Local Willingness-To-Pay Estimates for the Remediation of the Davis Tannery Brownfield in Kingston, Ontario

by Maria Vavro
(5426121)

Major Paper presented to the
Department of Economics at the University of Ottawa
In partial fulfillment of the requirements of the M.A. Degree

Supervisors: Professor Catherine Deri Armstrong
Professor Leslie Shiell

ECO 7997

Ottawa, Ontario
August 2010

TABLE OF CONTENTS

INTRODUCTION 1

CONTAMINATION AT THE SITE 5

SITE DESCRIPTION 5

KINGSTON INNER HARBOUR 6

BROWNFIELDS 9

FRAMEWORK OF EVALUATION 10

HEDONIC PRICING MODEL 10

PREVIOUS RESEARCH 13

DATA 16

RESULTS 24

POLICY IMPLICATIONS 34

CONCLUSION 35

REFERENCES 38

APPENDIX A: TABLES 41

APPENDIX B: FIGURES 48

INTRODUCTION

The knowledge of consumers' willingness-to-pay for improvements in environmental quality is beneficial information for policy-makers for a variety of reasons. It can help them design policies such as targeting the clean-up of hazardous waste sites and conduct cost-benefit analysis to determine the net benefit that a clean-up may have on a community (Palmquist, 1992). Further, understanding which factors influence the demand for environmental quality and understanding how residents will be affected by such changes as an environmental clean-up of a contaminated site have been cited as key information to determine consumer's willingness-to-pay for changes in environmental quality (Brasington and Hite, 2005).

A variety of projects are being planned in the City of Kingston, Ontario to clean-up several historical brownfields along its waterfront (Manion et al., 2010).[1] Brownfields are defined by the Government of Ontario (2007) as "properties that are potentially contaminated due to historical, industrial or commercial land use practices, and are underutilized, derelict or vacant" (p.6). Interest in the re-development of these sites has recently increased due to the federal and provincial government's objectives to preserve the heritage of these sites and to protect green space and agricultural land from development (Government of Ontario, 2007).

One of these brownfields is the 37-acre property of the former Davis Tannery. This site is highly contaminated with several contaminants such as PCBs and metals (Manion et al., 2002) and is currently the focus of an environmental clean-up initiative by

[1] Brownfields along the Kingston waterfront are the result of past industrial land use including a coal plant, a tannery and lead smelter, a municipal dump and more. More details on this area are reported in the section called "Contamination at the Site".

the City of Kingston and its Inner Harbour Working Group (KEAF, 2002). More details on the Davis Tannery site are reported in a later section.

No clean-up options or associated costs have yet been proposed for the clean-up of the Davis Tannery site. Before any remediation efforts are begun it is important to first determine whether the costs of the project are justifiable based on the potential benefits of remediation (Ferrara et al., 2007). The purpose of this study is to estimate the potential benefits of a remediation of the Davis Tannery site using the hedonic pricing model. Using data from the Kingston area Multiple Listing Service (MLS) between 2004 and 2005, I estimate the average amount house sale prices are affected in dollars per kilometre from the contaminated site. Next, I estimate the average change in house sale price the affected neighbourhoods would experience if the Davis Tannery site was fully remediated and from this I calculate the aggregate projected benefits of remediation for the City of Kingston.

Hedonic pricing models have been used in the past to measure the benefits of an improvement in environmental quality based on residential property sale prices, including research on the effect of noise, air and water pollution on property values (Ketkar, 1992).[2] Some of these studies were conducted for hazardous waste locations in the United States, which have found that price-distance gradient premiums range from approximately 3,372 dollars to 16,867 dollars per kilometre (2005 Canadian dollars), but these values are ultimately dependent on the type of contamination present and the magnitude of the contamination (Farber, 1998).[3] To the best of my knowledge, only two

[2] Studies estimating the effects of hazardous waste disposal facilities on property values began as early as 1971 (Ketkar, 1992).
[3] All dollar values reported in this paper are in 2005 Canadian dollars.

studies using the hedonic pricing method to estimate the willingness-to-pay of a community for the remediation of a contaminated site have been conducted in Canada, with both studies focusing on the clean-up of the Sydney Tar Ponds located in Nova Scotia (Ferrara et al., 2007, Neupane and Gustavson, 2008). These studies are discussed in a later section.

There are two main contributions of this paper. First, it provides willingness-to-pay measures for remediation of the Davis Tannery brownfield. I exploit the lessons learned in similar previous works which have demonstrated the importance of taking into account spatial correlation between houses (see for example Ferrara et al., 2007). To this end, I estimate the hedonic models taking into account neighbourhood effects using the most recent tax value paid on the property.

The second contribution of this paper is that it incorporates variables for qualitative comments from house sale listings to better control for the condition of the house on sale price. To the best of my knowledge, this type of qualitative information has never been exploited in hedonic price estimates of residential real estate. A priori, I expect that the use of this information will improve the fit of the hedonic model, and therefore improve the accuracy of the estimated willingness-to-pay for environmental quality.

My results suggest that both neighbourhood effects and qualitative descriptions of houses play an important role in the hedonic price model. For example, with the inclusion of the neighbourhood variable "tax", the magnitude of the distance to the Davis Tannery site coefficient decreased from 94,845 to 32,359 where the latter is much more consistent with previous findings. Ferrara et al. (2007) argue that the model excluding spatial effects provides an upward bias on the distance to the Tar Ponds coefficient resulting in an over-estimate of the total willingness-to-pay of the community for the clean-up of this site.

The inclusion of qualitative variables for high or low quality homes and seller's impatience to sell do not substantially alter the results for the change of house sale price per kilometre; however, it does affect the magnitude and statistical significance of various physical characteristics of the home, such as age and number of bedrooms and bathrooms. In the main regression where all variables are included, it was determined that the average amount house sale price changes per kilometre farther from the tannery site is 13,928 dollars. The average price of a house in the sample is 198,818 dollars. This leads to an average change in value of 44,371 dollars to move 8.46 kilometres from site (the farthest observation in the sample is 8.46 kilometres away from site) and to a total willingness-to-pay of approximately 353.6 million dollars for the City of Kingston.

The paper proceeds as follows. Section 2 provides a brief summary of the Davis Tannery site in Kingston, highlighting the demands by Kingston residents for the clean-up of the site and the federal and provincial government's commitment to the clean-up of contaminated sites in Canada. Section 3 provides a description of the hedonic pricing method and a brief literature review of the two Canadian studies that estimated the City of Sydney's total willingness-to-pay for the clean-up of the Sydney Tar Ponds. Section 4 summarizes the data employed for the analysis. The final section presents the empirical results and the policy implications.

CONTAMINATION AT THE SITE

Site Description

The City of Kingston (pop: 117,207) is home to several former industrial sites along its waterfront which have been the subject of many research and clean-up discussions (Manion et al., 2010). One notable property and the focus of this study is a 37-acre site geographically situated on the southwest shore of the Kingston Inner Harbour named the Davis Tannery site. The site and surrounding areas are illustrated in Figure 1. The Davis Tannery site is bordered to the north by Belle Park, a former landfill operating from 1952 to 1974 and currently home to a golf course. To the south there exists various residential, commercial, and recreational centres, including rowing and sailing facilities and three commercial and bait fisheries (KEAF, 2002, Manion et al., 2010). The site is bordered to the west by a residential district and its eastern property edge is located directly along the Kingston Inner Harbour.

The Davis Tannery site has been the subject of research studies and discussion for decades due to its long history providing home to numerous industries, most recently the Davis Tannery, which operated until 1973 (Welbourn et al., 2009). Initial concerns over soil and sediment contamination resulting from past industry were first raised in 1977 when the present-day owner of the tannery requested that the property zoning be changed to residential, commercial, and parkland designation (City of Kingston, 2006). At that time, a study was undertaken to assess the contaminant levels of soils, sediments, water and vegetation from the Davis Tannery site, which revealed that there were indeed elevated contaminant concentrations, including polychlorinated biphenyls (PCBs), lead, copper, chromium, and mercury (Stokes, 1977). According to Stokes (1977), results from early studies determined that total mercury soil and sediment concentrations ranged between 100 and 7,710 μg/kg and between 370 and 870 μg/kg, respectively. CCME (1999) state that the inorganic mercury soil quality guidelines for residential land is 6,600 μg/kg and 170 μg/kg for mercury interim sediment quality guidelines. Manion et al. (2010) state that soil concentrations at the Davis Tannery site were measured again during a study undertaken 17 years later and samples collected yielded similar total mercury results in the range of 50 to 15,000 μg/kg.

Kingston Inner Harbour

The Davis Tannery site is one of many sources of contamination that exist in the City of Kingston's inner harbour. According to Manion et al. (2010), more than 40 industries once operated within the inner harbour, many along the southwest shoreline near the Davis Tannery site. Manion et al. (2010) state that some of these previous industries include a coal gasification plant, manufacturing operations, a gristmill, shipyards, a fuel depot, a railway corridor, a lead smelter and the former Davis Tannery. Studies conducted within the inner harbour, but beyond the borders of the Davis Tannery site, have found elevated levels of similar contaminants close to the south-western shoreline (Manion et al., 2010). Furthermore, in a study conducted by the Ministry of the Environment in 2002, total mercury concentrations were determined to be greater than 2000 μg/kg, which is more than twice the severe effect limit (Manion et al., 2010). The severe effect limit is defined as being heavily polluted and potentially toxic to biota (Manion et al., 2010). The risk to humans is also significant as the sign and fencing in Figures 2 and 3 suggest.

The inner harbour, which is the mouth of the Cataraqui River, lies in close proximity to the Cataraqui wetlands conservation area, residential districts and Kingston's downtown core. Blancher (1984) and Manion et al. (2010) state that the Cataraqui wetlands conservation area is home to 206 different bird species, 51 different plant species and 36 reported fish species and that this 3.5 km stretch of shoreline located at the northern end of the inner harbour is an important migratory stop for birds and spawning location for fish species. To the south, the inner harbour opens up to Lake Ontario, which can be seen in Figure 1. KEAF (2002) states that the inner harbour shoreline represents approximately 10% of Kingston's 150 km of shoreline, and, due to its size and proximity to environmentally-sensitive and urban areas, the City and its citizens have determined it necessary to quantify and assess the extent and mobility of the contamination and to work towards clean-up options (Manion et al., 2010).

As a result of the community's demand for remediation of the inner harbour area, the City of Kingston formed a volunteer organization called the Kingston Environmental Advisory Forum (KEAF) in January 2000, which would assist the City in identifying pressing environmental issues and develop a strategy to solve these issues (KEAF, 2002). Through this forum, the City hosted public consultations where concerned citizens had a platform to express their concerns and at a public consultation in July 2000, the inner harbour was identified as a top environmental matter when citizens wished it to be protected both environmentally and developmentally in a manner that provided greater public access to the waterfront (KEAF, 2002). In response, the Kingston Inner Harbour Working Group was formed to address KEAF's recommendations related to the inner harbour, which primarily included assembling environmental data, holding public workshops and adopting a plan to remediate the inner harbour (KEAF, 2002).

Although the focus of this paper is to determine an estimate of the City of Kingston's willingness-to-pay for the environmental clean-up of the Davis Tannery site, it can be argued that the estimate will also include the clean-up of soil and sediment beyond the borders of the site, such as the surrounding southwest edge of the inner harbour. This argument may be realistic as the Davis Tannery site is likely a source of contamination to the inner harbour and through the remediation of the Davis Tannery site, the inner harbour contamination may be partially improved. Also, due to the proximity of the Davis Tannery site and other areas of contamination along the southwest shoreline, individuals may view the complete southwest section of the shoreline and the Davis Tannery site as one area requiring remediation. Lastly, as the clean-up of the Davis Tannery site may be viewed as only a portion of the remediation of the southwest shoreline of the inner harbour, it is not possible to directly compare the benefits that will be estimated, which are based on complete remediation, to the costs any of future clean-up options that involve only partial remediation of the area. It should also be noted that although Belle Park has been subject to controversy due to its operation as a landfill from 1952 to 1974, Manion et al. (2010) state that none of the well-monitoring programs have detected mercury at this property. Additionally, although contaminant concentrations have found to be elevated in the soil and sediment during past studies, KEAF (2002) notes that surface water has been found to be relatively clean.

Following these research studies and working group consultations, the City of Kingston submitted an improvement project plan to the Ontario Government in 2005 with the objective to designate the Davis Tannery site as a brownfield (Welbourn et al., 2009). In 2006, the plan received approval.

Brownfields

According to the Government of Ontario (2007), "brownfield properties are lands that are potentially contaminated due to historical, industrial or commercial land use practices, and are underutilized, derelict or vacant. Brownfields are often situated in key areas throughout a community, such as the downtown or along the waterfront" (p.6). In recent years, citizens and municipalities have become more concerned with environmental aspects of their communities and are looking for ways to develop their cities in more environmentally sustainable ways (Government of Ontario, 2007). For example, the Government of Canada committed 3.5 billion dollars in the 2004 budget to be used over 10 years through the Federal Contaminated Sites Action Plan (FCSAP) for the clean-up of federal lands and an additional 500 million dollars for the clean-up of sites where the federal government may be responsible (ECO Canada, 2007). An example of such a site is the Sydney Tar Ponds in Nova Scotia. Furthermore, 300 million dollars was invested into the Green Municipal Fund so that municipalities can fund the clean-up and redevelopment of brownfields within their communities (ECO Canada, 2007).

ECO Canada (2007) argues that the recent commitment from the government is based upon the fact that Canadians are demanding the clean-up of contaminated sites within their cities because contaminated properties are environmental hazards that pose health risks and because Industry Canada reported that an economic impact of 50 million dollars could be created through the redevelopment of brownfields. The Government of Ontario (2007) also notes that brownfield properties not only hold monetary value but often cultural heritage and social value and their redevelopment can increase community pride, tourism, and encourage economic investment. Therefore, calculating an estimate for a community's willingness-to-pay for an environmental clean-up can provide an important element in the decision-making process for municipalities.

FRAMEWORK OF EVALUATION

Hedonic Pricing Model

Ridker and Henning (1967) were the first economists to use residential property prices in order to estimate the benefits of changes in environmental quality. Subsequently, Rosen (1974) developed the theoretical foundations of the hedonic pricing model. The basis of the model rests on the theory that differentiated products such as houses are able to be explained by their individual attributes, including neighbourhood, structural, and environmental characteristics (Palmquist et al., 1997). In fact, Palmquist et al. (1997) note that one of the few places environmental quality is traded is on the housing market. Through the use of hedonic regressions, it can be revealed whether households value a marginal change in environmental quality by determining whether the environmental variable of interest has a significant effect on housing values (Palmquist et al., 1997).

As in Neupane and Gustavson (2008), the hedonic price function can be described as:

$$P = F(S, N, E)$$

where P is the house sale price; F is a function that relates the house sale price to its physical characteristics, S, its neighbourhood characteristics, N, and its environmental characteristics, E.

Rosen (1974) establishes that the hedonic pricing method consists of two steps in order to determine household's willingness-to-pay for a given feature, such as environmental quality. In the first step, a hedonic price schedule is estimated, which isolates the effect of a marginal increase in environmental quality on the price of houses, while controlling for other variables that influence house prices, such as structural and neighbourhood characteristics. Boardman et al. (2001) indicate that the relationship between house price and environmental quality should be non-linear implying that the amount households' are willing-to-pay for a marginal change in environmental quality should decline as the level of environmental quality increases. However, the hedonic price schedule is only an equilibrium price schedule and because it does not reveal information on individual household behaviour, the second step of the hedonic pricing method is required (Rosen, 1974). This second step accounts for household differences such as income, education, and tastes, and allows for the estimation of the inverse demand curve, which can then be used to calculate changes in individual and total consumer surplus from a change in the level of environmental quality. However, as Palmquist (1992) states, theoretical and econometric difficulties at the second stage make it difficult to complete. Even when estimation is possible, policy changes may cause a shift in the hedonic price schedule. One of the main issues with the second stage is difficulty obtaining data on household personal characteristics, such as income. Without this data, it is impossible to identify preferences of each household (Palmquist and Israngkura, 1999).

Due to the complexity of the second step, many studies employ only the first stage when estimating the effect of a localized externality (Ferrara et al., 2007). Palmquist (1992) describes a localized externality as one that has significant impacts on those affected by it; however, nearby comparable houses are unaffected. Hazardous waste sites fit this description, as past research has found that house prices are only affected at locations within 10.3 kilometres of sites (Kohlhase, 1991). In the localized case, the equilibrium hedonic price schedule estimated in step one would be unchanged by the externality although houses nearby the externality would have their own house value affected (Palmquist, 1992). Following the logic of Palmquist (1992), with the improvement of an environmental externality, such as a hazardous waste site, the prices of houses affected by the externality would increase even though the hedonic price schedule has not changed. The premium for an increase in environmental quality estimated in the hedonic price schedule arises because households are willing-to-pay to avoid the externality (Palmquist, 1992), or similarly, eliminate the negative externality in the case of a hazardous waste site. Ferrara et al. (2007) also states that when studying a localized externality, it is sufficient to estimate the hedonic price schedule for a relatively homogeneous neighbourhood. For further discussion on localized externalities, refer to Palmquist (1992).

Previous Research

Previous studies that used the hedonic price model to consider the effects of environmental quality on house prices include topics such as hazardous waste sites (Ferrara et al., 2007, Neupane and Gustavson, 2008, Farber 1998, Ketkar, 1992), highway noise (Palmquist, 1992), irrigation water (Mallios et al., 2009), hog operations (Palmquist et al., 1997), tree canopy (Netusil et al., 2010), and even tourism (Hunt et al., 2005). Due to the similarity of the studies to this paper, a summary of the research by Ferrara et al. (2007) and Neupane and Gustavson (2008) on the hedonic analysis of house prices in Sydney, Nova Scotia follows.

Ferrara et al. (2007) completed a hedonic analysis on the Sydney Tar Ponds in Nova Scotia to estimate local willingness-to-pay for the remediation of the abandoned tar ponds. The study employed both Ordinary Least Squares (OLS) and spatial lag models to analyze the effect the tar ponds have on nearby house prices (Ferrara et al., 2007). Recent studies have found that hedonic property pricing models are subject to spatial autocorrelation issues and therefore, future studies should test and account for spatial dependence between observations (Brasington and Hite, 2005).

Basu and Thibodeau (1998) explain that house prices can be spatially autocorrelated for two reasons. One reason is that neighbourhood properties typically have similar structural characteristics because the tendency of cities to develop full neighbourhoods at a time. Secondly, neighbouring properties share similar characteristics, such as school quality and the distance to amenities. Neighbourhood effects also take into account that neighbourhoods attract residents with similar qualities, such as income and that expensive homes will attract residents with higher incomes regardless of the environmental characteristics associated with the house (Palmquist, 1992).

Since OLS estimates do not account for the spatial effects between observations, they will likely be biased. Indeed, based on the results, Ferrara et al. (2007) determine that the spatial parameter for a spatial lag model is significantly different from zero based upon Lagrange Multiplier (LM) tests and therefore, reject the OLS model. According to Ferrara et al. (2007), the spatial lag model accounts for house prices being set in partial response to house prices of neighbouring properties. As a result, the OLS model in Ferrara et al. (2007) provided a larger estimate for the distance variable coefficient than did the spatial lag model, which leads to a larger value estimation of the total benefits of remediation of the site with the OLS model. In other words, the spatial lag model provided a more conservative estimate of the direct community benefits from the remediation of the Sydney Tar Ponds than the OLS model. Both models resulted in significant coefficient estimates for the distance variable at the one percent level. Although the models resulted in different total benefit estimates, Ferrara et al. (2007) state that the true benefit of remediation of the site is likely greater than the hedonic model provides, as possible indirect benefits are not included in the model. For example, indirect benefits such as decreased health care costs and increased tourism will add to the total benefits calculated. Therefore, when accounting for the addition of indirect benefits, the differences between the OLS model and the spatial lag model may not be considered as substantial. For more information on spatial econometrics, refer to Anselin (1988). The results of Ferrara et al. (2007) determine that Sydney's willingness-to-pay for the clean-up of the Tar Ponds is approximately $200 million (2005 dollars) using the spatial lag model and approximately $239 million (2005 dollars) using the OLS model.

In a similar study, Neupane and Gustavson (2008) performed a hedonic analysis of Sydney, Nova Scotia to estimate the impact of the contaminated site on urban property prices in the community. Initially, the study includes neighbourhood characteristics such as income, employment, and poverty levels in the model; however, these variables were omitted in the final model because of lack of data and the failure of the variables to appreciably improve the model fit (Neupane and Gustavson, 2008). Upon testing for spatial effects, the null hypothesis of no spatial dependence could not be rejected; therefore the analysis was completed using the OLS model without spatial effects (Neupane and Gustavson, 2008). Results determined that the price-distance relationship is such that house price will increase as distance from the site increase, but at a decreasing rate (Neupane and Gustavson, 2008). Results for other coefficients were consistent with literature findings; however, the model failed to explain the variance in property prices by more than 50 percent (Neupane and Gustavson, 2008). Similar to the study conducted by Ferrara et al. (2007), second-stage analysis of the hedonic price model was not completed due to the complexities discussed in the previous section. Final estimates of the negative impact of the Sydney Tar Ponds on area house prices were $36 million (2005 dollars) (Neupane and Gustavson, 2008). There are several differences between the study conducted by Neupane and Gustavson (2008) and Ferrara et al. (2007) to account for the difference in the results, primarily the dataset and models employed.

Unfortunately, accounting for the effects of spatial dependency between observations is beyond the scope of the present paper. However, it is expected that by accounting for neighbourhood effects using the tax variable, the OLS model will provide less biased coefficients than otherwise. This issue is explored in the section on Regression 4.

DATA

This study employs Multiple Listing Service (MLS) transaction data for the City of Kingston, available to member realtors of the Kingston and Area Real Estate Association (KAREA). The data includes both quantitative and qualitative information, including the sale price of the home and the most recent tax value paid on the property. Data for all housing transactions conducted by member realtors of KAREA were collected for the two-year period of January 2004 through December 2005, for real estate districts adjacent to and surrounding the Davis Tannery property.

The analysis is carried out for single-family dwellings only, as is common in this literature (see for example Ferrara et al., 2007). In total, 1067 observations (house sales) are included in the dataset and no observations were dropped. Home sales prices and taxes are adjusted to 2005 dollars using the inflation rates provided from Bank of Canada's website.

The real estate districts included in the study are described in Table 1. The real estate district of East Sir John A Boulevard, referred to as District 22, contains the neighbourhoods that are situated closest to the Davis Tannery site and thus includes observations whose sale price is expected to be most affected by the contaminated site.

District 22 is bordered by the Davis Tannery site and the Kingston inner harbour to the east, Princess Street to the south, Sir John A MacDonald Boulevard to the west, and Highway 401 to the north, and is approximately 11.9 square kilometres in area. The other districts contain neighbourhoods located near the downtown core and south of highway 401 and were included to ensure a sufficient price-distance gradient could be estimated.

Since individual address information is provided in the MLS listings, the individual address is used to calculate distance variables. Using Google Earth (http://earth.google.com), the latitude and longitude of each house listing was determined and straight-line distances (as opposed to driving distances) were manually calculated between each observation and the Davis Tannery site, as well as between each observation and Kingston's downtown core. For distance calculations, the approximate centre point of the Davis Tannery site was used as the location of the brownfield and for Kingston's downtown core, the intersection point of two main downtown streets, Montreal Street and Princess Street, was used. The distance between the Davis Tannery site and the downtown core is 1.58 km. The maximum distance an observation in District 22 is located from the Davis Tannery site is 2.83 kilometres. The maximum distance an observation is located from the Davis Tannery site in the total sample is 8.46 kilometres.

Table 2 describes each variable used in the analysis and Table 3 presents the summary statistics. The dependent variable in the hedonic regressions is the home's sale price and has a mean of value of 198,818 dollars.

The independent variables include the two distance variables (from the home to the Davis Tannery and to downtown), structural and other physical characteristics of a home listed in the MLS listing, measures of quality derived from the "additional comments" description of the home found in individual house listings, occupancy status of the house, the season the house was purchased, and the most recent annual tax amount paid on the property.

The key variable in this study is the distance from each observation to the Davis Tannery site. Due to its close proximity to the downtown core, a distance variable was also created for each observation to the downtown core as a control. The closest home in the dataset to the Davis Tannery site is located only 23 metres away, while the farthest home from the site is located approximately 8.5 kilometres away. Over 75 percent of the observations in the dataset are between 500 metres and 3.5 kilometres from the site. Fewer than 1 percent of observations are located closer than 500 metres to the site and fewer than 8 percent of observations are located 4 kilometres or more from the site.

As other studies have assumed (for example Ferrara et al., 2007), the price-distance gradient is considered to be non-linear for the hazardous waste site. Therefore, a distance variable entered the model in natural log form to account for the non-linearity of the price-distance gradient. As Ferrara et al. (2007) state, "observations closest to the site are expected to bear the greatest externalities from the toxicity, and therefore should bear the largest negative impact on property values. As the distance from the site increases, the negative externalities diminish and property values should increase" (p.448). In contrast, I assume that the price-distance gradient for proximity to the downtown is linear to remain consistent with Ferrara et al. (2007). Additionally, since the function of the price-distance gradient for proximity to the downtown is unknown, the assumption of a linear specification appears to be the most reasonable. For example, there could be some optimal distance a house is located from downtown on sale price where an identical home at any other distance from this site would reduce its value. For example, if the optimal distance from downtown was 0.5 kilometres, an identical house closer to downtown would be worth less because of noise pollution and traffic congestion concerns, while an identical house farther from downtown would also be worth less because its less convenient distance from downtown. This differs from the assumption of the price-distance gradient for proximity from the tannery site because it is assumed that the farther the distance from the tannery site, the higher the sale price for all distances.

The variables related to physical characteristics include age, total living area, lot size, the number of bedrooms and bathrooms, the presence of a garage, and the number of storeys. Many of the MLS listings expressed the house age as being within an age range rather than an exact age in years; therefore, the age variable was divided up into four dummy variables of age ranges and one additional dummy variable indicating no age was provided in the home's listing.[4] It is expected that the age of a home will affect the sale price in a positive way when the house is either relatively new (if the average buyer prefers to move into a modern and newer house) as well as when the house is older than 50 years old (if the average buyer also has a preference for the charm or character of older homes).

[4] Of the 1067 observations in the dataset, 14 percent did not provide information on the age of the house. Furthermore, observations with listings that stated the age of the house as "old" are treated as houses over the age of 50. Observations with listings that stated the age of the house as "new" are treated as being in the 0 to 10 years old category. The number of observations that were stated as "old" and "new" are 14 percent and less than 1 percent, respectively.

The influence of total living area and lot size are expected to be positive as in previous studies such as Ferrara et al. (2007). Neupane et al. (2008) suggest that buyers are willing to pay a premium for larger homes and properties because these qualities may be viewed as more desirable and luxurious by others and buyers could consider these characteristics as reflections of their social status.[5]

The number of bedrooms in a house is expected to have a positive impact on the sale price; however, Ferrara et al. (2007) state that some studies in the literature find that the number of bedrooms has a negative effect on sale price. The number of bathrooms in a house is also expected to be a positive influence on the sale price, as found in Neupane et al. (2008). In cases where the number of bathrooms and bedrooms were stated as half of a room, as may be the case for an ensuite bathroom, the number was rounded up to the next integer value.

A two-storey home is expected to positively influence the sale price, although this may not be the case in a community which has a greater portion of its population over 55 years old, as seniors may be willing to offer more for bungalows and homes with fewer steps than for a multi-storey home. However, according to Statistics Canada (2010), the largest age group in Kingston is of people between 20 and 24 years of age followed by the 40 to 44 age group. Based on these numbers and the likelihood that buyers of this age will have families or be preparing for children, it is expected that the sales price of a home should increase when it is a two-storey home or more.

[5] Dummy variables controlling for MLS listings that did not provide information on the total living area or lot size are created and included in all regressions. From the dataset, 47 percent of observations did not include information on total living area in their listing, while 3 percent of observations did not include information on lot size.

With respect to the other physical characteristics, the estimated coefficient is expected to be positive for the presence of any of the following: garage, natural gas, central air conditioning, hardwood floors, fireplace, pool, and a deck or patio. It is believed that all of these characteristics are desirable to most buyers, which has been shown in past studies (Palmquist, 1992). Although observed in the MLS listings, variables for the presence of a garage, paved driveway, partially or fully finished basement, and fence were excluded from most regressions.[6] Fewer than half of the observations in the sample noted a garage, finished basement and fence, while just over half noted a paved driveway. Since it is likely that these characteristics are present in more than half the observations, I decided to exclude these characteristics from the regressions based on data quality issues. I argue that agents representing "low quality" homes emphasis these characteristics in order to note some features for the home, while agents representing "average quality" or "high quality" homes assume these characteristics as standard qualities of a house and focus the buyers attention to special features of the home, such as the presence of hardwood floors and a fireplace. Initial analyses confirmed that this argument was a reasonable assumption as the coefficients for these variables reported negative signs suggesting that the characteristics for garage, finished basement, paved driveway and fence appear in the MLS listings for lower priced homes most often.

From the "additional comments" section of the listing, I constructed indicator (dummy) variables for high quality home, low quality home and for rushing to sell the

[6] An indicator variable for the presence of a garage was included in Regression 1 for comparison purposes to Ferrara et al. (2007).

home. Examples of high quality keywords include "completely renovated" and "mint condition" in comparison to low quality keywords such as "needs updating" and "starter home".[7] Rushing keywords include "seller anxious" and "immediate possession preferred". A full list of keywords is available in Table 4. Using these sets of keywords, homes were placed in the appropriate category. Similarly, in cases using less standardized keywords, discretion was used to place the home in the appropriate category based on the complete listing information. The indicator for high quality is expected to be correlated with a higher sale price and the indicator for low quality is expected to be correlated with a lower sale price ceteris paribus. To the best of my knowledge, the use of qualitative keyword comments in this manner is unique. For example, Neupane and Gustavson (2008) state that the low ability of their model to explain variance in the property values based on their R-squared value may be due to the unknown variation in the condition of residences, such as any renovations or upgrades that may have been completed. Likewise, rushing keyword comments are expected to be correlated with lower sale prices as these comments may indicate to the buyers that the seller is anxious to sell and may be more likely to accept a lower offer on their house.

Tenant occupied or vacant homes are expected to negatively influence the sales price. Although this may not be true in the case when buyers are looking for an investment property to rent and the home is tenant occupied; it is assumed that in general, buyers may consider a property to be in worse condition when a home is occupied by tenants rather than the owner. Additionally, a vacant home may not be physically as

[7] An indicator variable was not created for homes portrayed as average quality. Observations with listings that did not have either high or low quality keywords are considered to be in average condition.

attractive to buyers during its viewing or it may give the buyer the impression that the seller is in more of a rush to sell and could be willing to accept a lower offer.

Coefficients for homes purchased in the winter are expected to negatively influence sale price relative to homes sold in the fall as properties may not look as attractive in the winter as in other times of the year. Homes sold in the spring and summer are expected to positively influence sale price relative to homes sold in the fall, as demand for homes is typically known to increase during the warmer months when households are able to move more easily because of summer holidays and properties typically appear more attractive at this time of year. To the best of my knowledge, the incorporation of seasonal controls is unique.

I control for neighbourhood effects on house sale prices by the use of a tax variable for the most recent tax value paid on the property in 2005 dollars.[8] As property taxes are based on the home's previous sale price and assessed value based on its key features, as well as the assessed value of comparable properties in the community (MPAC, 2010), this variable is expected to capture other unobserved neighbourhood or quality characteristics. It is expected that the estimated coefficient will be positive as a higher (lower) than average tax value should be a reflection of a property that has a higher (lower) than average market worth, which should then command a higher (lower) sales price in the market.

The main regression in this study can be described as:

---

[8] A dummy variable was created and included in all applicable regressions to control for observations whose MLS listings did not state a tax value. The observations that did not include a tax value are fewer than two percent.

$$P = c + \beta ln(d_{site}) + \alpha\, d_{downtown} + \gamma' S + \delta' M + \varepsilon$$

where P is the house sale price in 2005 dollars, c is the constant, β is the coefficient for the natural log of the distance to the tannery site variable, d_{site}, α is the coefficient for the distance to downtown variable, $d_{downtown}$, S represents the vector of structural characteristics of the home, γ represents the vector of coefficients for the structural characteristics, M represents the vector of all other characteristics of the home (e.g. year and season the home was sold), δ represents the vector of coefficients for these characteristics, and ε represents the residual.

RESULTS

The following section details the results of four regressions analyzed in this study. The first regression uses only variables analyzed in Ferrara et al. (2007). The second regression includes all variables in the dataset. The third and fourth regressions include all variables in the dataset except for qualitative variables and the tax variable, respectively.

For comparative purposes, the first regression includes only variables employed in Ferrara et al. (2007): distance to site and downtown, age of the home, lot size and total living area, the number of bedrooms and bathrooms, the number of storeys, and indicator variables for the presence of a garage and fireplace.[9] . As heteroskedasticity is commonly reported as an issue in the literature (see for example Ferrara et al., (2007) and Neupane and Gustavson (2008)), the White test was conducted to test for heteroskedasticity (Table 5). Results from the White test determine that the null hypothesis of homoskedastic errors

[9] Indicator variables for age ranges are used here versus the age number used in Ferrara et al. (2007).

can be rejected and thus, corrected Huber-White standard errors are obtained for Regression 1 and reported in Table 6.

The model explains approximately 63 percent of the variance in house sale price and many of the variables are significant at the 1 percent level.[10] The coefficient for the distance from site variable (natural log) has the expected sign and is significant at the 1 percent level. The coefficient for this distance variable suggests that a home located two kilometres from the Davis Tannery site is worth approximately 68,072 dollars more than an identical home located 1 kilometre from the site, while, a home located 4 kilometres from the site is worth 28,252 dollars more than an identical home located 3 kilometres from the site. Results reporting the change in sale price per kilometre increase from site are shown in Table 7.

The coefficient for distance from downtown suggests that a 1 kilometre increase from downtown decreases sale price by 43,187 dollars on average. These results match those found in the OLS model of Ferrara et al. (2007) where both coefficients for distance to site and distance to the central business district were found to be significant at the 1 and 10 percent level, respectively.[11]

Other coefficients for lot size, total living area, the number of bedrooms and bathrooms, and the dummy variables for fireplace, storeys and age less than 10 years old are all significant at the 1 percent level. These estimated signs agree with previous

---

[10] The adjusted R^2 is used to report the goodness of fit for all five regressions in this paper as no two regressions have the same number of variables.

[11] However, when Ferrara et al. (2007) applied the spatial lag model, the coefficient for distance to the central business district was no longer reported as significant. Ferrara et al. (2007) attributed this to the fact that the majority of houses are located within 4 kilometres of Sydney's downtown core. It is unlikely that the same would be true for the City of Kingston, as the City is geographically more dispersed than Sydney with many living away from the downtown core.

findings reported in Neupane and Gustavson (2008) and Ferrara et al. (2007). The coefficients that are not found to be statistically significant are for the dummy variables indicating the presence of a garage and whether the house is between age 11-25 and age 26-50.

Next, Regression 2 (Table 6) presents the main regression model of the paper and includes the complete set of variables described above. Again, a White test was conducted to confirm for heteroskedasticity and Huber-White standard errors were substituted for Regression 2 and included in Table 6.

The model explains approximately 85 percent of the variance in house sale price, a large increase in comparison to the previous regression, which explained approximately 63 percent of the variance in the sale price of houses suggesting that the additional variables have been appropriately included in the model. Again, the coefficients for variables of distance from both the Davis Tannery site (natural log) and the downtown core (linear) are significant at the 1 percent level and have the expected signs. The non-linear relationship between distance from the site and house sale price is shown in Table 7. At one kilometre away from the site, the increase in house sale price is 22,429 dollars to move an additional kilometre from site, while the increase in house sale price at 3 kilometres from the site is 9,309 dollars to move an additional kilometre away. The average price of a house in the sample is 198,818 dollars. This non-linear relationship between sale price and distance from site implies that homes closest to the site are more directly impacted by the negative externality of the site than those farther away.

These findings are consistent, although somewhat higher than those in previous studies such as (Farber, 1998), which reported that price-distance gradient premiums range from approximately 3,372 dollars and 16,867 dollars per kilometre with an average value change of 3,937 dollars per kilometre. Although these results represent the influence of contaminated sites that have varying types and concentrations of contaminants than the Davis Tannery site, as each contaminated site has unique characteristics, previous studies provide some guidance in interpreting whether estimated coefficients provide reasonable results. Neupane and Gustavson (2008) also note that the influence of contaminated sites on house sale price cannot be determined by the contamination type and concentration alone, but is also influenced by other factors such as the visual aesthetics of a site. Therefore, the effect of a contaminated site on house sale price will change depending on the site and its unique characteristics than contamination alone.

One important change from Regression 1 pertains to the magnitudes of the estimated coefficients of these variables. Upon the inclusion of more variables, the coefficient for distance from the tannery site variable is reduced from 98,207 to 32,359. Likewise, the coefficient for distance to downtown increases from -43,187 to -17,576. These changes could be due to the inclusion of tax variable representing neighbourhood effects. If so, the coefficient reduction would be a similar result to Ferrara et al. (2007), which found that when accounting for spatial effects, the coefficient value was reduced for the distance from site variable. These results also highlight the importance of the additional control in estimating the effect of distance on house sale price. This discussion is explored further in the section on Regression 4.

The coefficients for the qualitative variables "high quality" and "rushing" are significant at the 1 percent level and 5 percent level, respectively and are reported with the expected signs. On average, the inclusion of high quality keywords increases sale price by 21,841 dollars. The appearance of rushing comments in a house listing reduces house sale price by 5,621 dollars on average. The coefficient for the low quality variable reported the expected negative sign, but is not statistically significant. These results suggest that the MLS listing comments chosen to represent whether a house property is of high quality is representative of the physical condition of the house. The results reported above determine that the physical condition of the house substantially influences house sale price. The coefficient for the rushing value suggests that buyers are able to purchase a property for less, all else equal, than if the seller does not attempt to rush the buyers through keywords such as "hurry" or "this won't last".[12] This is reasonable as these comments imply to buyers that the seller may be willing to accept an offer that is less because of their desire to sell the property quickly.

The coefficient for the year dummy variable is significant at the 5 percent level and reports a sign that suggests that all else equal, house sale prices were lower in 2004 than in 2005. This result is in line with evidence from Statistics Canada's New Housing Price Index report published in January 2005 (Statistics Canada, 2005), which states that favourable market conditions in combination with higher costs of construction materials and labour and increased land values caused house sale prices to increase from January 2004 to January 2005.

[12] Keywords that induce the buyer to rush to buy a property, such as "don't delay" and "this won't last" are included in this category. I am assuming that buyers will interpret these statements as though the property is priced lower than expected and is therefore a bargain. In this case, these keywords would be expected to decrease the sale price.

Results determine that the tax variable have substantial influence on the sale price of a house. The coefficient for the tax value reports a positive sign and is highly significant at the 1 percent level. Results suggest that on average, an increase in property tax of 100 dollars increases the house sale price by 6,964 dollars. This is reasonable as the tax value is based on its assessed value and the assessed value of similar neighbouring properties (MPAC, 2010). Therefore, a larger tax value of a house suggests the market price of the house should also be higher than average.

The coefficient for the tenant and vacant occupancy variables report negative signs as expected and are both significant at the 5 percent level or less. These results indicate that on average, allowing buyers to know whether a house is tenant occupied or vacant reduces the sale price of a house by approximately 11,227 dollars and 6,653 dollars, respectively.

The coefficients for total living area, the number of bedrooms and the dummy variables for the presence of two-storeys, hardwood floors, and a deck or patio are significant at the 5 percent level or less. The result that on average, the addition of an extra square foot of living space increases the sale price by approximately 14 dollars is similar to findings in other papers (Rahmation, 1992). Likewise, the effect that an addition of another bedroom increases sale price by 4,364 dollars on average is consistent with past studies (Palmquist, 1997, Ferrara et al., 2007). The presence of a two-storey home increases sale price by 11,249 dollars on average. The presence of hardwood floors, and a deck or patio both have relatively large effects on sale price, increasing the sale price by 9,024 dollars and 5,085 dollars, respectively. The coefficient for age less than 10 years old is significant at the 1 percent level and suggests that a home less than ten years old has a higher sale price by 22,598 dollars on average than a home older than 50 years old. The coefficient for age 11-25 years old was significant at the 10 percent level and suggests that a home this age commands a higher sale price than a home older than 50 years by 5,662 dollars on average. The coefficient for spring is significant at the 10 percent level and indicates that a home sold in the spring results in a higher sale price by 5,061 dollars than a home sold in the autumn, which is consistent with assumptions. The coefficients for the number of bathrooms, age 26-50 years old, lot size and dummy variables for central air conditioning, fireplace, pool, and winter and summer seasons all reported expected signs; however are all statistically insignificant.

In Regression 3, all variables were included with the exception of the three qualitative variables in order to observe their effects on house sale price and on other explanatory variables. The coefficients for these variables are reported in Table 6. A White test confirmed that the null hypothesis of homoskedastic standard errors should be rejected. Huber-White standard errors were obtained and are reported with coefficient results. The results from the White test are shown in Table 5.

The model explains approximately 84 percent of the variance in house sale price, which is slightly less than the fit in Regression 2. The distance coefficients are not substantially influenced by the exclusion of the qualitative variables; however, some of the variables described below are affected. First, the coefficient for the year dummy variable increased by over 1,500 dollars and changed significance from the 5 percent level to the 10 percent level. Second, the coefficients for tenant and vacant occupancy variables decreased by approximately 3,140 dollars and 1,817 dollars, respectively and the vacant occupancy became significant at the 1 percent level. This is result is consistent with logic as tenant or vacant occupied homes may be of lower quality than owner occupied homes, which was indicated through the low quality qualitative variable. Without the inclusion of this variable in the model, the influence of the physical state of the home on the sale price was captured through the low quality variable rather than the occupancy variables. The coefficient for a house being less than 10 years old remains significant at the 1 percent level and suggests that a home that is less than 10 years old is approximately 25,393 dollars more than a home older than 50 years. This also is consistent with assumptions because without the high quality variable to capture the effect of renovated and modern homes on sale price, the age of the home likely captures some of the influence instead. Coefficients for the number of bedrooms and bathrooms and the dummy variable for the presence of natural gas also changed slightly and became more significant.

In the final regression performed (Regression 4), all variables with the exception of the tax variable was included to observe the influence tax has on house sale price and on other explanatory variables by comparing results to those in the main regression (Regression 2). The coefficients for Regression 4 are shown in Table 6. Huber-White standard errors were obtained following the rejection homoskedasticity in the standard errors based on a White test. Results from this test are reported in Table 5.

The model explains approximately 66 percent of the variance in house sale price, much less than the goodness of fit reported in Regression 2. This suggests that the tax variable does substantially improve the ability of the model to explain the variance in house sale price. Interestingly, most coefficient values and their significance were impacted by the exclusion of the tax variable. Firstly, the coefficient for the distance from the Davis Tannery site reported an increase from 32,359 in Regression 2 to 94,845 in Regression 4. This coefficient suggests that at one kilometre away from the site, the increase in sale price is 65,742 dollars to move an additional kilometre from site, while the increase in sale price at 3 kilometres from site is 27,285 dollars to move an additional kilometre from site. Similarly, the coefficient for the distance from the downtown core increased suggesting that house sale price decreases by 41,489 dollars per kilometre increase away from downtown. Both distance coefficients remained significant at the 1 percent level.

These findings are again consistent with those in Ferrara et al. (2007). When spatial effects are not considered, the model inflates the coefficient values suggesting that these characteristics have more influence on house price than they appear to when spatial effects are accounted for. This is especially the case when the tax variable is excluded from the model. It is reasonable that the physical characteristics of the house and property capture some of the influence that the tax variable was having on sale price since houses built in the same neighbourhood tend to have many of the same physical characteristics (Basu, 1998).

Secondly, excluding the tax variable from the model increased the significance and/or changed the magnitude of the following variables: high quality, rushing, year, tenant, vacant, age less than 10 years old, age 26-50 years old, lot size, total living area, bedroom, bathroom, storeys, hardwood floors, fireplace, and pool.

To assess the impact of the Davis Tannery site on the total property value of the community, the average change in value was calculated using the distance from site coefficient from Regression 2. Similar to Ferrara et al. (2007), each dwelling in the sample is valued at its actual location and at 8.46 kilometres from the site using the estimated model (the maximum distance in the sample an observation is located from the Davis Tannery site is 8.46 kilometres). The average of the difference in sale price between distances reflects the average household's willingness-to-pay for the clean-up of the site and is calculated to be 44,372 dollars. Multiplying this average change in value by the number of the 7,970 dwellings the sample (Statistics Canada, 2010) results in the City of Kingston's total willingness-to-pay for the clean-up of the Davis Tannery site to be approximately 353.6 million dollars. This information is summarized in Table 8. The populations for each real estate district and neighbourhood are shown in Table 1.

These results are similar to those found in Ferrara et al. (2007), which determined the total impact of the Tar Ponds on the City of Sydney to be 169.2 million dollars (2005 dollars) when accounting for spatial effects. Additionally, Kiel and Zabel (2001) estimated that benefits range between 133.2 million and 227.6 million (2005 dollars) for the clean-up of two Superfund sites in Woburn, Massachusetts which are contaminated with volatile organic compounds (VOCs) and PCBs.[13] Based on the calculations above,

---

[13] Contaminated sites in the United States are designated as Superfund sites based on the impact the site has on local residents and the environment determined in a hazardous ranking system (Kiel and Zabel, 2001).

the results suggest that any research and clean-up projects undertaken at the Davis Tannery site and the Inner Harbour should be completed for less than 353.6 million dollars to ensure a net benefit to the community. However, it should be noted that this value is likely an over-estimate of the total willingness-to-pay as it does not account for the second stage analysis of the hedonic pricing method to control for individual household preferences and socio-economic status. Future work should include this analysis; however, it is beyond the scope of this paper.

Policy Implications

The hedonic pricing method to determine the total direct impact of contaminated sites on a community is important for both research purposes and for policy-makers deciding on clean-up efforts (Palmquist, 1992). As Brasington and Hite (2005) argue, it is helpful for governments and communities to know how residents are being affected by changes in contaminated sites because often government resources are being used to at least partially fund clean-up efforts. Palmquist (1992) adds that understanding a community's willingness-to-pay for an improvement in their environmental quality is an important element when designing policies.

The true benefits of remediation would be far larger than those estimated by hedonic pricing methods because of indirect benefits excluded from the analysis (Ferrara et al., 2007). Some of these unknown benefits may include increased enjoyment of the area by residents in Kingston that live outside the neighbourhoods that suffer the direct impacts of the Davis Tannery site or by visitors of the city, increased tourism and use of the area by future employers. The combination of these unknown indirect benefits would likely cause total community benefits from a contaminated site clean-up to be greater than the estimate provided using the hedonic analysis (Ferrara et al, 2007). Neupane and Gustavson (2008) agree, stating that hedonic estimates require careful interpretation because calculation are only based on direct impacts of a site through property value effects to measure potential welfare gains.

Other limitations of the hedonic price method are discussed by Neupane and Gustavson (2008) and include the exclusion of commercial and public property values from the analysis and benefits that may not be realized until the completion of a clean-up project. Due to these limitations and difficulty applying the second-stage analysis of the hedonic model, estimates from this method will tend to be an underestimate of potential social welfare gains (Neupane et al., 2008).

CONCLUSION

This study presents hedonic estimates of the City of Kingston's willingness-to-pay for the environmental remediation of the Davis Tannery site based on house sale prices. A variety of regression models were estimated to account for neighbourhood effects on the sale price of houses, as well as adding qualitative variables representing the condition of the house and the seller's preference to sell quickly into the model.

The inclusion of neighbourhood variables to account for spatial autocorrelation between house sale prices significantly altered the results of many of the variable coefficients, including those for the distance variables for the Davis Tannery site and the downtown core. Simply adding the tax variable to the model deflates the distance from site coefficient leading to a more accurate result of price-distance premiums based on previous findings in the literature. Similarly, the addition of the three qualitative variables for high quality, low quality and rushing reduced the influence of many of the physical characteristics of the home, as well as the occupancy status of the home on house sale price.

In addition, a non-linear price-distance gradient was assumed. For example, in Regression 2, a home located at 2 kilometres from the Davis Tannery site was estimated to be worth approximately 22,429 dollars more than the same home located 1 kilometre from the site. This price-distance premium decreases to 9,309 dollars when comparing a home located at 4 kilometres from the site rather than 3 kilometres. This determines that homes closer to the site will increase in value more than homes located farther from the site. Ferrara et al. (2007) state that previous studies have found that following remediation, house sale prices do recover to some extent.

Using the results from Regression 2, the City of Kingston's willingness-to-pay for the remediation of the Davis Tannery site was measured. The total impact of the site based on these calculations was estimated to be 353.6 million dollars. Although there are currently no proposed clean-up options available, this figure is likely sufficiently substantial to justify some clean-up of site as this amount is close to some of the costs for proposed clean-up options for the Sydney Tar Ponds, a contaminated site that is much larger in size compared to the Davis Tannery site. This is more likely to be true once indirect benefits of the clean-up are considered.

Although there are limitations to the hedonic pricing model; overall, it provides reasonable estimates of the impact of contaminated sites on property values and estimating the benefits associated with the clean-ups of these sites are important elements in policy design.

REFERENCES

Anselin, L. (1988) *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer Academic.

Basu, S. and T.G. Thibodeau (1998) "Analysis of Spatial Autocorrelation in House Prices," *Journal of Real Estate Finance and Economics* 17(1):61-85.

Blancher, PJ. (1984) *Natural Resource Description and Management Considerations*, Cataraqui Marsh–Rideau Canal. Cornwall, (ON): Parks Canada, Regional Office.

Boardman, Anthony, David Greenberg, Aidan Vining, David Weimer, *Cost-Benefit Analysis: Concepts and Practice*, 2nd ed. (Prentice Hall, 2001), ch. 13 subsection "Hedonic Price Method," pp.339-344.

Brasington, David M. and Diane Hite (2005) "Demand for environmental quality: a spatial hedonic analysis," *Regional Science and Urban Economics* 35:57-82.

Canadian Council of Ministers of the Environment (1999) "Canadian sediment quality guidelines for the protection of aquatic life: Mercury," *Canadian environmental quality guidelines*.

Canadian Council of Ministers of the Environment (1999) "Canadian soil quality guidelines for the protection of environmental and human health: Mercury (inorganic)," *Canadian environmental quality guidelines*.

City of Kingston (2006) *City of Kingston Community Improvement Plan: Brownfield Project Areas 1A and 1B*, Prepared by the Planning and Development Department, Community Development Services, City of Kingston.

ECO Canada (2007) *Who will do the cleanup? Canadian Labour Requirements for Remediation and Reclamation of Contaminated Sites 2006–2009*, Environmental Labour Market (ELM) Research, Environmental Careers Organization Canada.

Espinoza, Eugenio (2009) "Valuing Environmental Characteristics in Urban Slums. A Spatial Hedonic Approach for Chilean Cities," Fifth Urban Research Symposium, Marseille, France.

Farber, Stephen (1998) "Undesirable Facilities and Property Values: A Summary of Empirical Studies," *Ecological Economics* 24(1):1-14.

Ferrara, Ida, Stephen McComb, Paul Missios (2007) "Local Willingness-to-Pay Estimates for the Remediation of the Sydney Tar Ponds in Nova Scotia," *Canadian Public Policy* 33(4):441-456.

Freeman, Myrick, *The Measurement of Environmental and Resource Values: Theory and Methods*, 2nd ed. (Resource for the Future, 2003), ch. 11 subsection 'Property Value Models," pp.353-397.

Government of Ontario (2007) *A Practical Guide to Brownfield Redevelopment*, Prepared by the Ministry of Municipal Affairs and Housing, Queen's Printer Press.

Hunt, Len M., P. Boxall, J. Englin, W. Haider (2005) "Remote tourism and forest management: a spatial hedonic analysis," *Ecological Economics* 53:101-113.

Ketkar, Kusum (1992) "Hazardous waste sites and property values in the state of New Jersey," *Applied Economics* 24:647-659.

Kiel, Katherine and Jeffrey Zabel (2001) "Estimating the Economic Benefits of Cleaning Up Superfund Sites: The Case of Woburn, Massachusetts," *Journal of Real Estate Finance and Economics* 22(2/3):163-184.

Kingston Environmental Advisory Forum (KEAF) (2002), Towards a Sustainable Future, KEAF's Progress Report #2 to City Council.

Kohlhase, J.E. (1991) "The Impact of Toxic Waste Sites on Housing Values," Journal of Urban Economics 30(1):1-26.

Mallios, Z., A. Papageorgiou, D. Latinopoulos, P. Latinopoulos (2009) "Spatial Hedonic Pricing Models for the Valuation of Irrigation Water," *Global NEST Journal* 11(4):575-582.

Manion, N.C., L. Campbell, A. Rutter (2010) "Historic Brownfields and industrial activity in Kingston, Ontario: Assessing potential contributions to mercury contamination in sediment of the Cataraqui River," *Science of the Total Environment* 408:2060-2067.

Municipal Property Assessment Corporation (MPAC) (2010) "How MPAC Assesses Property" URL: http://mpac.ca (July 28 2010).

Netusil, Noelwah, Sudip Chattopadhyay, Kent Kovacs (2010) "Estimating the Demand for Tree Canopy: A Second-Stage Hedonic Price Analysis in Portland, Oregon," *Land Economics* 86(2):281-293.

Neupane, Anish and Kent Gustavson (2008) "Urban property values and contaminated sites: A hedonic analysis of Sydney, Nova Scotia," *Journal of Environmental Management* 88:1212-1220.

Palmquist, Raymond and Adis Israngkura (1999) "Valuing Air Quality with Hedonic and Discrete Choice Models," *American Journal of Agricultural Economics* 81(5):1128-1133.

Palmquist, Raymond, Fritz Roka, Tomislav Vukina (1997) “Hog Operations, Environmental Effects, and Residential Property Values,” *Land Economics* 73(1):114-124.

Palmquist, Raymond (1992) “Valuing Localized Externalities,” *Journal of Urban Economics* 31:59-68.

Palmquist, Raymond, Measuring the Demand for Environmental Quality, (North Holland, 1991), subsection “Hedonic Methods”, pp.77-120.

Thayer, Mark, Heidi Albers, and Morteza Rahmation (1992), "The benefits of reducing exposure to waste disposal sites," *The Review of Economics and Statistics*, 7:265-282.

Ridker, Ronald G., and John A. Henning (1967) “The Determinants of Residential Property Values with Special Reference to Air Pollution,” *Review of Economics and Statistics* 49(2):246-257.

Rosen, S. (1974) “Hedonic Price and Implicit Markets: Product Differentiation in Pure Competition,” *Journal of Political Economy* 82(1):34-55.

Statistics Canada (2005) “New Housing Price Index (March 9 2005)” URL: http://www.statcan.gc.ca/dai-quo/index-eng.htm (July 28 2010).

Statistics Canada (2010) “Population and Dwelling Count” URL: http://www12.statcan.ca/census-recensement/2006/dp-pd/hlt/97-550/Index.cfm?Page=INDX&LANG=Eng (July 28 2010).

Stokes, Pamela (1977) *A survey of heavy metals in soils, water and vegetation from the Davis Tannery, Kingston, Ontario,* Prepared for the City of Kingston, Ontario.

Welbourn, Pamela, Joseph Davis, Harry Cleghorn and Steven Rose (editors) (2009) *The Story of Brownfields and Smart Growth in Kingston Ontario: From Contamination to Revitalization*, Classroom Complete Press.

APPENDIX A: TABLES

TABLE 1: KINGSTON REAL ESTATE DISTRICTS INCLUDED IN SAMPLE

District	District Name	Neighbourhoods	No. of Dwellings (single-detached)	District Area (Km^2)
14	City Central East	Sydenham	80	4.2
		Queen's	125	
		Alwington	315	
		Sunnyside	1305	
18	City Central West	Kingston Penitentiary	n/a	2.3
		Portsmouth	490	
		Calvin Park	580	
		Fairway Hills	250	
		Polson Park	275	
22	East Sir John A Boulevard	Inner Harbour	685	11.8
		Williamsville	320	
		Kingscourt	995	
		Rideau Heights*	380	
		Collins Bay Penitentiary	n/a	
23	Rideau	Rideau Heights*	380	2.9
		Markers Acres	555	
25	West Sir John A Boulevard	Strathcona Park	825	12.9
		Balsam Grove/Grenville	260	
		Cataraqui North	530	
Total Number of Dwellings			7970	

Note: Neighbourhoods obtained from City of Kingston Maps and approximate area size calculated using Google Earth. Number of dwellings obtained from Statistics Profile for City of Kingston based on 2006 Census by Statistics Canada.
*Rideau Heights is split between Districts 22 and 23. The dwelling count was only included once in calculations.
Source: KAREA and author's compilation.

TABLE 2: VARIABLE DEFINITIONS

Variable	Description
Dependent	
Sale Price	Home sales price in 2005 dollars
Independent	
Distance to Site	The minimum distance to the Davis Tannery site in kilometres
Distance to Downtown	The minimum distance to the downtown core in kilometres
High Quality	Indicator for high quality keywords in listing comments, 1= yes 0=no
Average Quality	Indicator for average quality home. Baseline category.
Low Quality	Indicator for low quality keywords in listing comments, 1= yes 0=no
Rushing	Indicator for whether vendor is rushing to sell, 1= yes 0=no
Year	Indicator of the year home was sold, 1=2004 0=2005
Tax	Most recent tax paid on property in 2005 dollars (if provided)
Tax Listed	Indicator for whether a tax value was listed, 1=no 0=yes
Tenant	Indicator for whether home is tenant occupied, 1=yes 0=no
Vacant	Indicator for whether home is vacant, 1=yes 0=no
Age 0-10	Indicator for whether home is between 0 and 10 years old, 1=yes 0=no
Age 11-25	Indicator for whether home is between 11 and 25 years old, 1=yes 0=no
Age 26-50	Indicator for whether home is between 26 and 50 years old, 1=yes 0=no
Age 50+	Home is greater than 50 years old. Baseline category.
Age Listed	Indicator for whether age of home was listed, 1=no 0=yes
Lot Size	Lot size of home in square feet (if provided)
Lot Size Listed	Indicator for whether lot size of home was listed, 1=no 0=yes
Total Living Area	Total living area of home in square feet (if provided)
Total Living Area Listed	Indicator for whether total living area of home was listed, 1=no 0=yes
Bedrooms	Number of bedrooms in home
Bathrooms	Number of bathrooms in home
Storeys	Indicator for two storey style or larger, 1=yes 0=no
Garage	Indicator for a garage, 1=yes 0=no
Natural Gas	Indicator for natural gas in heating system, 1= yes 0=no
Central A/C	Indicator for central air conditioning, 1= yes 0=no
Hardwood Floors	Indicator for hardwood flooring, 1= yes 0=no
Fireplace	Indicator for a fireplace, 1= yes 0=no
Pool	Indicator for a pool, 1= yes 0=no
Deck or Patio	Indicator for a deck or patio, 1= yes 0=no
Fall	Indicator for home sold between September and December. Baseline category.
Winter	Indicator for home sold between January and March, 1=yes 0=no
Spring	Indicator for home sold between April and June, 1=yes 0=no
Summer	Indicator for home sold between July and August, 1=yes 0=no

Source: Author's compilation.

TABLE 3: DESCRIPTIVE STATISTICS

Variable	Mean	Standard Deviation	Min/Max
Sale Price	198818	95499.68	11788/975000
Distance to Site	2.41	1.04	0.23/8.46
Distance to Downtown	2.35	1.18	0.23/7.83
High Quality	0.23	0.42	0/1
Average Quality	0.71	0.46	0/1
Low Quality	0.08	0.27	0/1
Rushing	0.10	0.31	0/1
Year	0.51	0.50	0/1
Tax	2293	979.23	0/9197
Tax Listed	0.01	0.12	0/1
Tenant	0.11	0.31	0/1
Vacant	0.12	0.33	0/1
Age 0-10	0.04	0.21	0/1
Age 11-25	0.07	0.25	0/1
Age 26-50	0.29	0.45	0/1
Age 50+	0.04	0.21	0/1
Age Listed	0.14	0.35	0/1
Lot Size	5161	2892.06	0/38870
Lot Size Listed	0.03	0.16	0/1
Total Living Area	742	812.76	0/6050
Total Living Area Listed	0.47	0.50	0/1
Bedrooms	3.42	1.13	1/10
Bathrooms	1.81	0.75	1/9
Storeys	0.36	0.48	0/1
Garage	0.45	0.50	0/1
Natural Gas	0.60	0.49	0/1
Central A/C	0.23	0.42	0/1
Hardwood Floors	0.51	0.50	0/1
Fireplace	0.29	0.45	0/1
Pool	0.03	0.17	0/1
Deck or Patio	0.38	0.49	0/1
Fall	0.26	0.44	0/1
Winter	0.24	0.42	0/1
Spring	0.32	0.47	0/1
Summer	0.18	0.39	0/1

Source: Author's compilation.

TABLE 4: QUALITATIVE VARIABLE KEYWORDS

High Quality	Low Quality	Rushing
Completely renovated	Needs someone who knows	Priced to sell
Extensively updated	renovation and construction	Low, low price
Custom built	Renovator's project	Absentee owner wants an
Pride of ownership	Cosmetics needed	offer
Well-finished	Needs TLC	Seller anxious
Attention to detail	Needs work	Vacant for immediate
White glove treatment	Needs modernizing	possession
Modern	Needs updating	Immediate possession
Excellent condition	Currently under construction	available or preferred
Immaculate condition	Potential for handyman	Great value
Mint condition	Dated	Priced for quick sale
Too many upgrades to list	Oldie	Unbeatable value
One of Kingston's finest	Sold as is; no warranties	Must be sold
homes	Excellent potential for first	Don't delay
Sensational	time buyers	This won't last
Quality construction	Starter home	Hurry
Move-in condition	Opportunity	-
-	Good potential	-

Note: Keywords were used to categorize property listings at the author's discretion.
Source: Author's compilation.

TABLE 5: WHITE TEST

	Test Statistics	P-Value
Regression 1	617.24	0.00
Regression 2	791.60	0.00
Regression 3	686.66	0.00
Regression 4	745.95	0.00

Source: Author's compilation.

TABLE 6: ESTIMATED COEFFICIENTS OF REGRESSIONS

Variable	Coefficient			
	Regression 1 Control Variables	Regression 2 Main Regression	Regression 3 Excl. Qual. Var.	Regression 4 Exc. Tax Var.
Distance to Site	98,207.23	32,358.64	32,765.75	94,845.35
(Natural Log)	(5,754.32)***	(4,711.97)***	(4,865.58)***	(5,712.43)***
Distance to	-43,186.69	-17,575.76	-18,089.77	-41,489.11
Downtown	(3,382.16)***	(2,133.67)***	(2,176.21)***	(3,286.01)***
High Quality	-	21,840.98	-	25,978.45
		(2,932.18)***		(4,434.97)***
Low Quality	-	-5,620.63	-	-1,022.47
		(4,329.89)		(6,850.55)
Rushing	-	-7,972.10	-	-10,975.54
		(3,337.54)**		(4,898.72)**
Year	-	-6,447.43	-4,868.25	-16,013.97
		(2,536.21)**	(2,632.25)*	(3,805.13)***
Tax	-	69.64	70.27	-
		(4.10)***	(4.16)***	
Tenant	-	-11,226.66	-14,366.04	-16,298.91
		(3,882.89)***	(3,973.52)***	(6,201.29)***
Vacant	-	-6,652.93	-8,470.09	-9,221.68
		(3,085.7)**	(3,232.00)***	(4,328.59)**
Age 0-10	65,416.17	22,598.12	25,392.68	66,618.22
	(9,777.20)***	(7,843.95)***	(8,019.02)***	(9,253.71)***
Age 11-25	8,469.99	1,118.74	131.64	1,814.49
	(8,766.35)	(6,911.17)	(7,089.69)	(8,751.62)
Age 26-50	-6,167.63	-5,661.99	-5,295.17	-9,859.71
	(4,590.38)	(3,105.76)*	(3,236.26)	(4,666.78)**
Lot Size	3.68	0.16	0.20	3.40
	(1.36)***	(0.51)	(0.55)	(1.22)***
Total Living Area	55.59	14.26	15.40	52.57
	(14.00)***	(6.62)**	(7.01)**	(13.03)***

Bedrooms	5,773.84	4,364.34	3,658.17	12,610.51
	(1,971.11)***	(1,537.05)***	(1,595.60)**	(2,287.44)***
Bathrooms	29,228.67	5,773.84	7,125.18	25,939.00
	(8,228.15)***	(3,610.26)	(3,757.52)*	(7,507.09)***
Storeys	14,637.70	11,248.60	11,424.17	15,113.17
	(4,704.90)***	(2,872.94)***	(3,028.93)***	(4,509.52)***
Garage	3,707.29	-	-	-
	(3,644.48)			
Natural Gas	-	3,615.42	5,117.82	3,727.36
		(2,506.19)	(2,556.41)**	(3,872.95)
Central A/C	-	-1,914.41	-766.64	4,257.91
		(2,848.65)	(2,951.62)	(4,171.78)
Hardwood Floors	-	9,023.87	8,853.54	13,439.65
		(2,636.61)***	(2,705.27)***	(3,498.49)***
Fireplace	23,106.63	3,014.17	3,970.92	15,351.74
	(4,853.74)***	(3,133.91)	(3,198.14)	(4,663.86)***
Pool	-	1,067.37	-699.80	7,396.01
		(9,927.00)	(10,006.52)	(11,892.75)
Deck or Patio	-	5,085.09	5,913.42	4,340.17
		(2,528.16)**	(2,599.05)**	(3,718.86)
Winter	-	2,001.46	2,298.76	-1,635.35
		(3,145.64)	(3,280.58)	(4,656.23)
Spring	-	5,061.23	5,797.79	6,959.22
		(2,939.70)*	(3,093.93)*	(4,591.78)
Summer	-	2,776.95	3,684.54	1,561.55
		(3,193.80)	(3,314.99)	(4,682.15)
Constant	30,643.92	-7,056.61	-8,127.40	25,638.56
	(15,012.01)**	(9,020.12)	(9,264.74)	(14,146.28)*
Adjusted R^2	0.63	0.85	0.84	0.66
N	1,067	1,067	1,067	1,067

Notes: Huber-White standard errors in parentheses.
* denotes significance at the 10 percent level, **significance at the 5 percent level, and ***significance at the 1 percent level.
Source: Author's compilation.

TABLE 7: CHANGE IN SALE PRICE PER KILOMETRE INCREASE FROM SITE

Distance Range (Km)	Change in Sale Price (2005 $)			
	Regression 1	Regression 2	Regression 3	Regression 4
0.23 – 1.23	164,663.09	54,255.41	54,938.01	159,026.26
1 – 2	68,072.06	22,429.30	22,711.49	65,741.79
2 – 3	39,819.61	13,120.30	13,285.37	38,456.48
3 – 4	28,252.46	9,309.00	9,426.12	27,285.31
4 – 5	21,914.31	7,220.62	7,311.47	21,164.13
5 – 6	17,905.30	5,899.68	5,973.90	17,292.35
6 – 7	15,138.71	4,988.11	5,050.86	14,620.48
7 – 8	13,113.75	4,320.89	4,375.26	12,664.83
8 – 9	11,567.15	3,811.30	3,859.25	11,171.17

Note: The distance of the closest observation to site (0.23 kilometres) was used instead of the range 0 to 1 kilometre to avoid an extremely large value for the change in sale price. The change in sale price per kilometre increase from site was calculated using the following equation: $\beta_D(\ln(d+1) - \ln(d))$, where d represents the distance of the house from the tannery site. This equation represents the area beneath the sale price–distance curve.

Source: Author's compilation.

TABLE 8: COMMUNITY BENEFITS DERIVED FROM TOTAL PROPERTY PRICE IMPACTS

Model	Coefficient	Average Change in Value (2005 $)	Community Change in Value (2005 $)
OLS (Regression 2)	32,358.64	44,371.54	353,641,205.56

Source: Author's compilation.

APPENDIX B: FIGURES

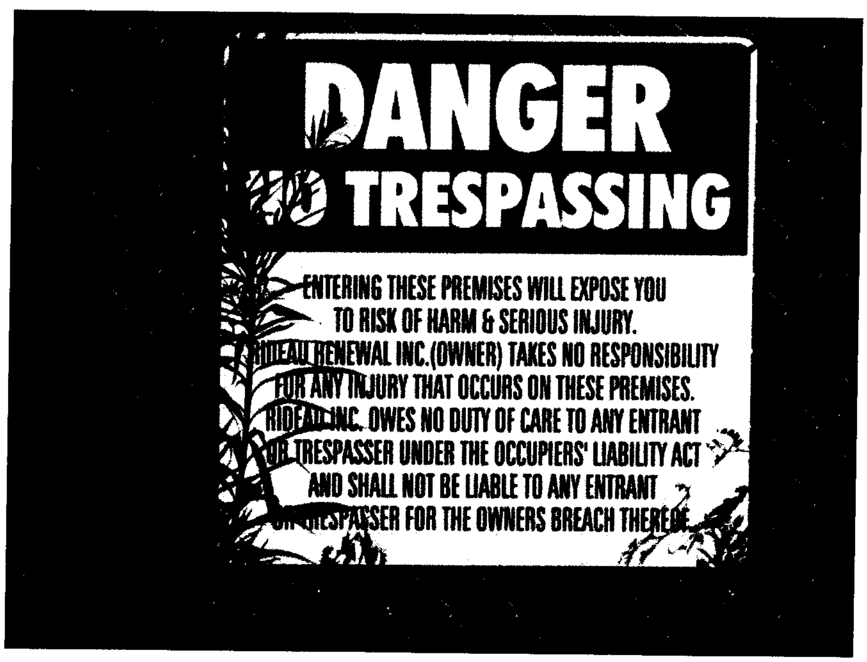
FIGURE 1: MAP OF DAVIS TANNERY SITE AND SURROUNDING AREA, KINGSTON, ONTARIO

Source: Google Earth 2010

FIGURE 2: PHOTO OF DAVIS TANNERY BROWNFIELD FACING EAST

Source: Author

FIGURE 3: PHOTO OF WARNING SIGN POSTED AT THE DAVIS TANNERY BROWNFIELD



Source: Author