligibility in the program is broad. For structural practices, such as grassed waterways or manure handling facilities, EQIP provides cost-sharing for initial installation. Payments are made when practices have been completed and approved. For management practices, such as conservation tillage or nutrient management, producers can receive annual incentive payments over a three-year period to smooth the transition to new production methods. As of September 2006, there were nearly 140,000 active EQIP contracts covering almost 81 million acres all over the nation.

EQIP is operated in a decentralized manner, with two separate indices used to implement the program. The first index is a single index used to allocate the national program budget to States, where the allocation is made on the basis of a range of agri-environmental and other indicators (see Table 2.2). This index largely determines the overall spatial distribution of total environmental benefits that can be achieved (Cattaneo *et al.*, 2006). The second index consists of a set of indices developed by State and local Natural Resources Conservation Service conservationists, which are used to prioritize and select applications for acceptance into the EQIP program. States and localities have considerable flexibility in designing their indices, with some States even allowing for county-level variation within the State-level index (see three examples of State-level EQIP weights in Table 2.3)[34]. These indices distribute potential environmental benefits across the landscape at a finer spatial scale and also determine the types of benefits that will be achieved in any particular location (Cattaneo *et al.*, 2006; Claassen *et al.*, 2008).

[34] For methodological details, refer to Cattaneo *et al.* (2006, p. 47, Table A1.3).

Table 2.2: Summary of EQIP Formula to Allocate National Program Funds to States

Top 10 factors (accounting for about 50 percent of funds). These factors are measured in the appropriate units (such as tons of waste and acres of cropland):

- Animal waste generation
- Livestock animal units
- Impaired rivers and streams
- Air quality - wind erosion
- Cropland erosion > T
- Pastureland needing treatment
- Irrigated cropland
- Fair and poor rangeland
- Limited-resource producers
- Non-Federal grazing lands

Other factors (accounting for about 50 percent of funds):

- Phosphorous runoff potential
- Waste management system costs
- Cropland
- Wetlands
- Land with saline/alkaline problems (surface water vulnerability)
- Land with saline/alkaline problems (groundwater vulnerability)
- Forest land
- Federal grazing lands
- Acres subject to flooding
- Coastal zone lands
- Native American tribal lands
- Land in specialty crops
- At-risk species habitat conservation
- Potential pesticide and nitrate runoff
- Forest land erosion > T
- Commercial fertilizer/cropland
- Number of farms and ranches
- Population
- Carbon sequestration
- Combined animal feeding operations/animal feeding operations
- Water body acreage
- Livestock animal units/cropland
- Air quality nonattainment areas
- Other land in farms

Source: Cattaneo *et al.* (2006, p. 46, Table A1.2.).

Between 1996 and 2002, states' program managers were required by statute to "maximize environmental benefits per dollar of expenditure." Producers' bids were ranked for acceptance using indices that included a cost factor accordingly. Beginning in 2002, Congress abandoned the statutory requirement to maximize environmental gain at the same time that it eliminated bidding for financial assistance. While the offer indices were retained, cost was no longer used at the national level.[35] Yet many State- and local-level indices for ranking EQIP applications still consider cost.

As a result of EQIP's allocation mechanism, environmental concerns receiving priority in the program –and hence the environmental benefits likely to be achieved– vary significantly across locations. Thus, national or regional scale analysis of benefit-cost targeting in EQIP is extremely difficult to do, which might explain the limited amount of research on its cost-effectiveness.

[35] Instead, a flat 50% rate of cost-sharing for structural practices and a (locally) fixed rate of payment for management practices are now in use.

Table 2.3: Examples of State-Level EQIP Weights

Utah

Item	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
Water quantity	60	50	65			0	14
Water quality	0	35	35	Weight is	Weight is	35	0
Soil erosion	10	0	0	based on	based on	0	20
Grazing and rangeland	30	15	0	share of	share of	65	34
Multiple resource benefits	0	0	0	applications	applications	0	32

Iowa

Item	Palo Alto	Benton	Union	Lee	Carroll	Winnebago	Allamakee
Water quality	66	48	25	37	40	38	45
Soil erosion	21	18	44	37	37	62	0
Wildlife habitat	14	12	0	4	7	0	0
Livestock grazing	0	15	31	22	17	0	55
Air quality	0	7	0	0	0	0	0

Minnesota

Item	State ranking (advisory	County adaptation of advisory State ranking (subset of counties)					
		Aitkin	Beltrami	Cotton-wood	Murray	Root River	Traverse
Water quality	29	35	28	47	54	18	44
Erosion control	21	13	4	23	36	49	27
Wildlife habitat	11	15	11	2	2	10	9
Air quality	10	6	2	2	2	3	4
Grazing system	10	4	22	2	2	8	15
Forest management	10	12	11	2	2	13	2
Additional local concern	10	15	22	21	2	0	0

Source: Cattaneo *et al.* (2006, p. 47, Table A1.3).

Concerning this issue, Claassen *et al.* (2008) argue that the 2002 act lowered EQIP cost effectiveness by reducing the role of cost in the offer indices, eliminating bidding for financial assistance, and focusing more resources on assisting producers with regulatory compliance. In a different vein, Cattaneo *et al.* (2006), conjecture that variation in local priorities contributes to variation in the types of practices that are ultimately funded given EQIP relying on voluntary participation.

2.6 BROWNFIELD REDEVELOPMENT, SMART GROWTH AND URBAN PLANNING

The most commonly suggested end use alternatives for the redevelopment of Brownfield include industrial, commercial, residential and open spaces. Development of industrial and commercial entities on Brownfield has less stringent regulatory standards compared to residential and open spaces. Also, Brownfield that demonstrate the potential to generate immediate economic benefits are usually prioritized. Apart from stringent cleanup standards, factors like high costs of site remediation and expenses associated with the maintenance of publicly owned parks and recreational areas and lack of revenue from recreational and open spaces in the absence of user fees imposed could discourage the development of open spaces (Siikamaki and Wernstedt, 2008). According to Devive (1996), the information required for proposed end uses-

- an accurate inventory of available sites
- environmental compliance status history of incidents and any enforcement actions

- Transportation access
- Presence of linked industries
- Availability of development incentives
- Labor pool characteristics

DeSousa (2000) and Ihlanfeldt, and Taylor (2002) argue that successful Brownfield redevelopment is more likely when the intended reuse is commercial or retail rather than industrial. With industrial reuses there is a greater probability of low marginal returns on investment. Further, redevelopment of Brownfield into industrial site is more likely to face public opposition due to the negative connotations associated with industrial pollution in an already contaminated land. (Bacot and O'Dell, 2006)

Greenberg et al (2000) mention three categories of Brownfield in terms of their desirability for redevelopment. The first categories are the Brownfield with good location attributes and limited contamination that are more likely to be redeveloped successfully. The other two categories are disadvantaged sites as they have less desirable location attributes, and have significant contamination that is costly to remediate. The latter two differ in terms of the extent and severity of their disadvantages. Private investors are more interested in the first category while the later two are unlikely to be redeveloped by private sectors without significant government investment. Another category of Brownfield are designated by the acronym TOADS which stands for Temporary Obsolete, Abandoned Derelict Site. TOADS are contaminated buildings and land that can affect the surrounding neighborhood by polluting the local environment, by giving the impression that the area is dangerous and not being secured so that illegal activities occur on the site. These sites can stigmatize the neighborhood in such a way that that no one wants to invest in it, that those who live or work nearby want to leave. (Greenberg et al, 2000). TOADS could significantly lower property values in the surrounding community, thus affecting property transactions, and requiring the local government to change zoning regulation in the surrounding neighborhoods. The worst case scenario would be partial abandonment of the neighborhood, leaving the poorest and most vulnerable people with limited opportunities and services. These categorizations of Brownfield are however, only confined to literature. A systematic categorization of the existing Brownfield site could actually not only help prioritize the sites for redevelopment, but also would be an important initial step for Brownfield redevelopment.

Despite the abundance of different categories of Brownfield, it is evident that sites with economic potential are usually considered for redevelopment. Brownfield sites where industrial or commercial facilities can be established are usually considered to have greater economic potential. Brownfield sites that cannot be categorized as economically viable are least likely to be developed by private entities and would apparently require adequate subsidies and interventions for redevelopment (Davis, 2002).

2.6.1 Smart Growth

The Smart growth principles developed by the Smart Growth Network (formed in 1996 in association with, EPA, different government and nonprofit organizations) is compilation of ten principles that emphasize

- mixed land uses,

- compact building design,
- diverse housing opportunities and choices,
- walkable, bikeable, neighborhoods
- distinct, attractive communities with a strong sense of place
- transit oriented neighborhoods providing a different transportation options,
- direct development towards existing communities
- natural resource preservation,
- economize development,
- adequate community participation

An innovative approach to brownfields redevelopment is incorporating smart growth principles into brownfield redevelopment. This could help in attracting federal funding and in making brownfield competitive with greenfields.

The concept of smart grown has continued to gain acceptance in the recent years and different organizations have continuously endorsed smart growth principles. Smart Growth has been defined by the EPA as "development that serves the economy, community, and the environment. It changes the terms of development debate away from the traditional growth/no growth question to 'how and where should new development be accommodated"' Ye *et al.* (2005).The definition of smart growth however is flexible enough for different organizations to manipulate it to have their purposes, missions, and goals fulfilled. The example of smart growth definitions/principles provided by different organizations, as compiled by Ye *et al.* (2005), are provided in the Appendix. Despite of the inconsistencies in the definition Ye *et al.* (2005) point out six major components of smart growth obtained from different definitions provided by various organizations. These six dimensions of smart grown include planning, transportation, economic development, housing, community development, natural resource preservation. The conclusions of the study using logic model (Lange and McNeil, 2005) emphasizes that successful brownfield redevelopment should incorporate mixed uses that include open space creation, invest in infrastructure improvements in the vicinity of brownfields, emphasize redevelopment nearby existing adequate facilities and infrastructures, assure job creation(Lange and McNeil, 2005). This basically is a reiteration of smart growth principles.

Both Brownfield redevelopment and smart growth share similar objectives that seek to reuse land to enhance economic and community vitality, control urban sprawl, and thus meet the need for development by using infill to their maximum potential. While smart growth encourages brownfield redevelopment, using smart growth principles in brownfield redevelopment has been highly emphasized.

Table 2.4: Main Elements of Smart Growth Policies

Planning	Transportation	Economic Development
Comprehensive planning Mixed land uses Increased density Street connectivity Alternative/innovative water infrastructure and systems Public facilities planning	Pedestrianization Facilities for bicycling Public transit promotion Systems integration and nodal networks	Neighborhood business Downtown revitalization Infill development Using existing infrastructure
Housing	**Community Development**	**Natural Resource Preservation**
Multifamily housing Smaller lots Manufactured homes Housing for special needs and diverse households	Popular participation Recognizing/promoting the unique features of each community	Farmland preservation Subdivision conservation Easement conservation Transferable development right Purchase of development rights Historical preservation Ecological land preservation

Source: Ye *et al.*(2005).

2.6.1.1 Smart Growth Scorecards

With the increasing acceptance and endorsement of smart growth, organizations and municipalities have developed scorecards to assess whether their development are indeed smart or not. Smart growth scorecards are assessment tools that provide some insight to whether the growth and development patterns exhibit smart choices or not. Scorecards basically serve as a rating system with weights provided to each criterion in the scorecard. A collection of municipal, project specific and component scorecards are available at the EPA's website as examples of tools that are publicly available for use by communities. Municipal level scorecards serve as self assessment tools for municipalities. Project specific scorecards analyze whether a specific development project is in sync with the communities' smart growth goals, and is an important tool in assessing whether a proposed development is cut out to meet the set objectives. Component scorecards assess whether individual components of a communities smart growth goals are being addressed by the development project. Examples of such individual components are compactness, walkability, bikeability.

Points in project specific scorecards are assigned in a relative order of importance to each criterion, and the total points are established to determine the highest possible weighed point value. A look at the existing scorecards suggests that sites without industrial or commercial potential are unlikely to score high as higher points are assigned to site with industrial and commercial potential. Project specific scorecards would be the most relevant smart growth scorecards that can be used for Brownfield redevelopment to assess whether the smart growth principles have been accommodated in the redevelopment process. The existing project specific scorecards do provide points if a specific project is to be developed on a Brownfield, however there are very few score cards that solely revolve around Brownfield and exclusively deal with various aspects of Brownfield redevelopment. Table 2.5 summarizes and distinguishes the scorecards by pointing out their unique features.

Table 2.5: Summary of Projects Specific Scorecards

State	Name	Introduced By	Score System	Smart Growth	Brownfield Included in the Matrix	Unique Concepts
Alabama, City of Mobile	Smart Growth Criteria Matrix	City of Mobile Planning Department	Points- Weight Value, Maximum Points Available, Score	Mixed Use, Utilizing Existing Infrastructures, Emphasis on-Transportation Options, Transit, Walkability, Bikeability; Open Space and Environmental Conservation, Housing options.	Yes- Brownfield redevelopment assigned more points	Sets Criteria For-Focused Public Improvement Area, Elaborate Environmental Criteria, Desired Development Zone, Commercial Use
New Jersey	Smart Growth Scorecards	New Jersey Future	Weight Value, Maximum Points Available Maximum score reflects is relative importace smart growth goals.	Use of existing development and Infrastructure, Housing options, Community Design, Mixed Uses, Transportation , Transit, Walkability/Bikability	Yes - Whether project cleans a brownfield site.	Designated Area in Need of Development. Energy Efficiency of the project-Standards of NJ energy star homes program etc. Recycling, low impact building designs. Designed for larger projects." larger projects - larger implications for smart growth"
Texas, City of Austin	Smart Growth Criteria Matrix	Transportation, Planning and Design Department	Weight Value, Maximum Points Available	Mixed Uses, Transit oriented development, Walkability/bikeability, Housing Options, Greenspaces, Local economy considerations Historic Review, Incentive Package, Location Risks, Population, Tax Base Enhancement	No	Defined their own Smart Growth Goals- 1.Determine how and where development occurs. 2. Improve Quality of life. 3. Enhance Tax Base Designated Smart Growth Zone LEED Certification Renewable energy Program

Illinois, City of Chicago	Brownfield Screening Tools	GSC Consultants Inc	Assigned Points and Scoring Guide	Transit, Transportation, Walkability, Accessibility to facility, Open Spaces, Mixed Land Use	Yes	Detailed Preliminary Screenings, Visual Site Inspection, Reuse of existing structures, Screenings based on- Historic Uses of site and adjoining projects, presence of USTs, Site Inspection and Demolition of Structures
Maryland	Smart Growth Scorecard	Maryland Office of Smart Growth	Grades- Poor, Fair, Good, Excellent, N/A	Services and Facilities, Density Compactness, Mixed Use, Housing Diversity, Transportation, Transit, Walkability, Community Design, Stakeholder Participation, Economic Development, Making use of existing infrastructures.	Yes- In terms of whether the project reuses brownfields or not.	Priority Funding Areas-Service Provision and Government Expenditures, Economic Development in Detail.
Idaho	Smart Growth Commercial Development Scorecard. Smart Growth Neighborhood Development Scorecard	Idaho Smart Growth	Points.0, 1, 2, 3, 4. 0 = Does not meet the Criteria. 2= Somewhat meets the criteria. 4 = Perfectly meets the criteria.	Oriented around Land Use and Transportation Criteria in terms of Commercial and Neighborhood Development.	Yes	Scoring System, Reduce Water Pollution Potential, Light Pollution, and Specifics on what percent of land should be designated for what purpose.
North Carolina, Charlotte	Sustainability Index	Planning Department	Grades – Poor, Fair. Good, Excellent, N/A	Neighborhoods, Transportation, Public Services, Environment, Economics.	No	Financial Need, Risks and Return.
Connecticut	Responsible Development Scoring Sheet	DECD	Points	Mix of uses (more compatible uses- extra points), transit oriented development, encourage standards for green buildings, environmental conservation, compact design.	Yes. (Extra points assigned if the project involves remediated land/brownfields)	Standards for green buildings, use of alternative energy, and use of energy star projects

	LEED for Neighborhood Development Scorecards	Developed in collaboration with Congress for New Urbanism(CNU), Natural Resources Defense Council (NRDC) and US Green Building Council(USGBC)	Certification. Categories - Certified (40 - 49 points); Silver (50-59 points); Gold (60-79 points) ; Platinum(80+ points)	Smart Location and Linkage, Neighborhood Pattern and Design, Green Construction and Technology, Innovation and Design.	Brownfields are included in the matrix under Smart Location and Linkages. Points are assigned for - brownfields redevelopment and high priority brownfields redevelopment.(High priority brownfields - to encourage the cleanup of contaminated brownfields sites in areas targeted for redevelopment)	

Not all aspects of smart growth principles have been accommodated in these scorecards; only those that are consistent with the project goals are included. The type of the project seems to determine what smart growth principles are to be incorporated rather than accommodating all the principles in the project to make it smart. Scorecard by New Jersey future mentions that the card is best applied to lager projects as they have larger implications for smart growth. Some scorecards are designed for a specific community and might not be applicable for another community with a different set of zoning and community requirement.

Scorecards have been designed with a purpose to help evaluate the proposed project with respect to smart growth. It is however not clear whether the existing scorecards are being used. Further research is needed to determine the use of scorecards, and if they are indeed being used who actually uses them, how are they supposed to be used, and where are they submitted. Another purpose of smart growth scorecard is to recognize smart development but it is unclear if they are real world tested approaches or are to be used only has as references and self assessment tools. Documentation on developments where scorecards are used is lacking. Although it needs to be documented, in come cases developers do retain consultants and professional planners to fill out the scorecards and have an organization endorse the project in an attempt to attract funds.

For Brownfield redevelopment information regarding different parameters- physical, environmental, political, economical, social, and public aspects becomes important. Information on these parameters is crucial in evaluating land use options, and attracting capital for redevelopment. Therefore a decision support system that provides information on various aspects of Brownfield which would facilitate better understanding and help in decision making becomes essential. Brownfield redevelopment scorecard could prove to be an important tool under these circumstances. Although scorecard could serve as an important tool for Brownfield redevelopment; whether it will expedite site remediation and development along with how to use it efficiently needs to be determined.

The more information available for a site the better it is. Scorecards can be used not only to obtain information but also to educate developers on what standards will be used to evaluate their proposal. Scorecards could be designed in a way that requires all the site specific information to be filled out so that it can be evaluated in terms of smart growth.

However accommodating smart growth principles into Brownfield redevelopment can be a daunting task because the size and the location of the Brownfield might not always necessarily be appropriate and convenient to comply with these principles, and all the smart growth principles might not be compatible with Brownfield redevelopment. It is a challenge to incorporate every dimension of smart growth in Brownfield redevelopment. Brownfield redevelopment is in itself a complex process due to different regulatory requirements, environmental and legal restrictions and accommodating smart growth principles does force us to look into different facets and various components.

2.6.2 Brownfields and Urban Planning

Brownfield redevelopment came to the foreground in the US in the 1990s. The links between brownfield redevelopment, smart growth principles, and urban and transportation planning strategies have not been clearly established although research has shown that they are intertwined. Smart growth, urban and transportation planning tools have been noted to foster the cause of brownfield redevelopment in the US. Some of these tools are zoning that permits well-planned compact mixed-use development, directing development towards existing communities, urban growth boundaries and providing a variety of efficient transportation choices.

Smart growth principles tend to curb sprawl and redirect development towards existing communities which invariably involves the redevelopment of brownfields (Heberle, 2006). Land-use planning strategies such as zoning, parking and building codes have been researched to have a positive impact on redevelopment by attracting investors and developers to brownfield sites (Heberle, 2006). Zoning that permits well-planned compact mixed-use development meets multiple needs, increasing the profitability of projects within these communities for both the developer and the citizens. The redevelopment of the Belmont dairy in Portland, Oregon and a former industrial site in Louisville, Kentucky are good examples of where flexible zoning has helped in building mixed-use communities (Heberle, 2006). The former dairy had been abandoned in 1990 and remained unoccupied until the late 1990s. Factors that facilitated the redevelopment of this site were its closeness to Portland's downtown and easy access to public transportation. In 1997 the first phase of the redeveloped was completed. This included 19 market-rate lofts and 26,000 square feet of ground-level retail and 66 affordable housing units (Heberle, 2006). Phase two of the project was completed in 1999 and this provided 30 row houses with higher density than other row house densities in Portland (Heberle, 2006). The Belmont dairy redevelopment project created a livable mixed-use community that led to the rejuvenation of the neighborhood. The project won the Oregon Governor's Livability Award in 1997 and 1999 for phase one and two respectively and was the award winner for the Best Business for an Environmentally Sustainable Tomorrow in 1997 as well. The city of Louisville, Kentucky had to change its zoning law to include a "planned development district (PDD) which permitted mixed-use development (Heberle, 2006). This change came about because of the need to redevelop a highly contaminated former industrial site. Again, as in the case of the Belmont dairy project, the proximity of the site to a working class neighborhood, a central business district, transit and highways made it very marketable to developers. The decision to have a mixed-use development was driven by the fact that the site had varying degrees of contamination, so it made sense to place housing or retail on the least contaminated parts and commercial or light industrial uses on the other parts (Heberle, 2006). Reducing parking requirements, especially in communities where walking, biking and transit are the most employed modes of transportation can make it easier and less costly for developers to redevelop brownfields, give developers greater flexibility in project design, and support redevelopment that meets community goals (Heberle, 2006). The Buckman Heights Apartments and Buckman Terrace, a housing and retail development in Portland had reduced parking requirements to the extent of about half the minimum parking for typical urban developments (Heberle, 2006). This reduction was driven by the fact that the area had light rail service, dedicated bike lanes and was pedestrian friendly (Heberle, 2006). As a result of the low parking requirements, the developer costs were reduced by $857000 and more land was available for development (Heberle, 2006).

The effectiveness of brownfield redevelopment as a tool for urban planning and smart growth has been investigated. Brownfield redevelopment has been compared to five viable smart growth options in the US (Greenberg, Lowrie, Mayer, Miller & Solitare, 2001). The first option was for the government to directly purchase or to facilitate the purchase of land in environmentally sensitive locations. The second approach was to make it more difficult to develop farms, forests and other greenlands by not providing water, sewerage, and other infrastructure for such developments. The third option was to change transportation polices to control sprawl. The fourth was to reward architects, builders, bankers, planners, and mayors who promote compact settlements. The fifth alternative was the combination of fair-share housing agreements, regional tax collection and sharing, and regional planning and review of development. Six criteria were used to scrutinize these options and these are; ecological and public health, short and long-term economic feasibility, government reaction, public and special interest reaction, moral imperative, and flexibility and time pressure (Greenberg, Lowrie, Mayer, Miller & Solitare). Considering that brownfield redevelopment increases developable land, reduces pressure for outward growth and Greenfield construction and has a positive effect on air, water, public health and ecology among others, it was concluded that brownfield redevelopment was the smartest smart growth option in the US but was better off an independent policy and not tied to smart growth (Greenberg, Lowrie, Mayer, Miller & Solitare). A number of studies have shown that local communities tend to value the recreational and leisure uses of brownfield sites, whereas developers consider the commercial value of the land (Raco & Henderson, 2006). The effectiveness of brownfield redevelopment as a tool for smart growth can be maximized by its inclusion in broader development projects which have a holistic approach to urban regeneration. The initiation of the Thames gateway project in the United Kingdom (UK) is a good representation of a holistic approach to urban planning and regeneration. The key principle of the Thames gateway project was that brownfield development alone could not tackle the broad range of planning and environmental problems that affect cities and regions and that it needs to be part of a wider, strategically planned set of agendas (Raco & Henderson, 2006). The Thames Gateway project is the biggest regeneration program in Western Europe. Initially proposed in 1991, it was not until 2003 that the concept of redeveloping the Thames Gateway corridor came into the spotlight in the UK (CABE, 2009). It is to be a 40-mile long development along River Thames which would include mixed-use development, transportation links and low income housing units and other land uses that would ensure sustainable communities (CABE, 2009).

Transportation planning can either hinder or drive brownfields redevelopment. While obsolete transportation infrastructure makes brownfield corridors or areas less attractive to potential developers, transportation projects strategically designed and located to improve accessibility between brownfield corridors and major economic centers tend to drive brownfield redevelopment (Amekudzi & Fomunung, 2006). There have been cases where former transportation facilities like freight and rail yards were identified as brownfield sites themselves (Brownfields Bulleting 4th Quarter 2001, Issue 14). Presently, accessibility to transportation resources has almost become a requirement for developers who seek locations for new projects. Case studies on the influence of transportation in brownfield redevelopment projects in some American cities have been done over the years (Amekudzi & Fomunung, 2006). Three scenarios have been identified from these case studies. The first scenario shows an initial brownfield redevelopment project that later needed to include transportation improvements to help in the

regeneration of the brownfield as seen in the American Axle project in Buffalo, N.Y and the Euclid Corridor Project in Cleveland, OH (Amekudzi & Fomunung, 2006). The second scenario shows an initiated transportation project that later includes the redevelopment of a brownfield because, the extent of the transportation project ran through that brownfield corridor. This case can be seen in the Lawrence Gateway and Merrimack Riverwalk project in the City of Lawrence, MA; the North Marine Drive project in Portland, OR; the Riverfront Heritage Trail project in Kansas and the Wellston Technology Park project in Wellston, MO (Amekudzi & Fomunung, 2006). The last scenario shows the integrated planning of transportation and brownfield redevelopment projects to rejuvenate a community or city. Projects that show this scenario are the New Jersey's freight-related development of abandoned industrial sites; the Gateway District Revitalization project in Salt Lake City, UT; the City of Stamford's Brownfields and Transportation Improvements, CT; the Phalen Corridor Initiative (PCI) in the City of St. Paul, MIN (Amekudzi & Fomunung, 2006); and the French Creek Center project, Phoenixville Borough, PA (Johnson, Dixson & Tochterman, 2002). The cases studies show that long-term transportation planning activities can be used to stimulate brownfields redevelopment and accelerate the associated economic, environmental, and social benefits.

In April 1998 the U.S Department of Transportation (U.S.DOT) introduced a new policy on brownfield redevelopment (Brownfields Bulleting 4th Quarter 2001, Issue 14). Under this new policy, transportation agencies were eligible to spend federal transportation funds on the assessment and clean up of contaminated sites and to stimulate the reuse of brownfields by improving access to the sites, provided that the activity was part of an "eligible transportation project" and made "transportation sense (AMPO, 2001). This showed the DOT's commitment to encouraging state and local transportation agencies to undertake transportation-related brownfield projects and their support for the regeneration and revitalization of brownfield lands. The Federal Highway Administration (FHWA), in the same year, revised its policy on hazardous waste and contaminated sites to be more favorable to transportation-related brownfield projects, making it crystal clear the role transportation authorities in the country wanted to play in the brownfield redevelopment process (Brownfields Bulleting 4th Quarter 2001, Issue 14). Since 1998 many brownfield-related transportation projects and transportation related-brownfield projects have accrued funds from the DOT and some agencies with the DOT such as the FHWA, the Federal Transit Authority (FTA) and the Federal Railroad Authority (FRA), both at the state and federal levels (See Table 2.6). Other government agencies that have been prominent in providing funds are the US Environmental Protection Agency (USEPA) and the US Department of Housing and Urban Development (HUD) (See Table 2.6). The Transportation Improvement Program (TIP) has also been a source of funding for some projects. State level agencies such as the Department of Communities and Natural Resources (DCNR) also play a role in funding these projects in conjunction with the states and cities themselves. The private investor cannot be left out of the list of capitalists in brownfield redevelopment. A number of remediation projects have taken off with funds from private investors and later aided by the government and the public. The realization of the need for collaboration between private investors, government agencies and communities in funding brownfields projects in recent years has led to an increasing number of stronger and more successful public-private partnerships.

The success of a brownfield redevelopment extends beyond the immediate impact of clean up and reuse of derelict lands. There is a more rounded approach to evaluating the success of

projects which considers the quality of life within the neighborhood after remediation over a period of time and also considers the long term economic, social and environmental impacts (Dixon, 2006).

This boils down to the concept of sustainability. The concept of sustainable brownfield redevelopment emerged from sustainable development and it is therefore grounded on the three core precepts of sustainable development namely economic prosperity, environmental health and social equity and well-being. A sustainable brownfield development is one that has been produced in a sustainable way and which, according to theory provides a physical environment to enable end users to undertake their activities more sustainably (Williams & Dair, 2007). An EU-wide definition of sustainable brownfield redevelopment is the management, rehabilitation and return to beneficial use of brownfields in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally sensitive, economically viable, institutionally robust and socially acceptable ways within the particular regional context (Dixon, 2006). The measure of sustainability of brownfield projects is a conundrum to many. Although a range of sustainability indicator frameworks exist to measure sustainability, there is no single sustainability indicator framework that measures brownfield redevelopment at every stage (Dixon, 2006). The main concern about sustainability in brownfield redevelopment is its accomplishment in the field. The unclear definition of sustainability with respect to brownfield redevelopment in some projects makes it the more difficult to have a practical sense of it. In some cases the environmental issues are profound, excluding economic and social issues and in other cases all three issues are included in the definition sustainably (Williams & Dair, 2007). A paper by Williams and Dair (2007) mentions that it is not always clear which aspects of a development need to be sustainable: is it the land remediation process, the planning process, the buildings themselves, the final uses of the development, or all of these? Research conducted in the UK revealed that sustainability objectives could be achieved in numerous ways and although the framework covered the three main aspects of sustainability, not all the objectives were applicable to all brownfield sites, depending on the local context (Dixon, 2006).

Table 2.6: Summary of Case Studies

Redevelopment/ Location	Brief Description of Project	Stakeholders and Financiers	Scenario Type
American Axle Plant (NE Buffalo, N.Y.)	Development of access road along old rail corridor to attract businesses to vacant underutilized parcels along corridor.	American Axle and Manufacturing (developer); City of Buffalo ($1 million in general obligation bonds); NY State DOT ($3.5 million); U.S. Department of HUD ($1 million)	1
Euclid corridor (Cleveland)	Improvement of transportation corridor occurring in the vicinity of systematic brownfields improvements	Greater Cleveland Regional Transit Authority (developer); Federal Transit Administration (over $4 million); Ohio DOT; City of Cleveland; State Infrastructure Bank Program	1
Freight-related development of Abandoned industrial sites (North Jersey, N.J.)	Freight related redevelopment of brownfields including port expansion and roadway/guide way development	North Jersey Transportation Planning Authority, Inc.; and New Jersey Institute of Technology (oversight agencies); U.S. Department of Transportation	3
Gateway District (Salt Lake City)	Rejuvenation of 650 acre blighted industrial district that currently divides west and east sides of Salt Lake City.	Redevelopment Agency of Salt Lake City (developer); U.S. Environmental Protection Agency ($0.2 million); U.S. Department of HUD (over $3.5 million); Salt Lake City (over $30 million)	3
Lawrence Gateway and Merrimack Riverwalk (Lawrence, Mass.)	Extension of Walkway providing pedestrian and bicycle access to downtown and the City's National Heritage Park.	City of Lawrence (oversight agency); GenCorp Polymer Products, Massachusetts Highway Department ($4.5 million), U.S. DOT ($0.5 million); USEPA, U.S. Department of HUD, Massachusetts Land Bank Grant Fund	2
North Marine Drive (Portland, Ore.)	Relocation and improvement of outdated road through contaminated land that provides access from Interstate freeway through industrial district dotted with brownfields.	City of Portland ($2.6 million); Oregon DOT ($5.4 million), Federal Highway Administration ($14.6 million)	2
Phalen corridor Initiative (St. Paul, Minn.)	Comprehensive community initiative, including transportation improvements, to restore economic, physical, and social prosperity of St. Paul's East Side	Saint Paul Port Authority (oversight agency); City of St. Paul ($7.2 million); Federal Highway Administration ($12.25 million); Ramsey County ($3 million); U.S. Department of HUD ($10 million)	3

Riverfront Heritage Trail (Kansas City, Mo. and Kan.)	Development of 9-mile long bi-state system of bicycle and pedestrian paths, coordinated with bus transit service, connecting the cities of Kansas in Kansas and Missouri.	Federal Highway Administration (over $6.1 million); U.S. Army Corps of Engineers ($1.2 million), State grants ($3 million); Local funds ($6 million)	2
Stamford Urban Transitway and Intermodal Center Improvement (Stamford, Conn.)	Transitway and intermodal center improvements being undertaken in the vicinity of brownfields redevelopments.	Federal Highway Administration ($18 million); Connecticut Department of Transportation; City of Stamford ($5.8 million); U.S. Environmental Protection Agency ($0.2 million)	3
Wellston Technology park (Wellston, Mo.)	Development of brownfields being driven by transportation improvement project: opening of a Metrolink station.	City of Wellston and St. Louis County Economic Council (oversight agencies); Federal Highway Administration ($4 million); Federal Transit Administration; Wagner Electric Company, Moog Automotive, General Electric; Interglobal; Vijon	2
French Creek Center project (Phoenixville Borough, PA)	Redevelopment of abandoned steel mills into a new town center, complete with a mixed-use office and residential development plan, public recreational trail along the French Creek, Linear Park System and intermodal transportation network	Delaware Valley Regional Planning Commission(DVRPC), Pennsylvania Department of Transportation (PennDOT)($ 6.7 million), Federal Highway Administration (FHWA), Federal Transit Administration (FTA)($ 1.25 million), Department of Environmental Protection (DEP), Pennsylvania Department of Communities and Natural Resources (DCNR), Transportation Improvement Program Federal funding (4.8 million)	3

Source: Amekudzi & Fomunung (2004), Johnson *et al.* (2002)

3.0 INDEXING APPROACH AND GIS TOOL

3.1 INTRODUCTION

The problem of allocating resources when several environmental and socio-economic objectives co-exist is one of the most crucial issues in the context of brownfield revitalization. Indeed, developers and economic development agencies often face difficulties in choosing which sites to remediate, market and/or purchase even when redevelopment incentives are available (Thomas, 2002a). Given that the resources to promote and affect redevelopment are limited compared to the vast number of existing brownfields, it is necessary to provide decision-makers with support tools that aim to maximize the benefits that can be achieved with the available funds.

Some decision support systems for the assessment of brownfield projects are currently available. These take the form of models, GIS-based tools and scorecards that are primarily geared towards assessing the smart-growth potential of a particular project. In the following, we provide a conceptual and practical overview of these methodologies and highlight some of their advantages and limitations.

In general, existing decision support systems have been designed to evaluate specific projects that are either evaluated within the context of a particular brownfield site, or within the context of selecting an appropriate brownfield site for implementation of a specific project. Thomas (2002a, 2002b) designed a prototype brownfield decision support system that aimed at assessing brownfield sites in the context of a particular end use and development requirements. The idea behind this type of assessment was that, when a developer reached out to the local government looking for a site with a set of desirable attributes, the government would be able to use this tool to select the most appropriate site for this particular project. However, the assessment tool also allows several brownfield sites to be pre-ranked for specific end uses (e.g. industrial or commercial) based on their redevelopment potential, using more general criteria such as transportation and telecommunications infrastructure, compliance with zoning ordinance, labor market conditions, public opinion and availability of funding. The result is a set of multivariate, weighted criteria that can be used to evaluate and rank sites according to their redevelopment potential. The ranking can then be combined with physical considerations compiled from spatial data in an expert GIS system called Smart Places to evaluate the effects of various land use alternatives. The prototype was tested by Thomas in a city- and county-level brownfield identification, screening, and marketing effort in Jackson County, Michigan, and provided a model for commercial developers, real estate brokers, siting consultants, and local communities in selecting target sites for redevelopment.
While potentially useful in identifying sites with high redevelopment potential, the main drawback of the system developed by Thomas (2002a, 2002b) is that it requires very detailed information on the environmental status of the brownfield, as well as extensive public interaction in order to obtain the desirable end uses for a particular site, as noted by the author himself. This renders the comparison process for the various brownfields very slow. Thomas (2002a, 2002b) spoke of the assessment of 90 brownfields using this tool in Jackson county, out of a total number of 45,000 sites for the state of Michigan. Thus, the time and data intensity of this approach limits its applicability in many localities, where authorities have to deal with a very

large number of brownfield sites, for most of which there are no comprehensive environmental data available.

Similarly, the City of Chicago in the U.S. developed a screening tool for brownfield sites that entails two types of evaluations (GSG Consultants 2005): smart-growth potential (end use-specific) and assessment of environmental contamination (location-specific). This tool follows the example of several other scorecards that were developed to evaluate the smart growth potential of projects independent of their brownfield character, such as the Smart Growth Scorecards suggested by New Jersey Future (2005), the Smart Growth Commercial Development Scorecard and the Smart Growth Neighborhood Development Scorecard proposed by Idaho Smart Growth (2010), and the LEED-ND Scorecards (U.S. Green Building Council, 2009). The environmental evaluation includes criteria that require a visual site inspection and an actual site investigation to answer questions about, for example, the amount of hazardous material present and the presence of groundwater contamination. While more general than a detailed risk assessment, as with the Thomas (2002a, 2002b) assessment tool, this evaluation requires information that is not available for the majority of brownfield sites; by the time that a site has reached a Phase II assessment, there is often a commitment to redevelop this property by either a town or a private developer.

In Europe, the brownfield-related literature has focused on evaluating the sustainability of brownfield redevelopment projects. Several evaluation tools have been developed for this purpose. A Sustainability Assessment Tool (SAT) for brownfield redevelopment was developed in the frame of the European CLEAR project (Kogelheide et al. 2004) to guide the investment of public funding. Koj and Francis (2006) also developed an evaluation tool for sustainable development of brownfields, and Pediaditi et al.'s (2005) Redevelopment Assessment Framework included sustainability indicators for brownfield redevelopment. Williams and Dair (2007) presented a framework for evaluating sustainability from three perspectives: economic, environmental and social. They defined specific objectives that should be met in each category in order for the project to be characterized as sustainable and evaluated five case studies using this approach.

Finally, some studies have sought to identify important factors for successful brownfield redevelopment. For example, Lange and McNeil (2004) developed a logit model to evaluate the probability of success of a redevelopment project based on the analysis of the key factors in the success of 75 brownfield sites in the United Sites. The most important variables that determined the potential for success were the political support that a project could obtain and the support of the banking and lending community. Similarly, the meta-analysis of 18 Dutch case-studies conducted by Nijkamp et al. (2002) concluded that legal procedures, problems with financial support and getting the owner to assume responsibility were the most important factors for stagnation of a remediation. The authors also developed an expert system that could guide decision makers through the various stages of brownfield reclamation, helping them identify stagnation points and opportunities.

While multiple decisions support tools exist for brownfield redevelopment, in all of the aforementioned studies, the evaluation tool was designed to be used on a case-by-case basis. In particular, it either assumed that there is a potential developer with a set of criteria or that there is

a specific private end use that is assessed, so that the brownfield is evaluated in a specific context. Importantly, these tools do not allow broad identification of areas or sites that might be targeted for re-use as part of an effort to promote smart growth, where the end use might, for example, involve open space or recreational or residential use rather than commercial or industrial development. Thomas (2002a) underscored that the assessment of the brownfields using his proposed ranking system rarely led to a preferred use as open space or residential development. The main smart growth premise is to revitalize urban centers and to create walkable neighborhoods with a vital community life. Within this context, it is possible that urban planners seeking to promote neighborhood redevelopment may wish to promote the redevelopment of brownfields that do not fit the specific criteria of a developer or a specific end use. Examples exist in Connecticut where the rehabilitation of a brownfield to a park, a daycare center and a shopping center lead to a rapid change in community dynamics. While it is hard to assess which locations are critical to achieve such a transformation, these examples highlight the need to partially decouple the assessment of brownfields from their end use and to obtain a location-specific assessment for the prioritization and allocation of funding sources. In addition, it is desirable to have environmental indicators that are decoupled from the formal Phase I-III investigations, because the latter are not available in the vast majority of brownfield sites. Finally, all of the proposed evaluation schemes require a wealth of information on the brownfield and the project, which is usually available only after the stakeholders have decided to take action on investigating a brownfield and spend money on it.

Overall, there are three types of considerations when evaluating the benefits derived from brownfield redevelopment: socioeconomic, environmental and smart-growth related. The present paper develops a location-specific indexing and mapping approach that seeks to consider all three types of factors independently of the end use and without the need for site specific environmental investigations. This tool may be used by decision-makers in advance of the application of more targeted project-specific tools, in order to identify areas and/or sites that should be prioritized for funding.

3.2 METHODOLOGY AND DATA

The objective of this study was to create a location (rather than project) based decision support system to prioritize funding areas for brownfield redevelopment. To be effective, such a land use decision support system must provide access to data, appropriate tools or mechanisms to transform the data into useful information, and a context for interpretation and implementation of results of the analysis (Thomas, 2002a). This system is not designed to make the allocation decisions, but rather to provide a tool for organizing and visualizing information that can serve as a valuable input into the decision-making process.

The proposed decision support scheme takes account of location-specific —rather than project-specific— variables, which were categorized into three areas: socioeconomic, environmental and smart-growth related. For each area, an index was created to summarize the redevelopment priority of different locations based on each of the three considerations. In the development of the three indices, we sought to organize and classify the data based on widely accepted standards when possible. For example, categories for transportation and land use data were selected using the LEED-ND Rating System as a guide. After classifying the data, the three individual indices

were aggregated using an illustrative weighting scale reflecting the possible relative importance of each criterion and sub-criterion. The development of the system was data-driven and based on the data sources identified for the United States. Although we use the city of New Haven, CT as a case study, the data necessary to implement our approach are generally available across the U.S.

For illustrative purposes, we follow a two-step procedure:

a) In the first step, we use the socio-economic index to identify locations that would be a high priority for economic development in general. The target end-user for the developed socioeconomic index would be a government body at the state level, such as the Department of Economic and Community Development in CT. In our application, this step identified New Haven, CT as a good target for investment of redevelopment funds.
b) In step two, we then construct and overlay the smart growth and environmental indices within the area targeted by step one to identify more specific locations with high redevelopment potential based on these two additional criteria. In our application, this step identifies the neighborhoods within the city of New Haven with the highest potential.

Note that, although our case study applies the socio-economic index at the town level and reports the smart growth and environmental indices only within the targeted town, depending on data availability all three indices as well as the aggregate priority scores can be computed at different levels of spatial resolution. The relevant level of resolution will depend on the specific decision-making context. For example, a state agency seeking to allocate redevelopment funds across towns would presumably want to compare scores across towns, while a local planner seeking to target specific neighborhoods would need resolution at the neighborhood-level.

3.2.1 Socio-Economic Index

The incorporation of socio-economic factors into a general prioritization scheme is intended to capture the higher priority that should be placed on investment or redevelopment in areas where the associated benefits are high and costs are low. It is intended to incorporate some of the likely benefits and costs that are not reflected in the smart growth and environmental indices. While many (and perhaps even most) of these benefits and costs would be project-specific, nonetheless, some location-specific characteristics can be relevant as well. The socio-economic index we develop here focuses on these broader indicators. In particular, based on economic principles and available data, we chose four variables that we considered to be objectively related to priority for redevelopment: population density, unemployment rate, property values, and whether the town is designated as a Distressed Municipality or a Targeted Investment Community (TIC) in the state of Connecticut. Table 3.1 shows the variables along with the classification and weighting scheme.

Table 3.1: Socioeconomic Variables - Classification, Scores and Weights

Variable [Unit]	Classification	Score	Weight
Population density [Population/Sq. Mile]	High (top 25%)	2	30%
	Medium (middle 50%)	1	

	Low (bottom 25%)	0	
Unemployment [Unemployment rate]	High (top 25%)	2	25%
	Medium (middle 50%)	1	
	Low (bottom 25%)	0	
Targeted Development Indicators [Distressed Municipality or Targeted Investment Community]	Yes	2	25%
	No	0	
Property Values [House Median Price]	High (bottom 25%)	2	20%
	Medium (middle 50%)	1	
	Low (top 25%)	0	

Population Density

In our index population density correlates positively with priority for redevelopment because in general the benefits of brownfield redevelopment are likely to be positively related to population density in the surrounding area. For example, the benefits associated with revitalizing a neighborhood or providing new local services will be higher when more individuals live in the vicinity and can take advantage of the improvements or new services. In addition, the number of people who benefit from clean-up of contamination (through reduced exposure) will also be higher when the cleanup occurs in an area with high population density. Thus, all else equal, areas with higher population density should have higher priority for redevelopment. We obtained data on population density from the town profiles featured in the Connecticut Economic Resource Center (2010), which in turn compiles these figures from the US Census Bureau and the CT Office of Policy and Management.

Unemployment

The local unemployment rate is also a potentially important consideration because site development is often connected with job creation and it is desirable to create new jobs close to the locations with maximum need. A high unemployment rate can indicate the ready availability of the labor that might be needed for a redevelopment project. Even if the project itself does not generate a significant number of local jobs, if it triggers a revitalization that in turn leads to additional investment in the community, this spillover effect could stimulate much-needed jobs in an area with high unemployment. Thus, as with population density, the benefits of redevelopment are likely to be higher in locations with higher unemployment rates. Town unemployment rate data were obtained from the Local Area Unemployment Statistics released by the Connecticut Department of Labor in December 2009.

Targeted Development Indicators

Many states specifically identify certain communities as targets for development and investment. For example, the state of Connecticut has designated certain municipalities as Distressed Municipalities or Targeted Investment Communities (OBRD, 2009). The designation of Distressed Municipalities is based on demographic and economic indicators such as per capita income, educational attainment, changes in population and employment during the last ten years, among others, and serves as a criterion for qualifying projects for open space and brownfield remediation funding, while TICs are towns with an Enterprise Zone (Rappa, 2000). Other states have similar designations. It is presumably the judgment of economic development officials that investments in these communities will yield higher net benefits, all else equal, than investment in undesignated communities, and hence they should be a higher priority for development. For this reason, we include information about the cities and towns designated by the state of Connecticut DECD Commissioner as Distressed Municipalities and Targeted Investment Communities (OBRD, 2009) in our socio-economic index. Note that, while this designation reflects data on population and unemployment (among other things), the correlation between this variable and population density or unemployment is low for our dataset. Thus, this variable appears to be reflecting considerations that are not captured by the other two variables.

Property Values

Finally, in contrast to the variables above, property values are expected to be negatively correlated with priority for redevelopment. Property values can be viewed as an indicator of the cost (rather than the benefit) of redevelopment: the higher the property values, the higher the opportunity cost of the land. In addition, since one benefit of brownfield redevelopment can be the revitalization and hence increase in property values within the vicinity of the site, this potential gain is likely to be greater in locations where property values are depressed than in locations where property values are already relatively high. For these reasons, we include property values in our socio-economic index, with higher property values indicating lower priority for redevelopment. The data on local property values is taken from town profiles featured in the Connecticut Economic Resource Center (2010).

To construct the socio-economic index from the variables described above, it is necessary to categorize the levels of the variables and then aggregate them. Given the absence of standardized guidelines for categorizing these variables, we classified the towns on a high-to-low basis for each variable by considering the quartiles of the distribution of the corresponding variable values (see Table 3.1). Thus, for population density and the unemployment rate, “low” characterizes municipalities whose values are within the bottom quartile, “medium” corresponds to values within the intermediate quartile range, and “high” to the upper 25% tail. The reverse scoring scheme was used for property prices. Finally, Distressed Municipalities/TICs were classified as “high”, while “low” was assigned to the remaining towns.

For aggregation and visualization purposes, data for all the variables were classified into three groups —high was assigned a score of two (2), the medium class a score of one (1) and the low class a score of zero (0). The weights assigned to each of these should depend on their relative importance, which will vary with the decision-maker and context. For illustrative purposes, population density is weighed 30% and property value is assigned a 20% weight, while the unemployment rate and Connecticut Distressed Municipalities/TICs are both weighed 25%. These weights could easily be changed by potential end-users with different priorities.

3.2.2 Smart Growth Index

We adopted the **Leadership in Energy and Environmental Design** Neighborhood Development (LEED-ND) certified rating system (USGBC 2009) as a guide in the creation of our mapping index due to its gained recognition and accreditation in the U.S.. We selected spatial variables that were not project-specific and that were crucial to the smart growth concept, as well as variables for which geo-coded data was available. Six variables met these criteria, each of which will be described in detail and which are summarized in Table 3.2.

Table 3.2: Smart Growth Variables - Classification, Scores and Weights

Variable [Unit]	Classification	Score	Weight
Intersection Density [Intersection/Sq. Mile]	Above 140	2	25%
	90 -140	1	
	Below 90	0	
Utility Service Area [Sq. Mile]	Both	2	25%
	Either	1	
	Neither	0	
Job Housing Balance [Jobs/Employed Labor]	0.8-1.25	2	15%
	Above 1.25/Below 0.8	1	
Bus Transit – Access [Miles]	Below 1/4	2	10%
	1/4 - 1/2	1	
	Above 1/2	0	
Rail Transit - Access [Miles]	Below 1/2	2	10%
	1/2 - 1	1	
	Above 1	0	
Rail Transit - Service [Avg. Trips/Week]	Above 48	2	10%
	30 - 48	1	
	Below 30	0	
Potential Rail [Miles]	Most Likely	2	5%
	Possibly	1	

	Unlikely	0	

Utilities

For any smart growth related development it is imperative that the area to be developed has utility services in order not to further consume forest and natural habitats en route to providing these utilities. The LEED-ND Rating System states that developers should "locate the project on a site served by existing water and wastewater infrastructure". It is assumed in our work that areas with water and wastewater service would have other basic utilities (e.g. electricity) available as well. The water and wastewater service areas therefore represent our utilities layer.

The Connecticut Department of Public Health (CDTPH) and the Department of Environmental Protection (DEP) were the sources for the water and wastewater shapefiles, respectively. These data show areas being served as well as proposed service areas within the state. The two utility layers were joined to give a single layer showing areas with both, either or neither of the two utilities. These areas represent the high, medium and low class respectively in our utilities layer.

Job Housing Balance

Smart growth promotes development that creates a diversity of uses in an area. The provision of employment opportunities and affordable housing options in close proximity to each other are essential in the creation of a mixed use environment. The LEED-ND Rating System requires a balance in housing options and employment opportunities. In our analysis the job housing balance serves as our economic and land use variable and also as a proxy for mixed use.

In the creation of this layer we obtained data on the number of establishments and jobs in a zip code in 2007 from the US Census Bureau. The zip code was the smallest geographic scale at which we could obtain this data. We also acquired data on the number of employed population living in each zip code from the National Historical Geographic Information System (NHGIS). Though NHGIS could provide employed population data at smaller geographic scales, for example census tracts and census block groups, we decided to work with zip code data due to the geographic scale of the data obtained from the US Census Bureau.

We adopted job housing balance groupings from research done by Cervero (1996) on the job housing balance trends in the San Francisco Bay area. These groupings were: below 0.8 - characterizing housing-rich communities; between 0.8 and 1.25 - characterizing a balanced community and; above 1.25 - characterizing a job-rich community. The range 0.8-1.25 is the high class in this layer since it is the ideal place for smart growth development when considering the availability of jobs and affordable housing. The ranges above 1.25 and below 0.8 are the medium class. Both of these groupings were placed in the medium class because equal importance was placed on the need to balance job-rich communities and housing-rich communities.

Intersection Density

Smart growth principles promote compactly built and pedestrian friendly neighborhoods. One feature of such neighborhoods is their dense street network. Intersection density is used to represent the street network density in our mapping index. In the smart location and linkage (SLL) section of the LEED-ND Rating System, an intersection density of at least 90 intersections/sq. mi in an area is specified as an additional prerequisite to the presence of existing water and wastewater infrastructure for any project. We adopted 90 intersections per square mile as the base intersection density for our mapping.

The intersection density layer was created by first identifying intersections of roads excluding major highways and highway ramps. These roadways were viewed as not adding to the intersection density and connectivity of a given area. A TIGER 2000 centerline roads shapefile from the DEP was used for this process. An arc script 'Find Nodes' was employed in identifying these intersections (nodes). The intersection density of each census block group was then calculated by dividing the sum of nodes in the block group by the area of the block group.
As we mentioned earlier, the base intersection density for our analysis is 90 intersections/sq. mi and therefore any area with an intersection density lower than this represents the low class in this layer. In the LEED-ND project sites with intersection densities of at least 140 intersections/ sq. mi are used in identifying and defining infill sites. Based on this and the analysis of the intersection densities, we calculated for each block group we decided to used 140 intersections/ sq. mi as the upper limit of our medium class. The medium class therefore ranged from 90 to 140 intersections/sq. mi and the high class showed areas with intersection density greater than 140 intersections/sq. mi.

Transit Layers

The availability or provision of public transit is an important part of any smart growth related endeavor. The accessibility and frequency of the service are two main foci when providing transit in any area. The LEED-ND Rating System in the SSL section specifies an area with a transit corridor or adequate transit service as an additional prerequisite to the presence of existing water and wastewater infrastructure for any project. Our mapping index primarily contains three transit layers representing rail transit, bus transit and the potential for rail transit.

Rail Transit

Our rail transit variable has two components: access to the service and the quality of the service itself. For rail transit access the LEED-ND Rating System specifies a distance of a half mile from rail stations as the minimum distance a user of these transit systems would want to walk to use the service. We therefore apply this distance – a half mile – in our rail transit access layer as the minimum radii for train stop buffers.

Creation of the rail transit access layer involved obtaining rail lines shapefiles from the DEP. The Center for Land Use Education and Research (CLEAR) provided shapefiles of train stations and additional rail stops were geocoded into

ArcGIS from Metro North, Amtrak and Shoreline East databases. Circular buffers of a half mile and one mile were created around the train stops representing distances commuters would travel to use the train either on foot or by bicycle. Areas that are more than a mile radius away from a train stop represent the low class in this layer. Areas between a half and a mile radius from a train stop represent the medium class and areas within a half mile radius from a train stop represent the high class.

With regard to rail transit service, the LEED-ND Rating System specifies a minimum of 24 weekday and 6 weekend trips for a commuter rail system. We adopted this minimum number of trips as the starting point for classifying the service provided at each of the train stops within our mapping index. The creation of the transit service layer involved data collection of the weekly train schedules of Metro North, Amtrak and Shoreline East train services. Transit service was classified by the average number of combined weekday and weekend weekly trips leaving and arriving at a train terminal according to the LEED-ND Rating System classification. One mile buffers were created around train stations and stops. Buffers of stations with an average combined weekday and weekend weekly trips below 30 were placed in the low class. Stations with combined average weekly trips between 30 and 48 were placed in the medium class and stations with service greater than 48 average combined weekly trips were placed in the high level.

Bus Transit

Unlike the rail transit variable which combines rail transit access and rail transit service, our bus transit variable comprises only a bus transit access layer. Primarily due to time constraints and limited resources we were unable to collect the large amounts of bus transit service data for our mapping area needed to create the bus transit service layer. For bus transit access a distances of a quarter mile walk from bus and/or streetcar stops and a half mile from bus rapid transit (BRT) stops have been chosen by LEED-ND Rating System as minimum reasonable distances a user of the transit system would want to walk to use the service. Our bus transit access layer employs a quarter mile as the minimum radii for bus stop buffers.

In the creation of this layer, bus routes and stop shapefiles were obtained from CT Transit, Greater Bridgeport Transit Authority (GBTA), Central Connecticut Regional Planning Agency (CCRPA), South Regional Planning Agency (SWRPA), Windham Region Council of Governments (WRCG) and Southern Connecticut Council of Government (SCCOG). Circular buffers of a quarter and half mile radii were created around all bus stops. These buffers represent the distances a user of the bus system would want to walk to a stop. Areas that are more than a half mile radius away from a bus stop represent the low classification in this layer. Areas between a half and quarter mile radius from a bus stop represent the medium class and areas within a quarter mile radius from a bus stop represent the high class.

Potential for Rail

The last transit layer in our mapping index represents the potential for new rail transit or improved rail transit service in areas within the state. These areas are places that have existing rail infrastructure or are part of a rail corridor but do not have a station or stop. Train stations that have inadequate service according to the LEED-ND rating system are also included in this layer as having a potential for improved service.

One mile buffers were created around rail lines in Connecticut to show areas with the potential for new rail transit. One mile buffers of rail stops that were classified as having low transit service in our rail transit service layer were added to the rail line buffers to represent the potential for improved transit. Areas covered by the buffers of the rail stops that were classified as medium or high in our rail transit access layer were excluded from this layer. This was done to ensure that areas with adequate existing train service were not included as areas having the potential for transit. Areas within the one mile buffer of the train stops with low transit service represented the high class. Areas within the one mile buffer of the rail line were categorized as being in the medium class while areas outside the one mile buffer of both the rail and rail stops we categorized as the low class.

A large number of the geospatial datasets collected were shapefiles – a vector data format in GIS. Initial preparation of the component layers of our mapping index were carried out with the data in the format acquired using vector analysis. However, due to the analysis capabilities of raster analysis, all layers were converted to rasters with a cell size of 30 feet during the aggregation of our layers.

Similar to the socio-economic index, a raster reclassification of all layers was carried out with a low class score of 0, a medium class score of 1 and a high class score of 2 assigned to the respective classes in the layers discussed above. These integers were chosen primarily to make our GIS raster analysis simple and easy to execute. The Connecticut state boundary served as the spatial limits for all reclassified rasters to create uniformity and also to ensure that all areas within the state could be scored.

The weights assigned to each of the six variables for aggregation were not equal, but rather reflected our suggestion for the most important aspects that drive smart growth (Table 3.2): we consider street density and the availability of utilities to be the most important aspects, because they are prerequisites for other smart growth conditions to exist, including the availability of transit. Job housing balance was also ranked high because it is indicative of a mixed use area, which can reduce transit times and sprawl even in the absence of public transportation. The availability of public transit was ranked lowest both because it is very low in the state of CT and because it is possible to have smart-growth compliant project in

areas without public transportation. We reiterate that these weights may be easily modified by the end users depending on their priorities and the characteristics of the location.

3.2.3 Environmental Index

One of the main difficulties associated with brownfield redevelopment is the uncertainty in the cost and time requirements to perform site investigations and clean up actions, as environmental risk assessments are typically time consuming and expensive. Additionally, risk to human health and the environment should be one of the major factors to prioritize brownfields for investigation, remediation and redevelopment. In order to incorporate this dimension into our indexing scheme, we considered parameters that could be easily quantified and classified with available data sources, and which would provide a rough representation of the three elements that are typically part of environmental risk assessment: source, pathway and receptor. Seven variables were chosen, as presented in Table 3.3, which were classified as follows.

Table 3.3: Environmental Index Score Variables - Classification, Scores and Weights

Variable [Unit]	Classification	Score	Weight
Past use	Industrial	2	20%
	Commercial	1	
	Residential	0	
Soil type	Permeable (sand – $k>10^{-3}$ cm/s)	2	20%
	Semi-permeable (silt – 10^{-3} cm/s$>k>10^{-6}$ cm/s)	1	
	Impermeable (clay – $k<10^{-6}$ cm/s)	0	
Proximity to surface water body and aquifer protection area [Miles]	<0.25	2	20%
	0.25-0.5	1	
	>0.5	0	
Proximity to sensitive receptors [Miles]	<0.25	2	20%
	0.25-0.5	1	
	>0.5	0	
Zoning	Residential	2	20%
	Commercial	1	
	Industrial	0	
Characterization as floodplain	Yes	2	+10%*

	No	0	
Characterization as wetland	Yes	2	+10%*
	No	0	

* Extra "credit" for calculation of EIS with a max contribution of 0.2

Past Use of the Site

Classification of brownfields based on their past uses can provide some insight into the potential extent and type of contamination. For example, industrial sites are more likely to be contaminated than commercial or residential sites. This is the only variable that represents the likelihood that there is a source of contamination at the site, as anything more detailed would require site-specific information that is part of a Phase I investigation, which is typically not available for most brownfield sites. Industrial sites were assigned a value of 2 (high sensitivity), business sites a value of 1 (medium sensitivity) and residential sites a value of 0 (low sensitivity). This information was provided along with an inventory of brownfield locations by CTDEP, with additional sites and data provided by the City of New Haven.

Proximity to Surface Water Bodies and Groundwater

Water is the major pathway for non-volatile contamination that is typically present in chronically contaminated sites to reach sensitive receptors (human, fauna and flora) and thus proximity to water resources is a key variable in the assessment of environmental sensitivity of a site. Proximity to surface water is easy to obtain, while proximity to groundwater as a source of drinking water is more difficult to establish. In Connecticut, there are designated aquifer protection areas, for which there is available geo-coded data and it is also possible to locate the existing public water supply wells. The existence of private drinking water wells in the proximity of a site, however, can only be established through an on-site investigation and this is a major limitation in quantifying this parameter. In the case study we present later, the City of New Haven has public water supply, so that this problem was circumvented.

An additional difficulty for this variable was to establish objective criteria for environmental sensitivity, since risk is a function not only of the distance, but of the contaminant nature and concentration, and of the time it takes for the contaminant to reach the water body. Since we seek an index that is generic and does not require site-specific data, we chose 0.25 miles (402 m) as the distance that corresponds to high risk, 0.5 miles for medium risk and distances higher than 0.5 miles for low risk. Assuming an average groundwater velocity of 1 ft/day (0.3 m/d), it would take 1320 days (3.6 yr) for contamination in the groundwater underlying the site to reach the surface water or drinking water supply, which is relatively short for most chronically contaminated sites, but relatively long compared to decision making processes and clean up actions. If there are any data on site history and the groundwater velocity in the area, it may be possible to

come up with a defensible number for the minimum distance that poses a threat. Even if only groundwater velocity is known for a certain area, it is possible to adjust the distance based on what is considered a reasonable distance/time frame for exposure; still, some degree of arbitrariness cannot be avoided. Maps for aquifer protection areas and surface water were provided by CTDEP for the entire state of Connecticut.

Soil Permeability

Contamination typically reaches water bodies by percolation of contaminants from the source (spill or waste disposal area) through the soil. Thus, soil is a critical pathway for risk assessment; the more impermeable the soil, the longer it takes for contamination to reach the groundwater and consequently, nearby surface water bodies. This parameter is correlated to some extent with the previous variable "proximity to water bodies", but not necessarily: it is possible to have a site with a relatively impermeable top layer that is underlain by a deeper aquifer, so that the time is takes for contamination to travel vertically to the aquifer and the time it takes for contamination to travel horizontally to nearby drinking water wells may be different. Thus, we maintained both variables in the index.

We obtained data for soil hydraulic conductivity from the Soils Survey of the National Resource Conservation Service, which provides soil maps and data at a scale of 1:12,000. Thus, the maps do not provide true site-specific data, but can still provide an idea of the general soil properties in an area and enough resolution to distinguish between sites located within a single municipality, as will be illustrated for the case of New Haven. We used the hydraulic conductivity of the surficial soil layer as the indexing parameter and we classified it according to the scheme developed in geotechnical engineering by A. Casagrande (Holtz and Kovacs 1989): soils with hydraulic conductivity exceeding 10^{-4} cm/s are considered permeable, soils with hydraulic conductivity less than 10^{-6} cm/s are practically impervious, and the intermediate values are assigned to semi-permeable soils.

Zoning of the Site

This variable falls under the category "receptors". A brownfield located in a residential site has more impact on humans compared to a site located in a business or industrial zone and is thus correlated to higher environmental sensitivity. Zoning data for the City of New Haven were provided by the city.

Proximity to Sensitive Receptors

Sensitive receptors in this case are protected open space, state parks and critical habitat areas, all of which are lands of particular environmental sensitivity. Critical Habitats were based on Connecticut's Natural Vegetation Classification, which defines them as areas inhabited by a number of rare species. Natural diversity areas represent the general locations of endangered or threatened species, species of special concern, and significant natural communities (CTDEP, 2010a; CTDEP, 2010b). The same distances of 0.25 miles (402 m) and 0.5 miles (804 m) were again chosen to divide high, medium and low

environmental sensitivity. The issue of arbitrariness again arises here, but there is no meaningful way to deal with it; these values can be modified by end users depending on their views of the relative importance of these receptors. Maps for these variables were provided by CTDEP. It is also possible to include other receptors in the list of presented variables, such as proximity to schools, day care centers and hospitals. However, such data are typically not readily available for mapping and were thus not included in the index.

Characterization as Floodplain or as Wetland

A floodplain typically receives great amounts of water, which is the medium that carries contamination to sensitive receptors, either as runoff or through percolation. For that reason, characterization of a site as floodplain typically places additional restrictions on potential development. We therefore assigned floodplains as high environmental sensitivity sites. CTDEP also provided flood maps for the state of Connecticut. Wetlands are also typically ecologically sensitive areas and place development restrictions and were also assigned as high environmental sensitivity sites.

Even though each variable may be mapped individually, we recognized the need to provide potential users of our decision support tool with an indicative aggregation scheme in the form of an 'environmental index score' (EIS) for the prioritization of brownfields. Similar to the socioeconomic and smart growth indices, variables were assigned values of 0, 1 and 2 as shown in Table 3.3. We chose to assign all variables equal weights for aggregation purposes. It could be argued that a higher weight should be assigned to "source", followed by "pathway", because in the absence of a source or a pathway the proximity to a receptor becomes indifferent. However, given that the uncertainty with regard to both the actual existence of a source and the site properties is quite high, we chose to keep the weights of the receptors equal. The only exception was floodplains and wetlands, which were not included in the 100% calculation of the EIS, but rather as an additional feature ("extra" credit) because it is not an integral part of the environmental sensitivity of the site (i.e., there is no reason that a flooplain or wetland score of 0 should lower the overall environmental index). Based on this aggregation scheme, the EIS was then divided into three categories: high environmental sensitivity when the index was above 1.5, medium at values between 1 and 1.5 and low for values below 0.9. It should be noted that low environmental index does not imply the lack of need for a detailed investigation, but rather that, if considering only environmental criteria, the brownfield may not be a high priority for redevelopment.

We will now demonstrate the application of the indices to a case study in Connecticut.

3.3 RESULTS

3.3.1 Socio-Economic Index

The socio-economic mapping index, displayed in Figure 3.1 along with the locations of the brownfields in the state inventory, reflects the weighted average of the variable scores for each of

the 169 towns in the state of Connecticut. Some of those geographic units, depicted in the darkest areas, are the cities of Bridgeport, Hartford, New Haven and Waterbury, and the towns of Groton and New Britain. Perhaps not coincidentally, these are also the areas with the most brownfields. (Waterbury has a lot more brownfields that are not recorded in the state inventory.) Thus, *ceteris paribus*, brownfield sites located in those municipalities should be prioritized given the economic recovery and the community amenities its redevelopment may contribute to. However, further refinement is necessary to prioritize the large number of brownfields within each of these districts.

Based on this mapping index, and given that statewide inventories suggest that the City of New Haven is the municipality with the largest number of brownfields in Connecticut, we decided to apply step 2 of our location-specific GIS-based decision support tool to this city as a case study.

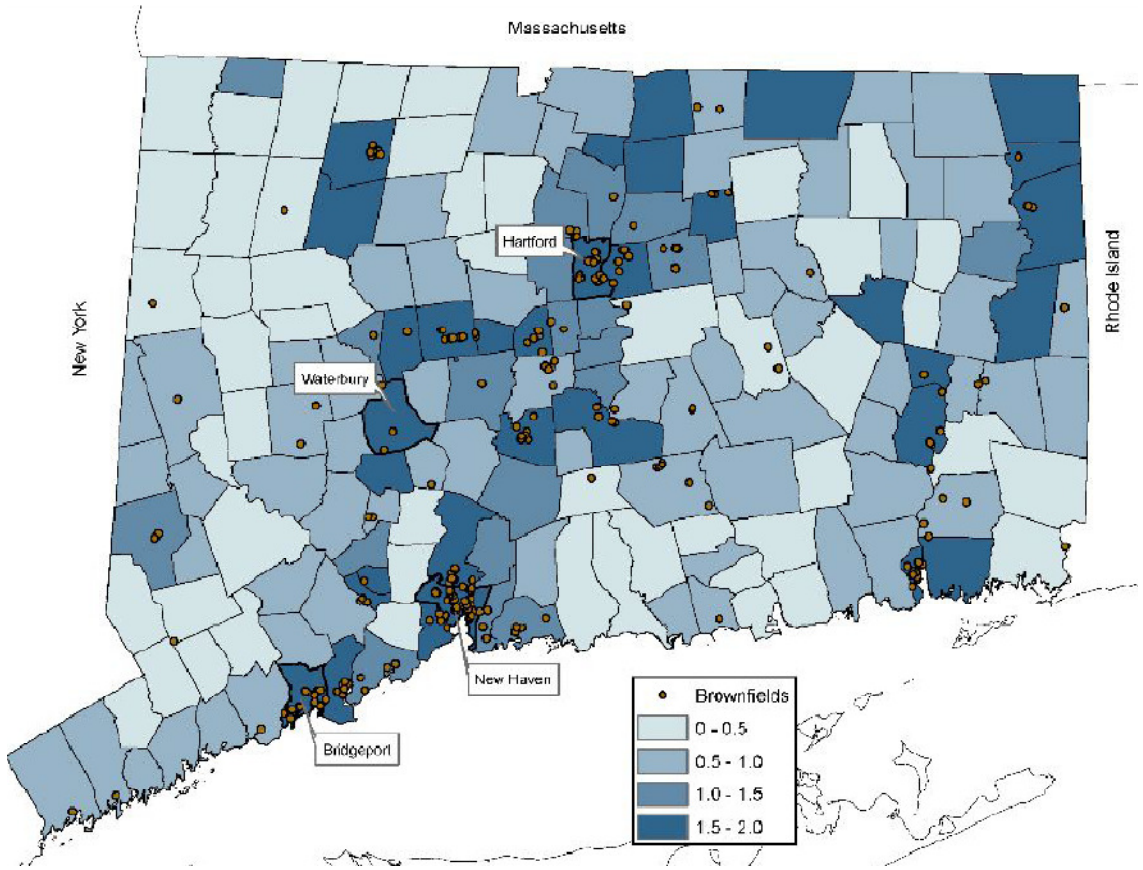


Figure 3.1: Socio-economic Index Mapping for Connecticut Municipalities

3.3.2 Smart Growth and Environmental Index

Figure 3.2 shows the individual maps for the smart growth variables and the aggregated mapping index for the City of New Haven. Locations with a mapping index score of below 0.8 were categorized as areas without the necessary infrastructure in place to support smart growth related projects, areas with values between 0.8 and 1.4 were designated with intermediate smart growth potential and areas with index higher than 1.4 were designated with high smart growth potential.

Based on this classification, the City of New Haven exhibits a sizeable smart growth potential, especially in the downtown area. That the city is one of the most densely developed and populated municipalities in Connecticut undoubtedly contributes to this potential; but the presence of commuter rail and a public bus system —a rarity in the state— also play a significant role. As shown in Figure 3.2, downtown New Haven has high scores in all individual variables of the smart growth index with the exception of the job-housing balance. Downtown New Haven has more jobs than residents, while the outskirts of the city present the opposite situation, typical of deserted urban cores with people living in the suburbs and commuting to work. Comparing this map with the zoning areas shown in Figure 3.3, it becomes apparent that the majority of the dark brown area in the job-housing balance map is designated as residential area, but in fact has fewer residents than workers.

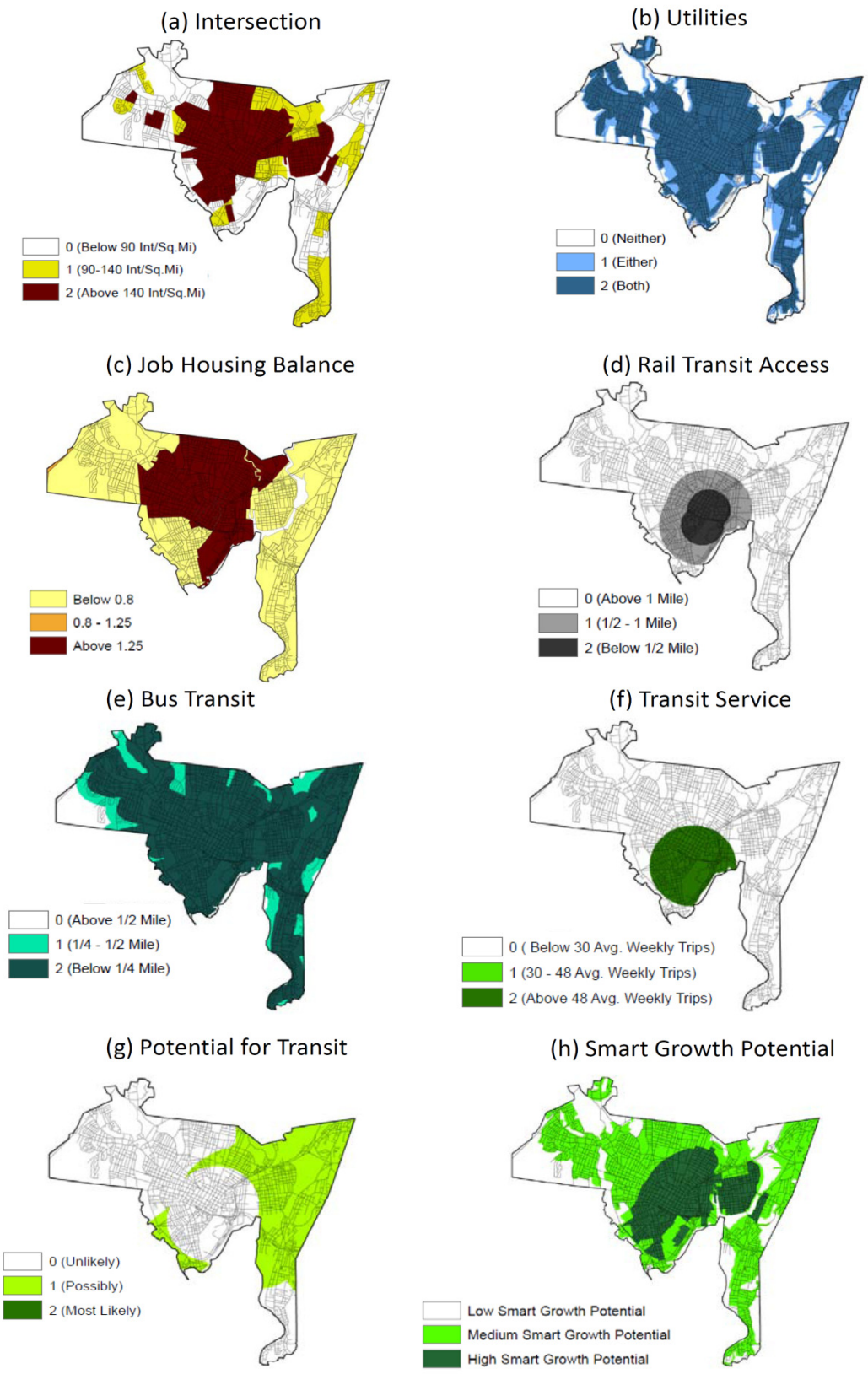


Figure 3.2: GIS Maps of Smart Growth Variables and Index in the City of New Haven

Additionally, this area constitutes the majority of the darkest area in the smart growth map (Figure 3.2h), so that a large part of the high smart growth potential area appears to be lacking in residents. Including population density as a smart growth factor would likely significantly influence the distribution of smart growth areas away from locations with high street density and infrastructure availability, which is the reason we chose not to include it as a factor; however, users should be cautioned that the smart growth map should be interpreted together with zoning and population maps. Thus, the smart growth map is an indicator of urban infrastructure, rather than an absolute measure of where redevelopment should occur.

The environmental classification of the brownfields in New Haven is shown in Figure 3.3, while Figure 3.4 shows the distribution of EIS for the 61 brownfields that were documented in the state and city inventories. The EIS had an approximately normal distribution, with few sites having high scores and only 4 sites in the low EIS (<1) category. Three out of these four sites had business as past use, were located in an industrial zone and away from surface water and had semi-permeable soil. The eight sites with the highest EIS were all located close to surface water and sensitive receptors, had permeable soils and were located within a residential or business zone. The latter was the main feature that differentiated these top priority sites from the next category of sites with EIS 1.6, which were located in industrial zones of the city. It should also be mentioned that no past use information was available for 14 sites. In this case, the past use was excluded from the calculation of the EIS and the weights were redistributed to the remaining variables. It is still possible to identify these sites with unknown past use in Figure 3.3a.

Figure 3.3f shows the EIS superimposed on the smart growth map; most of the brownfields are located within the highest smart growth area, and some within the intermediate smart growth area. Thus, using this map alone in order to prioritize brownfields is not particularly meaningful, and it is also not the purpose of this research. We will present here a few alternatives on how brownfields in the City of New Haven could be prioritized for redevelopment using the information provided by the individual maps and the EIS.

Scenario a

A small cluster of brownfields is present within a residential area with intermediate smart growth potential (top left corner of the city as shown in Figure 3.3). Two of these brownfields have a high EIS because of their proximity to several sensitive receptors with unknown past use and one has an intermediate EIS with commercial past use. The city could decide to initially perform a site visit to assess the blight imposed by these properties, and spend the required funds for a Phase I assessment, the outcome of which would be an assessment of the likelihood that there is contamination present in these sites. Depending on the characteristics of the area, it is possible that targeting these particular sites for redevelopment could completely eliminate the presence of brownfields from that neighborhood, which could have a larger impact on the quality of life of local residents compared to targeting individual sites in neighborhoods with several brownfields.

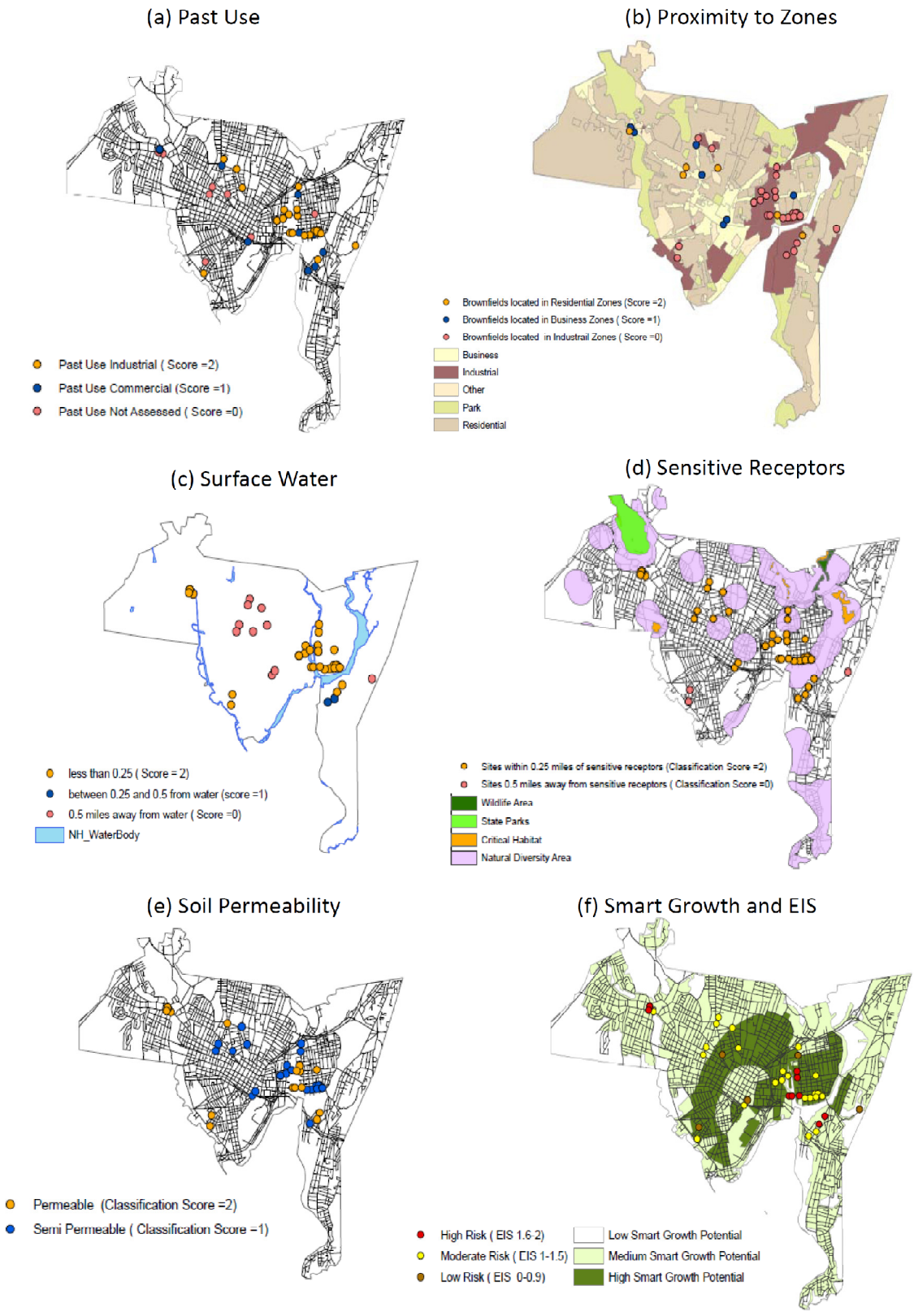


Figure 3.3: GIS Maps of Environmental Variables and Index Score in the City of New Haven

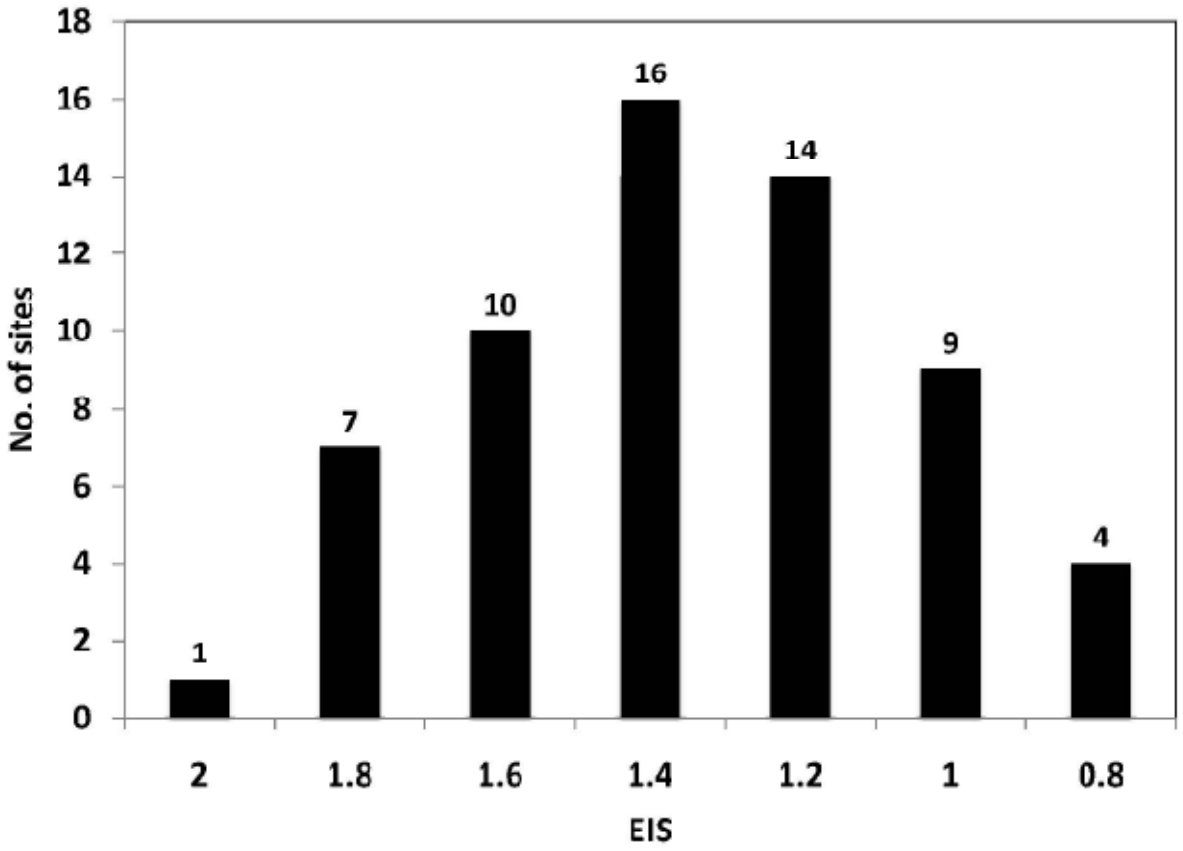


Figure 3.4: Distribution of Environmental Index Score (EIS) for 61 Brownfield Sites in New Haven

Scenario b

The city could decide to come up with a longer-term strategic plan to remediate brownfields located in the high smart growth industrial area, which has a large cluster of brownfields with high EIS. A piecemeal approach that would address a single brownfield at a time without longer term planning would likely not have a significant effect on the environmental quality or commercial attractiveness of such an area.

Scenario c

The city could decide to target all high EIS brownfields in residential areas, in order to remove the environmental risk associated with contaminated sites in close proximity to humans, with little consideration of smart growth issues, since New Haven is overall a city with a high smart growth potential compared to the rest of Connecticut.

Furthermore, stakeholders would have to take into account other factors, such as availability of short- and long-term funding, social opinions locally and environmental justice issues, which are not directly addressed by this tool. Environmental justice considerations could be incorporated in a GIS scheme by creating maps of demographics, income distribution etc. We chose to exclude these factors from our tool because that requires an intimate knowledge of the social issues that local communities face. In addition, it should be noted that we do not necessarily advocate that

any of the aforementioned scenarios is the preferred one, because each scenario has to be placed in a financial context: can the city afford to spend large amounts of money on a long-term strategic plan? How does the plan fit within the overall plans for the business growth of the community? What we do advocate is that stakeholders have a global view of the brownfields problem, consider these factors and develop an overall strategic plan for the allocation of funds in their area.

3.4 CONCLUSIONS

The goal of this study was to enable, through a visual tool based on mapping indices, the state government and other public agencies to prioritize brownfields for redevelopment and make decisions that would focus limited funds and other resources on the more promising remediation projects in terms of socioeconomic, smart growth, and environmental criteria. This constitutes a significant departure from previous decision support tools that aim at assessing the suitability of a particular end use for a brownfield site or to estimate the smart growth potential of a specific project.

Application of this GIS-based tool to the City of New Haven with the available data showed that the tool was able to discern between sites of variable environmental sensitivity, yielding a normal distribution for the Environmental Index Score of 61 brownfield sites in the state inventory. The resolution of high versus low smart growth areas was lower because the City of New Haven is an area with high smart growth within the state of Connecticut; however, if an end user so desired, it would be possible to apply stricter criteria in order to achieve higher resolution. By applying a combination of these indices and maps with economic and local considerations, it is possible to come up with specific strategic plans for systematic remediation of brownfields, instead of the current approach which relies on private interest or public outcry in order to focus on a particular site.

4.0 REFERENCES

Alberini, A.; Longo, A.; Tonin, S.; Trombetta, F. & Turvani, M. (2005), 'The role of liability, regulation and economic incentives in brownfield remediation and redevelopment: evidence from surveys of developers', *Regional Science and Urban Economics* 35(4), 327-351.

Amekudzi, A. & Fomunung, I. (2004), 'Integrating Brownfields redevelopment with transportation planning', *Journal of Urban Planning and Development* 130(4), 204-212.

Anonymous (2001), 'The road to brownfields redevelopment. Breaking down barriers to using brownfields', *Brownfields Bulletin*, No. 14.

Babcock, B. A.; Lakshminarayan, P. G.; Wu, J. & Zilberman, D. (1997), 'Targeting Tools for the Purchase of Environmental Amenities', *Land Economics* 73(3), 325-339.

Babcock, B. A.; Lakshminarayan, P. G.; Wu, J. & Zilberman, D. (1996), 'The Economics of a Public Fund for Environmental Amenities: A Study of CRP Contracts', *American Journal of Agricultural Economics* 78(4), 961-971.

Bacot, H. & O'Dell, C. (2006), 'Establishing indicators to evaluate brownfield redevelopment', *Economic Development Quarterly* 20(2), 142-161.

Bacot, H., O'Dell, C., 2006. Establishing indicators to evaluate brownfield redevelopment. Econ. Dev. Q. 20, 142-161.

Barrett, G. (2008), 'Environmental insurance', available at http://www.cga.ct.gov/2008/rpt/2008-R-0103.htm.

Baumol, W. J. & Oates, W. E. (1988), 'The theory of environmental policy', Second edition, Cambridge University Press.

Carlon, C.; Pizzol, L.; Critto, A. & Marcomini, A. (2008), 'A spatial risk assessment methodology to support the remediation of contaminated land', *Environmental International* 34(3), 397-411.

Cattaneo, A.; Hellerstein, D.; Nickerson, C. & Myers, C. (2006), 'Balancing the Multiple Objectives of Conservation Programs', Electronic Report, No. 19, Economic Reserve Service, United States Department of Agriculture.

Cervero, R., 1996. Jobs-housing balance revisited: trends and impacts in the San Francisco Bay Area. J. Am. Plan. Assoc. 62.4, 492-512.

Chang, H. F. & Sigman, H. (2007), 'The Effect of Joint and Several Liability under Superfund on Brownfields', *International Review of Law and Economics* 27(4), 363-384.

City of Meriden (2008?), ‘Brownfields Redevelopment’, available at http://www.cityofmeriden.org/CMS/default.asp?CMS_AreaID=123.

City of Portland Bureau of Planning and Sustainability (2009), '1997 BEST Winners', available at http://www.portlandonline.com/osd/index.cfm?c=41894&a=111811.

Claassen, R.; Cattaneo, A. & Johansson, R. (2008), 'Cost-effective design of agri-environmental payment programs: US experience in theory and practice', *Ecological Economics* 65(4), 737-752.

Commission for Architecture and the Built Environment, 'Thames Gateway. History of an idea', available at http://www.cabe.org.uk/default.aspx?contentitemid=1572.

Connecticut Brownfields Redevelopment Authority (2009), ‘Connecticut Brownfields Redevelopment Authority’, (http://www.ctbrownfields.com/default.asp).

Connecticut Department of Environmental Protection, 2004. CT DEP Brownfields Inventory (http://www.ct.gov/dep/lib/dep/site_clean_up/brownfields/brownfieldsinventory.pdf).

Connecticut Department of Environmental Protection, 2010a. Connecticut Critical Habitats (http://www.cteco.uconn.edu/metadata/dep/document/CRITICAL_HABITAT_POLY_FGDC_Plus.htm).

Connecticut Department of Environmental Protection, 2010b. Connecticut Natural Diversity Areas. (http://www.cteco.uconn.edu/metadata/dep/document/NATURAL_DIVERSITY_DATABASE_FGDC_Plus.htm)

Connecticut Department of Labor, 2009. Labor Force Data for Labor Market Areas & Towns. Office of Research. December. (http://www1.ctdol.state.ct.us/lmi/laus/laustown.asp)

Connecticut Economic Resource Center, 2010. Town Profiles. (http://www.cerc.com/TownProfiles/default.asp)

Connecticut Office of Brownfield Remediation and Development (2008), 'Brownfield Municipal Pilot Program', available at http://www.ctbrownfields.gov/ctbrownfields/cwp/view.asp?a=2620&q=416724.

Connecticut Office of Brownfield Remediation and Development (2007), 'Liability protection programs', available at http://www.ctbrownfields.gov/ctbrownfields/cwp/view.asp?a=2631&q=319608.

Connecticut Office of Brownfield Remediation and Development (2006), 'Funding sources', available at http://www.ctbrownfields.gov/ctbrownfields/cwp/view.asp?a=2620&q=319736.

Connecticut Office of Brownfield Remediation and Development, 2006. Governor Rell Issues Executive Order Championing Responsible Growth. Press release. (http://www.ctbrownfields.gov/ctbrownfields/cwp/view.asp?a=2633&q=320932)

Connecticut Office of Brownfield Remediation and Development, 2009. Urban Sites Remedial Action Program. (http://www.ctbrownfields.gov/ctbrownfields/cwp/view.asp?a=2620&q=319334)

Dair, C. M. & Williams, K. (2006), 'Sustainable land reuse: The influence of different stakeholders in achieving sustainable brownfield developments in England', *Environment and Planning* 38(7), 1345-1366.

Davis, T. S. (2002), 'Brownfields: A comprehensive guide to redeveloping contaminated property', Second edition, American Bar Association.

Department of Environmental Protection (2004), 'CT DEP Brownfields Inventory' (http://www.ct.gov/dep/lib/dep/site_clean_up/brownfields/brownfieldsinventory.pdf).

DePass, M. (2006), 'Brownfields as a tool for the rejuvenation of land and community', *Local Environment* 11(5), 601-606.

Dixon, K. A. (2003), 'Reclaiming Brownfields: From Corporate Liability to Community Asset', *in* James K. Boyce & Barry G. Shelley, ed., 'Natural assets: Democratizing environmental ownership', University of Massachusetts at Amherst, 57-76.

English, M. R.; Peretz, J. H. & Manderschied, M. J. (1999), 'Smart growth for Tennessee towns and counties: A Process guide', Energy, Environment and Resources Center, University of Tennessee.

Environmental Protection Agency (2000), 'Transportation and Brownfields', Brownfields Fact Sheet, EPA 500-F-00-212.

Environmental Protection Agency (2001), 'What is smart growth?', Smart Growth Factsheet, EPA 231-F-01-001A.

Environmental Protection Agency (2008), 'Project Specific Scorecards', (http://www.epa.gov/smartgrowth/scorecards/project.htm).

Environmental Protection Agency (2008), 'Smart Growth Scorecards', (http://www.epa.gov/smartgrowth/scorecards/index.htm).

Environmental Protection Agency (2009), 'Brownfields and Land Revitalization', (http://www.epa.gov/brownfields/index.html).

Greenberg, M.; Lowrie, K.; Mayer, H.; Miller, K. T. & Solitare, L. (2001), 'Brownfield redevelopment as a smart growth option in the United States', *The Environmentalist* 21(2), 129-

143.

Greenberg, M.; Lowrie, K.; Solitare, L. & Duncan, L. (2000), 'Brownfields, TOADS, and the struggle for neighborhood redevelopment - A case study of the state of New Jersey', *Urban Affairs Review* 35(5), 717-733.

GSC Consultants, I. (2005), 'Smart Growth for Brownfields Redevelopment', Final report, GSG Project No.: E03-24.06, Chicago Department of Environment.

GSG Consultants, 2005. Smart Growth for Brownfields Redevelopment. Final report. GSG Project No. E03-24.06 (http://www.epa.gov/dced/pdf/Chicago%20SG%20Brownfields%20Project%20Final.pdf).

Heberle, C.L., Kackar, A., 2006. Connecting Smart Growth and Brownfields Redevelopment. University of Louisville-Center for Environmental Policy and Management and U.S Environmental Protection Agency (http://cepm.louisville.edu/publications/PDF_docs/).

Heberle, L. C. (2006), 'Connecting smart growth and brownfield redevelopment', Center for Environmental Policy and Management, University of Louisville.

Holzkaemper, A. & Seppelt, R. (2007), 'Evaluating cost-effectiveness of conservation management actions in an agricultural landscape on a regional scale', *Biological Conservation* 136(1), 117-127.

Idaho Smart Growth, 2010. Scorecards (http://www.idahosmartgrowth.org/index.php/resources/resource/scorecards/).

Idaho Smart Growth, 'Commercial Development Scorecard Smart Growth', (http://www.idahosmartgrowth.org/projects/scorecards/Scorecard%20Commercial%20Development%201-pg.pdf).

Idaho Smart Growth, 'Smart Growth Neighborhood Development Scorecard', (http://www.idahosmartgrowth.org/projects/scorecards/Scorecard%20Neighborhood%20Development%201-pg.pdf).

Johnson, K.; Dixson, C. & Tochterman, S. (2002), 'Brownfield redevelopment and transportation planning in Philadelphia region', *ITE Journal* 72(7), 26-31.

Johst, K.; Drechsler, M. & Watzold, F. (2002), 'An ecological-economic modelling procedure to design compensation payments for the efficient spatio-temporal allocation of species protection measures', *Ecological Economics* 41(1), 37-49.

Kogelheide, C., 2004. Development of a Sustainability Assessment Tool for the Context of Brownfield regeneration, Proceedings, International RESCUE Conference, Cardiff, September 2004.

Koj, A., Francis, R., 2006. An evaluation tool measuring and monitoring sustainable development on brownfields. Report REVIT compendium “Ensuring Sustainability in Brownfield Revitalization, URL: www.revit-nweurope.org.

Lange, D. & McNeil, S. (2004), 'Brownfield development: Tools for stewardship', *Journal of Urban Planning and Development* 130(2), 109-116.

Lange, D., McNeil, S., 2004. Brownfield development: Tools for stewardship. J. Urban Plan. D.-ASCE 130, 109-116.

Leigh, N. G. & Coffin, S. L. (2000), 'How Many Brownfields Are There? Building an Industrial Legacy Database', *Journal of Urban Technology* 7(3), 1-18.

McCarthy, L. (2002), 'The brownfield dual land-use policy challenge: reducing barriers to private redevelopment while connecting reuse to broader community goals', *Land Use Policy* 19(4), 287 - 296.

McGrath, D. T. (2000), 'Urban Industrial Land Redevelopment and Contamination Risk', *Journal of Urban Economics* 47(3), 414 - 442.

Minnesota Population Center, 2010. National Historical Geographic Information System. University of Minnesota. (http://www.nhgis.org/)

Munro, J. F. & Tzoumis, K. A. (2000), 'Conquering the Brownfields Frontier through the Enhanced Deployment of Environmental Assessment Technologies', *Public Works Management Policy* 4(3), 213-223.

New Jersey Future, 2005. Proposed Developments Scorecard (http://www.njfuture.org/Media/Docs/development_card.pdf).

New Jersey Future, 'Smart Growth Scorecard', (http://www.njfuture.org/Media/Docs/development_card.pdf).

Nijkamp., P., Rodenburg, C.A., Wagtendonk, A.J., 2002. Success factors for sustainable urban brownfield development A comparative case study approach to polluted sites. Ecol.Econ. 40, 235-252.

O’Reill, M., Brink, R., 2006. Initial Risk Based Screening of Potential Brownfield Development Sites. Soil Sediment Contam. 93, 463-470.

Paul, J. & Petruzzello, C. (2004), 'Grants for brownfield redevelopment', *in* A. Donati; C. Rossi & C. A. Brebbia, ed.,'Brownfield sites II: assessment, rehabilitation and development', WIT Press, 313-319.

Pediaditi, K., Wehrmeyer, W., Chenoweth, J., 2005. Monitoring the sustainability of brownfield redevelopment projects: the Redevelopment Assessment Framework. Land Contamination & Reclamation. 13, 173-183.

Raco, M. & Henderson, S. (2006), 'Sustainable urban planning and the brownfield development process in the United Kingdom: Lessons from the Thames Gateway', *Local Environment* 11(5), 499-513.

Rappa, J.G., 2000. Distressed Municipalities. OLR Research Report (http://www.cga.ct.gov/2000/rpt/olr/htm/2000-R-0327.htm).

Regional Growth Partnership (2007?), 'Regional Growth Partnership', available at http://www.rgp-ct.org/rgp/

Regional Growth Partnership (2009), Regional Growth Partnership Brownfields Funding Accomplishments [computer file]. E-mail from Stephen Beck (sbeck@rgp-ct.org).

Ribaudo, M. O.; Hoagb, D. L.; Smith, M. E. & Heimlich, R. (2001), 'Environmental indices and the politics of the Conservation Reserve Program', *Ecological Indicators* 1(1), 11–20.

Robertson, H. G. & Reichert, A. K. (2000), 'Environmental and brownfield liability: Relative influence on corporate expansion and relocation', *Journal of Corporate Real Estate* 2(4), 315-329.

Schoenbaum, M. (2002), 'Environmental contamination, brownfields policy, and economic redevelopment in an industrial area of Baltimore, Maryland', *Land Economics* 78(1), 60-71.

Sherk, G. (2001), 'Reauthorization of CERCLA and the redevelopment of brownfields: who will pay the orphan's share?', *Environmental Engineering and Policy* 2(4), 171-179.

Sigman, H. (2006), 'Environmental Liability and Redevelopment of Old Industrial Land', Unpublished paper, Rutgers University, Department of Economics.

Siikamaki, J. & Wernstedt, K. (2008), 'Turning Brownfields into Greenspaces: Examining Incentives and Barriers to Revitalization', *Journal of Health Politics Policy and Law* 33(3), 559-593.

Siikamaki, J., Wernstedt, K., 2008. Turning Brownfields into Greenspaces: Examining Incentives and Barriers to Revitalization. J. Health Polit. Polic. 33, 559-593 (smart%20growth%20and%20brownfields%20for%20website.pdf).

Southwest Florida Regional Planning Council (2009), 'Regional Economic Model Incorporated (REMI) Policy Insight', (http://www.swfrpc.org/remi.shtml).

State of Connecticut Department of Economic and Community Development, 'Urban and industrial sites reinvestment tax credit program', (http://www.ct.gov/ecd/cwp/view.asp?a=1101&q=249842).

State of Connecticut Task Force on Brownfields Strategies (2007), 'Report of the State of Connecticut Task Force on Brownfields Strategies'.

State of Connecticut Task Force on Brownfields Strategies (2008), 'Report of the State of Connecticut Task Force on Brownfields Strategies'.

Thomas, M. R. (2002), 'A GIS-based decision support system for brownfield redevelopment', *Landscape and Urban Planning* 58(1), 7-23.

Thomas, M. R. (2002), 'A Weighted, Multi-Attribute, Site Prioritization and Selection Process for Brownfield Redevelopment', *Environmental Practice* 4(02), 95-106.

Thomas, M. R., 2002a. A GIS-based decision support system for brownfield redevelopment. Landscape Urban Plan. 58, pp. 7-23.

Thomas, M. R., 2002b. A Weighted, Multi-Attribute, Site Prioritization and Selection Process for Brownfield Redevelopment. Environmental Practice 4, 95-106.

U.S. Census Bureau, 2009. 2007 County Business Patterns: ZIP Code Business Statistics. (http://factfinder.census.gov/servlet/IBQTable?_bm=y&-ds_name=CB0700CZ1).

U.S. Environmental Protection Agency & Association of Metropolitan Planning Organizations (2001), 'Redeveloping brownfields with federal transportation funds', Technical report.

U.S. Environmental Protection Agency (2006), 'Valley Council of Governments Brownfields Program', (http://yosemite.epa.gov/r1/npl_pad.nsf/51dc4f173ceef51d85256adf004c7ec8/CE684A71E2A58B0185256C0E0055ED10)

U.S. Environmental Protection Agency (2007) 'City of Meriden Brownfields Program', (http://yosemite.epa.gov/R1/npl_pad.nsf/31c4fec03a0762d285256bb80076489c/d13dbc64a9006a8985256f62006e3259).

U.S. Environmental Protection Agency (2008), 'City of New Haven Brownfields Program', (http://yosemite.epa.gov/r1/npl_pad.nsf/51dc4f173ceef51d85256adf004c7ec8/3DCA6FAEAC0CADA585256C0E004C41B1).

U.S. Environmental Protection Agency (2008), 'Smart Growth Illustrated', (http://www.epa.gov/smartgrowth/case/belmont.htm).

U.S. Environmental Protection Agency (2009), 'Brownfields and Land Revitalization – Grants & Funding', (http://www.epa.gov/brownfields/pilot.htm).

U.S. Environmental Protection Agency (2009), ‘Regional Growth Partnership Brownfields Program’, (http://yosemite.epa.gov/R1/npl_pad.nsf/ 9214234b272d029e85256bbc0077af22 /94f94fcf35b6fac085256da300615452).

U.S. Environmental Protection Agency (2009), 'Brownfields and land revitalization frequent questions', (http://www.epa.gov/compliance/resources/faqs/cleanup/brownfields/).

U.S. Environmental Protection Agency (USEPA), 2011. About Brownfields. (http://epa.gov/brownfields/about.htm).

U.S. Green Building Council (USGBC), 2009. LEED for Neighborhood Development. Congress for the New Urbanism, Natural Resources Defense Council.

Valley Council of Governments (2008), 'Regional brownfields partnership of West Central CT', (http://www.valleycog.org/brownfields.html).

Wang, M. (2006), 'Optimal Environmental Management Strategy and Implementation for Groundwater Contamination Prevention and Restoration', *Environmental Management* 37(4), 553–566.

Whitney, H. (2003), 'Cities and Superfund: Encouraging Brownfield Redevelopment', *Ecology Law Quarterly* 30(1), 59-112.

Williams, K. & Dair, C. (2007), 'A framework for assessing the sustainability of brownfield developments', *Journal of Environmental Planning and Management* 50(1), 23-40.

Williams, K., Dair, C., 2007. A framework for assessing the sustainability of brownfield developments, J.Environ.Plann.Man. 50, 23-40.

Wu, J. & Boggess, W. (1999), 'The optimal allocation of conservation funds', *Journal of Environmental Economics and Management* 38(3), 302-321.

Ye, L.; Mandpe, S. & Meyer, P. B. (2005), 'What Is "Smart Growth?"--Really?', *Journal of Planning Literature* 19(3), 301-315.

Yount, K. R. & Meyer, P. B. (1999), 'Project scale and private sector environmental decision making: Factors affecting investments in small- and large-scale brownfield projects', *Urban Ecosystems* 3(2), 179-193.

APPENDIX A

SURVEY QUESTIONS

On the agency status:

1. How is the agency actually involved in brownfields redevelopment? (Provide information on the scope of your work)
2. How does the agency coordinate/interact with its federal, state, regional and local partners?
3. How is responsibility delineated among these partner agencies (so as to make sure that responsibilities do not overlap)?
4. What kind of authoritative power does the agency hold?

On brownfields classification and prioritization:

5. Is there any database of CT applicants for your programs (funds)? If there is any, does the database discriminate among assessment, remediation and redevelopment activities? How about small and large scale projects?
6. Do you have a classification system for brownfield sites (according, for example, to the degree of contamination, to the potential uses, etc.)?
7. Do you have a site priority list for contaminated properties? Is there in it a distinction among assessment, remediation and redevelopment activities associated to each site? How about a distinction between large scale and small scale projects?
8. On what basis are the brownfield development opportunities classified and prioritized?

On the relation of the projects with Smart Growth principles and Transit-Oriented Developments:

9. Are you familiar with Smart Growth principles? How are the projects the agency supports related to these principles?
10. How are the projects the agency supports related to Transit-Oriented Developments?

On budget allocation:

11. How much is your current budget for brownfield revitalization activities? How is it distributed among these activities –assessment, remediation and redevelopment?
12. How many staff does the agency currently have?
13. Who reviews the forms and proposals?
14. On what basis are the proposals selected and funded? Are Smart Growth principles considered as selection criteria for brownfield development opportunities? Is the integration of a brownfield development project with transit-friendly developments among the selection criteria?

On agency effectiveness:

15. How many successful brownfield redevelopment projects in CT have you collaborated to? Can you distinguish between small and large scale successful projects? How many of those projects can be said to meet Smart Growth principles, and to what extent? How many of those projects are integrated with transit-oriented developments, and how are they integrated?
16. Do you have any specific outreach programs to inform municipalities, property owners, economic development agencies and other organizations about the brownfields programs you carry out and how to involve in them?

On agency perceptions about barriers and challenges for successful brownfields development:

17. What is your perception about the main barriers for brownfield redevelopment in CT?
18. In conducting your activities, have you ever felt any necessity or preference in terms of a centralized or a decentralized mechanism for the allocation of brownfield revitalization funds? If there is any need/preference for a decentralized scheme, would the decentralization be related to the partners/programs/towns?
19. What is your perception about the major challenges for successful brownfields revitalization in CT?

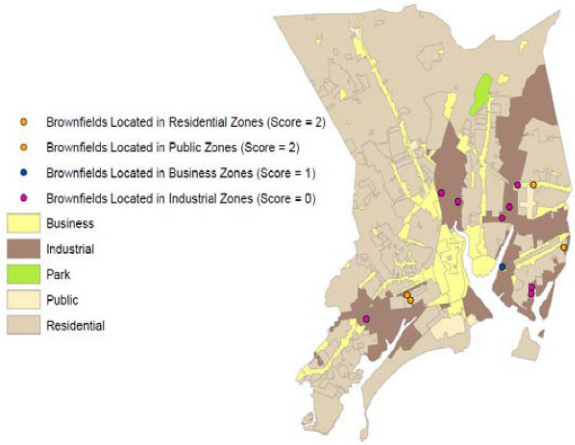
APPENDIX B

CASE STUDIES

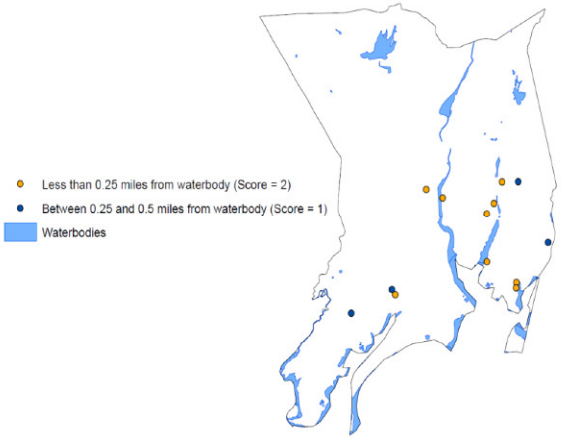
BRIDGEPORT

(a) Past Use

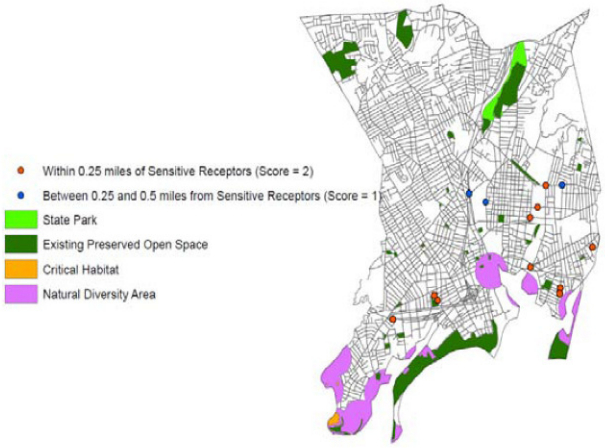
(b) Proximity to Zones



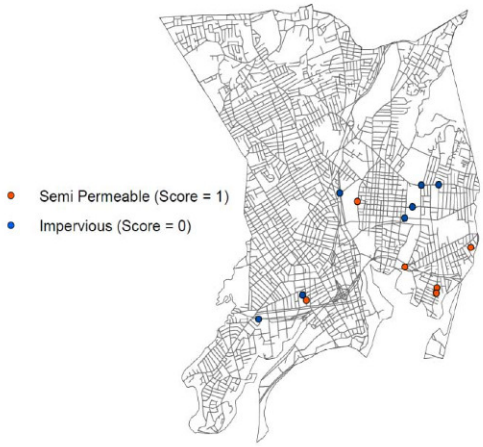
(c) Surface Water



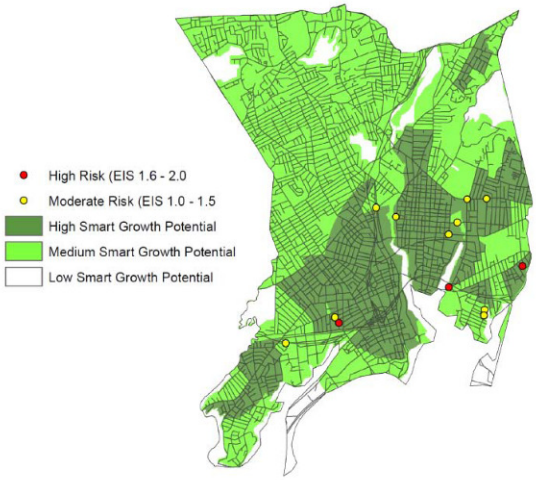
(d) Sensitive Receptors



(e) Soil Permeability

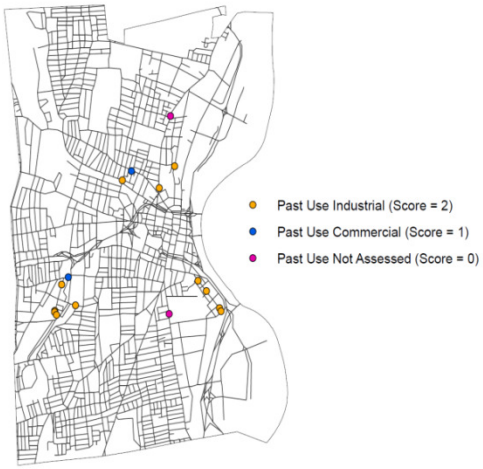


(f) Smart Growth and EIS

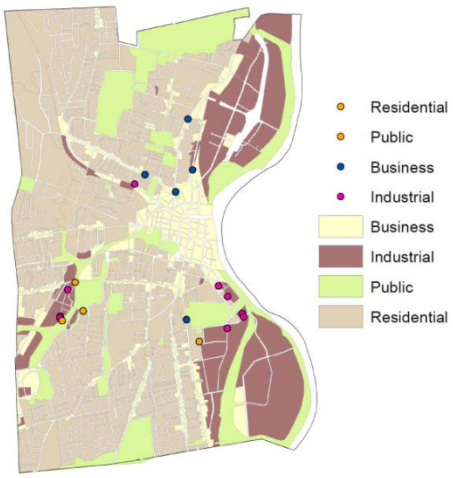


HARTFORD

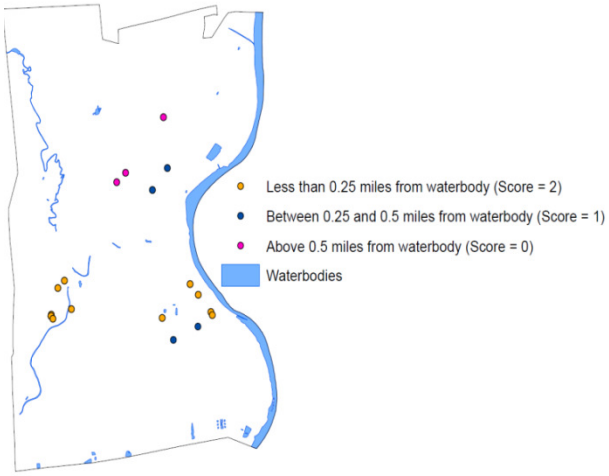
(a) Past Use



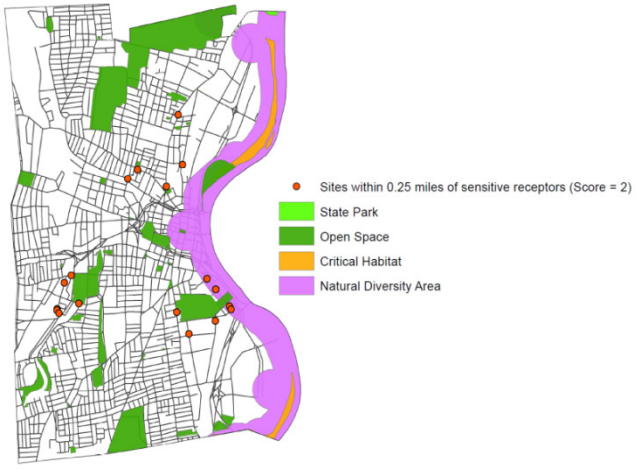
(b) Proximity to Zones



(c) Surface Water



(d) Sensitive Receptors



(e) Soil Permeability

(f) Smart Growth and EIS