# Wisconsin Brownfield Cleanup and Remediation Program: An Assessment of Economic and Fiscal Impacts

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**Abstract**

This paper uses Hedonic Analysis to identify the unobserved economic and fiscal impacts that Wisconsin's various state funded brownfield remediation programs have on the surrounding communities.   Literature suggests that remediating brownfields has positive economic, social, and environmental impacts, so it important to provide incentives for developing brownfields. The results indicate that properties that are adjacent to revitalized brownfields increase on average 16.7% to 17.4% once the remediation process begins.

## I. Introduction

The goal of this study is to investigate the economic and fiscal impacts of Wisconsin's Land Recycling Loan Program. This program provides loans, grants, assessment, and liability relief to real estate investors that are looking to redevelop land that has been soiled by previous industrialization. These sites are commonly referred to as "brownfields". The Environmental Protection Agency (EPA) defines a brownfield as a "property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant" (US EPA, 2016).

Because any past or present owner is held liable for the hazardous contamination, private brownfield development is strongly discouraged. Wisconsin's brownfield program encourages the remediation and development of brownfields with financial assistance and liability protection.

## II. Background

During the 1970s and 1980s, numerous cities nationwide underwent a process of deindustrialization. Unfortunately, this common practice has led to contamination and pollution of neighborhoods throughout the nation. As the country realized both the environmental and economic outcomes of the increasing number of vacant, contaminated properties had on the surrounding community, both State and Federal entities began working toward solutions.

The process began in 1980 when congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (commonly referred to as Superfund) in response to several environmental disasters caused by deteriorating industrial sites (US EPA, 2016). The purpose of Superfund was to deter companies from causing these industrial accidents by holding property owners liable for the damage the toxic waste from their property has on the community. However, these regulations had unintended consequences.

Rather than protect public health and promote favorable social and economic impacts, Superfund deterred potential investment in deteriorated sites due to exceedingly strict liability standards that held every past and present owner fully liable for any environmental damages. Developers, business owners, banks, cities, communities and other prospective brownfield investors were unwilling to take over these properties and redevelop them in fear of being held liable for any hazardous waste and pollutants arising from them. Entities began to purchase unspoiled, undeveloped land called “greenfields” as opposed to costly and risky brownfields.

Improvements to brownfield relief programs came later in the form of Brownfield Action Agenda in 1995 and the Small Business Liability Relief and Brownfields Revitalization Act (the Brownfields Law) in 2002. The focus of the Brownfield Action Agenda was to outline how communities should initiate brownfield redevelopment through the use of seed money from pilots, clarifying liability issues, outreach partnerships, and support for job development (EPA). The Brownfields Law provided funds for the use of brownfield clean up, addressed the liability issues of Superfund, and enhanced state response programs.

In addition to the federally funded brownfield cleanup programs, states have set up their own incentives to encourage redevelopment. One of the first states to introduce brownfield reform incentives was Wisconsin when the Land Recycling Law was passed in 1994. Since then, Wisconsin has been seen as one of the leading states in brownfield reform and development. Numerous State entities such as the Wisconsin Department of Natural Resources and the Wisconsin Economic Development Corporation have set programs that have encouraged developers to remediate hundreds of contaminated properties. This paper looks to measure the unobserved economic impact of that these programs have on the surrounding community.

## III. Literature Review

Determining the value of a brownfield remediation grant may seem trivial at first glance since there is a defined dollar amount assigned to each grant and the remediated brownfield may have a clear increase in market value. However, with remediation come inherent benefits not only to the remediated property, but the surrounding community. These come in the form of unobserved environmental and social improvements, which are more difficult to value.

There have been a number of studies that have attempted to determine the unobserved value of brownfield remediation. A common theme among these studies is the use of hedonic analysis. Hedonic analysis is a method pioneered by Dr. Sherwin Rosen that uses the known prices of goods directly traded in the market along with characteristics of the good to infer a value on a related, non-market good (Rosen, 1974). In this case, we are interested in deriving the value of the environmental and social benefits of remediating a brownfield using the values of surrounding properties. In the interest of brevity, this paper will focus on the literature most relevant to this study, but there are many more examples of the use of hedonic analysis to value the unobserved value of brownfield remediation (See e.g. Alberini et al., 2005; Bascot & O'Dell, 2006; Frank 2014; Linn 2012; Mihaescu & Vom Hofe, 2012; Paull 2008; Swickard, 2008).

One such report done for the EPA used a hedonic approach to analyze the effect the distance from the nearest brownfield had on the sale value of single family homes in Charlotte, North Carolina for the years 1990-2005 (Chilton, Schwarz, and Godwin, 2009). They found the direct effect of not being in direct proximity of a brownfield ranges from $17,000 to $45,000. Under the assumption that contamination levels were brought down to EPA standards, the same report estimated that 2.97 incidents of cancer were averted due to the remediated brownfields.

In an experiment that looked at the benefits of EPA brownfield remediation programs following the enactment of the Brownfield Law, it was found that following remediation, the values of housing properties in the vicinity of the remediated property saw an increase in property value ranging from 5.1% to 12.8% (Haninger & Timmins, 2012). This study used information on every brownfield that applied for cleanup grants with the EPA from 2003 to 2008, combined with data on housing sales and characteristics in the surrounding communities of the brownfields.

Not all research suggests that government funded brownfield remediation is a worthwhile investment. Some of the criticisms of the existing literature is that it lacks “appropriate comparison areas”, proof that specific programs can be credited with improvements, and longitudinal data.

In a study investigating the economic benefit of programs that promote physical investment in rundown manufacturing sectors, Ploegmakers and Beckers use Propensity Score Matching to compare the economic outcomes of industrial sites in the Netherlands from January 1998 to December 2006. They found that physical regeneration efforts of industrial sites had a "negligible effect" on economic outcomes such as job creation, lower crime rates, and economic development (Ploegmakers & Beckers, 2014).

This study recognizes the criticisms mentioned by the Ploegmakers and Beckers paper and looks to investigate this issue further by looking at properties that we believe are more appropriate comparison areas. Since the vast majority of brownfields tend to be old industrial sites and other places of business (such as gas stations and auto shops) and tend to be in industrial areas, not residential areas, it seems more appropriate to look at the effect the presence of a brownfield has on other industrial properties.

## IV. Data

As of the end of 2014, the Wisconsin Brownfield remediation program has awarded one or more grants to 703 different properties. Using information provided to us by the Wisconsin Department of Natural Resources (including site name, year grant was awarded, and grant amount) and additional information from internet searches, our research team was able to identify reliable addresses for 563 of those sites. Of the 563 sites that we located, we were able to find a panel of property value information using county assessor websites on 367 properties. A map of these brownfield can be found in Figure 1. To supplement the data, we also identified (using Google Earth Pro) and found property values for 365 properties that are located adjacent to the Brownfields locations. In total, the data consist of 732 individual properties with an unbalanced panel of property values spanning 16 years for a total of 4,400 observations. In addition to the property level data, county level total property value separated by industry was retrieved from State sources. A summary of the data used can be found in Table 1.

## V. Model

In an attempt to tease out the unobserved social and environmental benefits of remediating a brownfield, this report will incorporate a revealed preference approach that utilizes hedonic pricing. These models will assume that developers will be less inclined to purchase brownfield properties or properties within proximity of a brownfield. This disutility should be reflected in the property value of the brownfields and the adjacent properties. If these assumptions hold true, we should see an increase in property value after remediation for both the brownfield itself and the properties surrounding it. To test this hypothesis empirically, three models are used. Below is a brief explanation of the econometric theory of the modeling techniques utilized.

## VI. Multiple Regression with Fixed Effects

The first two estimation techniques used are based on an unobserved effects model. The power of unobserved effects models when used with panel data is that it allows for estimation techniques that are able to capture the effect of all unobserved, time invariant variables. In this case, we are attempting to capture the effect of different aspects of each individual property that do not change over time. Normally we would not be able to control for characteristics such as geography or the property's vicinity to other amenities, with this model it is possible.

The estimation technique used to capture the unobserved affects is a fixed effects estimation called a within estimator. The within estimator takes away the time invariant, unobserved affects by averaging the variables of a property over time and then subtracting averages off of each observation. In theory, the averages of the variables should capture the time invariant effects that we cannot measure. Equations (1) and (2) represent the fixed effects estimations.

$$\ln(AssessedValue_{it}) = \beta_0 + \beta_1 AfterBrown_{it} + \beta_2 \text{YearsAfter}_{it} + \beta_3 C\&MGrowth_{ct} + \beta_4 \text{OtherGrowth}_{ct} + \tau + \alpha i + \varepsilon it \quad (1)$$

$$\ln(AssessedValue_{it}) = \rho_0 + \rho_1 AfterAdj_{it} + \rho_2 \text{YearsAfter}_{it} + \rho_3 C\&MGrowth_{ct} + \rho_4 \text{OtherGrowth}_{ct} + \tau + \alpha i + \mu it \quad (2)$$

where $\beta_0$ and $\delta_0$ are constants, $\beta_1 - \beta_3$ and $\delta_1 - \delta_3$ are estimable parameters, ln(AssesedValue) is the assessed value of property i in year t, $AfterBrown$ is equal to 1 if property i is a brownfield that has been remediated in year t, $AfterAdj$ is equal to 1 if property i is a property adjacent to a brownfield that has been remediated in year t, YearsAfter is the number of years since the brownfield (or adjacent brownfield) has been remediated, $C\&MGrowth$ is the property value growth of commercial and manufacturing properties in county c and year t, OtherGrowth is the property value growth of all other property types in county c and year t, α is the unobserved, time invariant effects of property i, and τ is a vector of dummies that represent significant time periods.

## VII. Difference-In-Difference

The final model used is a difference-in-difference (D-I-D) model that combines the variables of equations (1) and (2) into one equation and adds an interaction term between $AfterBrown$ and YearsAfter. The power of D-I-D is that it allows you to compare the behavior of two distinct groups. In this case, we will be comparing the growth rates of the properties adjacent to brownfields (seen as the control group) to the growth rates of the brownfield properties (seen as the treatment group). The D-I-D model takes the form of equation (3):

$$ln(AssessedValue_{it}) = \gamma_0+\gamma_1 AfterBrown_{it}+\gamma_2 AfterAdj_{it}+\gamma_3 \text{YearsAfter}_{it}+ \gamma_4 AfterBrown * YearsAfter_{it} + \gamma_5 C\&MGrowth_{ct}+\gamma_6 \text{OtherGrowth}_{ct}+\tau+\alpha i+\varepsilon it \quad (3)$$

where $\gamma_4$ is the difference between the average property value growth rate of a brownfield after remediation and the average property value growth rate of an adjacent property after remediation.

## VIII. Results

Looking at the results of equation (1), the insignificant coefficient for $AfterBrown$ indicates that the remediation process initially has no (possibly negative) effect on property value. This result may seem unusual at first glance, but was expected because of our post-remediation definition. Since we were unable to find dates for significant milestones in the remediation process (clean-up, demolition, completion), we were forced to define post-remediation as the year the grant was awarded. With that in mind, it is not surprising to see there is no increase or even a dip in property value after a grant is awarded. This maybe because the remediation process can be lengthy.

Despite no initial bump in assessed value, the results do suggest that the assessed value does increase eventually. The coefficient for YearsAfter suggest that for each year after a remediation grant is awarded, we would expect the assessed value of the property to increase

9.3% holding all other variables constant. As a robustness check to these findings, a joint significance test with the following form is used:

$$(\beta_1 AfterBrown_{it} + \beta_2 \text{YearsAfter}_{it}) * \text{y} = 0 \qquad (4)$$

where y is equal to the number of years after the grant is awarded. The joint significant test yields significant results with year seven. This indicates that it takes seven years for the property value to overcome the initial dip in value and begin to have a positive growth rate.

The results of equation (2) indicate that biggest beneficiaries to a remediated brownfield may be the neighboring properties. From the coefficient of $AfterAdj$, we would expect the adjacent properties of a brownfield to see a 17.4% increase in property value the year a grant is awarded to the neighboring brownfield property. We would also expect to see a growth rate of 4.3% in the years following remediation. Modifying equation (4), so that it can be used as a robustness check to the findings of equation (2) results in equation (5):

$$(\beta_1 AfterBrown_{it} + \beta_2 \text{YearsAfter}_{it}) * \text{y} = 0 \qquad (5)$$

Significant results can be found after the first year with equation (5) indicating, that there will be positive value growth for the properties surrounding a remediated brownfield almost immediately.

For the most part, the findings of Model 3 are consistent with results of the previous estimations. The finding suggests that there is no evidence of an immediate increase in property value after remediation for the brownfield site itself, but there is evidence of a large increase in value for the adjacent properties (16.7%). The coefficient for the YearsAfter variable can be interpreted as the average growth rate in property value for an adjacent property and suggest that we could expect the value of adjacent properties to grow at an average rate of 4.7% per year after the remediation is complete. The sum of the coefficients of YearsAfter and the interaction between YearsAfter and $AfterBrown$ can be interpreted has the average growth rate of remediated brownfield after the remediation process takes place. The positive coefficient indicates that on average brownfields will have an expected yearly growth rate that is 2.9% higher than the average growth rate of the adjacent sites.

## IX. Conclusion

The purpose of this study was to attempt to measure the unobserved benefits of Wisconsin's Land Recycling Loan Program. This was done by looking at the property values of brownfield sites in Wisconsin that received aid from the State as well as properties adjacent to the brownfield sites. Hedonic analysis was used to measure how property values were affected before and after the remediation process began. The findings suggest that a property adjacent to a brownfield going through the remediation process would experience an immediate increase in property value, averaging from 16.7% to 17.4% increase. The results also indicate that, though delayed, the brownfield will also experience and increased growth rate. Although far from exhaustive, the results of this study seem to indicate that the benefits of remediating a brownfield extend beyond the property itself and that these unobserved benefits should be considered when future brownfield remediation programs are reviewed.

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***Table 1. Descriptive Statistics***

| **Descriptive Statistics** | | | | | |
|---|---|---|---|---|---|
| ***Variable*** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| *Assessed Value* | 4,400 | 487,292.80 | 2,331,101.00 | 0 | 42,400,000.00 |
| *Years After Remediation* | 15,372 | 2.62 | 3.69 | 0 | 16 |
| *Brownfield-Before Remediation* | 256 | 434,067.00 | 3,240,564.00 | - | 42,400,000 |
| *Brownfield-After Remediation* | 1,070 | 579,659.80 | 3,610,192.00 | - | 42,400,000 |
| *Adjacent-Before Remediation* | 560 | 244,966.10 | 852,278.50 | - | 8,923,300 |
| *Adjacent-After Remediation* | 2,514 | 507,378.70 | 1,650,271.00 | - | 24,800,000 |
| ***%County Property Value Growth:*** | | | | | |
| *Commercial & Manufacturing* | 13,558 | 11.27 | 458.78 | -99.72 | 27,931.36 |
| *Other* | 13,369 | 0.8 | 44.53 | -93.79 | 2,376.72 |
| ***Time dummies:*** | | | | | |
| *1998-2002* | 16,104 | 0.23 | 0.42 | 0 | 1 |
| *2003-2006* | 16,104 | 0.18 | 0.39 | 0 | 1 |
| *2011-2014* | 16,104 | 0.18 | 0.39 | 0 | 1 |

*Table 2. Estimation Results*

| Table 2 | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| **Dependent: ln(Assessed Value)** | Coefficient (Standard error) | Coefficient (Standard error) | Coefficient (Standard error) |
| **Brownfield-After Remediation** | -0.140 | | -0.121 |
| | (0.153) | | (0.154) |
| **Adjacent-After Remediation** | | 0.174*** | 0.167*** |
| | | (0.048) | (0.047) |
| **Years After Remediation** | 0.093*** | 0.041*** | 0.047*** |
| | (0.029) | (0.010) | (0.01) |
| **Brownfield*Years After** | | | 0.029* |
| | | | (0.071) |
| **%County Property Value Growth** | | | |
| **Commercial & Manufacturing** | 0.002 | 0.001 | 0.001 |
| | (0.005) | (0.001) | (0.002) |
| **Other** | -0.003 | -0.001 | -0.000 |
| | (0.004) | (0.001) | (0.002) |
| **Time dummies:** | | | |
| **1998-2002** | 0.021 | 0.018 | 0.020 |
| | (0.187) | (0.067) | (0.070) |
| **2003-2006** | 0.091 | 0.041 | 0.054 |
| | (0.108) | (0.037) | (0.039) |
| **2011-2014** | -0.309*** | -0.153*** | -0.192*** |
| | (0.115) | (0.037) | (0.041) |
| **Constant** | 10.715 | 11.574* | 11.352* |
| | (1.910) | (2.040) | (4.895) |
| **N** | 5,642 | 5,642 | 3,880 |
| **R-square** | 0.068 | 0.12 | 0.091 |

**OLS standard errors are robust**
***** signifies that the coefficient is significantly different from zero with a .01 or less probability of a type I error**
**** signifies that the coefficient is significantly different from zero with between a .01 and .05 probability of a type I error**
*** signifies that the coefficient is significantly different from zero with between a .05 and .1 probability of a type I error**

*Figure 1. Grant Recipients in Wisconsin by County*