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Multiple approaches to valuation of conservation design and low-impact development features in residential subdivisions

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ABSTRACT

Residents, developers and civic officials are often faced with difficult decisions about appropriate land uses in and around metropolitan boundaries. Urban expansion brings with it the potential for negative environmental impacts, but there are alternatives, such as conservation subdivision design (CSD) or low-impact development (LID), which offer the possibility of mitigating some of these effects at the development site. Many urban planning jurisdictions across the Midwest do not currently have any examples of these designs and lack information to identify public support or barriers to use of these methods. This is a case study examining consumer value for conservation and low-impact design features in one housing market by using four different valuation techniques to estimate residents' willingness to pay for CSD and LID features in residential subdivisions.

A contingent valuation survey of 1804 residents in Ames, IA assessed familiarity with and perceptions of subdivision development and used an ordered value approach to estimate willingness to pay for CSD and LID features. A majority of residents were not familiar with CSD or LID practices. Residents indicated a willingness to pay for most CSD and LID features with the exception of clustered housing. Gender, age, income, familiarity with LID practices, perceptions of attractiveness of features and the perceived effect of CSD and LID features on ease of future home sales were important factors influencing residents' willingness to pay. A hypothetical referendum measured willingness to pay for tax-funded conservation land purchases and estimated that a property tax of around $50 would be the maximum increase that would pass.

Twenty-seven survey respondents participated in a subsequent series of experimental real estate negotiations that used an experimental auction mechanism to estimate willingness to pay for CSD and LID features. Participants indicated that clustered housing (with interspersed preserved forest or open space areas), rain gardens, and neighborhood streams with a forested buffer were the features they were most willing to pay for. Participants were not willing to pay for neighborhood streams without buffers.

Finally, a spatial hedonic price model using 2093 homes in Ames, IA was used to estimate the effect of public and private open space on housing values. The model indicated that presence of neighborhood association-owned forest and water features as well as proximity to public parks had significant positive effects on housing prices. However, proximity to a public lake had a negative effect on home values.

The four methods used in this study include both stated and revealed preference techniques. Although the relative magnitude of value expressed varied, all methods indicated that residents value CSD and LID subdivision features. Subdivision features that included explicit environmental benefits were also consistently preferred over features that did not. Familiarity with alternative designs was an important factor influencing resident willingness to pay for neighborhood features, and developers and civic officials should consider ways to educate citizens about CSD and LID development techniques to increase interest in these designs.

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1. Introduction

Developers and civic officials face difficult choices in deciding appropriate land uses as city populations expand and urbanization changes how land is used in and around metropolitan boundaries.

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Often these parties are pitted against one another in debates over the environmental impacts of development decisions forcing choices between conservation or utilization of land resources. New alternative designs for residential development, such as conservation subdivisions or low-impact development, offer the possibility of addressing this by focusing on the purposeful identification, protection and integration of important natural resources on a development site. Such approaches could generate "win–win" outcomes as enhanced ecological functionality in urban contexts can add both private and public value, lower social and infrastructural costs, and support long-term economic development. However, many municipalities across the Midwest do not currently have any examples of conservation design and the lack of community-derived market information to identify possible support for or barriers to the application of these methods prevents more robust decisions for local land use policy from being made. This exploratory research uses both stated and revealed valuation methods to examine consumer value for conservation and low-impact design.

1.1. Conservation subdivision design and low-impact development

Advocacy for conservation in residential development as a way to preserve important ecological areas for communal benefit has a long history tracing its roots from Howard (1902) through Arendt (1999, 2004) and Arendt et al. (1996). Conservation subdivision design (CSD) can maintain overall housing density while preserving large areas of land for ecological and aesthetic benefits by decreasing lot sizes and clustering lots away from protected open spaces (Arendt et al., 1996; Arendt, 1999). Despite the potential benefits, conservation subdivision design use is limited in the Midwest (Bowman and Thompson, 2009; Crick and Prokopy, 2009; Miller et al., 2009). Further, when implemented, typically a limited array of conservation features is included (Crick and Prokopy, 2009). The rarity of "true" conservation subdivision designs has led to criticism about their effectiveness (Milder, 2007; Milder et al., 2008). For example, some previous studies have shown little improvement over standard design practices in terms of biodiversity conservation (Lenth et al., 2006). Certainly the benefits of conservation subdivision design are diminished when conservation subdivision features are used in ineffective configurations that do little to protect ecological functionality (Lenth et al., 2006) or at scales that merely protect isolated pockets while overall environmentally compromising development patterns remain unchanged (Daniels, 1999). Nevertheless, modern scientific assessments can help by providing designers with information on which parts of a specific property should be preserved (Pejchar et al., 2007). Effective use of CSD requires comprehensive design and maintenance at the subdivision level (Lenth et al., 2006) as well as regional-level planning for open space connectivity and conservation (Arendt, 2004; Lenth et al., 2006).

Low-impact development (LID) (Coffman, 2000) is an integrated approach that uses a system of practices distributed across a development site designed to help control stormwater runoff, eliminating the need for extensive storm sewer systems (common practices include using bioswales, open spaces, rain gardens and pervious surfaces). Empirical studies have demonstrated the effectiveness of LID techniques for controlling runoff from small and moderate rainfall events (Dietz, 2007; Dietz and Clausen, 2005; Hood et al., 2007), and for limiting pollution exportation from residential developments (Dietz and Clausen, 2008). However as with CSD practices, lack of planning and design in the implementation and placement of LID features along with ongoing maintenance and monitoring can compromise the effectiveness of individual practices (i.e., rain gardens, Dietz and Clausen, 2005) as well as whole site impacts (Dietz, 2007).

1.2. Methods of valuation

There are several avenues for eliciting the degree to which consumers have value for certain goods that possess complex attributes. Stated preference methods use survey, interview or negotiation techniques to directly ask consumers how much they are willing to pay for a good through open-ended, multiple choice, or dichotomous choice options. Revealed preference methods use statistical modeling to estimate the value of goods based on consumers' previous payment behavior. The choice of methods is determined by the type of information needed. While revealed preferences are linked to reality through actual market actions, values cannot be assessed for goods that are not available on the market or that have non-market values. To gain a more robust understanding of consumer value for CSD and LID features we use four different valuation techniques to estimate residents' value for those features in residential subdivisions.

1.2.1. Contingent valuation

Contingent valuation (CV) is a survey methodology that uses a series of questions to draw out a respondent's willingness to pay for a good *contingent* upon the context of a hypothetical market (Mitchell and Carson, 1993). There are generally accepted methodological standards in place to facilitate the use of CV techniques (Arrow et al., 1993) which are particularly useful to estimate value for goods that either do not currently exist or are associated with non-market values. Because conservation and low-impact designs are absent in many parts of the Midwest, CV is a means to assess preferences for specific design features by creating a theoretical market for consumers to interact with. CV has been used in a variety of studies to estimate willingness to pay for open spaces and natural features in residential areas, and respondents have expressed willingness to pay for parks (Jim and Chen, 2006), forests and trees (Lorenzo et al., 2000; Tyrvainen and Vaananen, 1998), and greenways or general open space (Bowman et al., 2009; Breffle et al., 1998; Peiser and Schwann, 1993). The magnitude of willingness to pay for conservation features has been found to be influenced by distance to natural areas, income, gender, age, number of children, length of residence and education (Bowman et al., 2009; Breffle et al., 1998; Cho et al., 2005; Lorenzo et al., 2000; Jim and Chen, 2006; Johnston et al., 2003).

1.2.2. Experimental real estate negotiations

One issue with standard CV surveys is that they evaluate consumer willingness to pay in a hypothetical situation outside of a real market. Methodologies such as experimental real estate negotiations (conceptually akin to experimental auctions) can provide a more real-world context by placing participants in a simulated environment that more closely resembles the home-buying experience.

Experimental real estate negotiations (Black, 1997; Black and Diaz, 1996) are hypothetical real estate pricing negotiations where participants (typically professional negotiators) use available information to make a series of offers to reach a mutually agreeable price. Black and Diaz (1996) and Black (1997) used these negotiations to examine how starting asking price for homes influenced the outcome of the negotiation process. They found that negotiators typically anchor their offers on asking price. Important aspects with regard to negotiation success included the negotiation time frame, the number of bidding rounds, available information on the property and other participants, and the background of participants (e.g., real estate agents) greatly influencing final prices (Bazerman et al., 1992; Neale and Bazerman, 1992; Ravenscroft et al., 1993).

Within the real estate negotiation framework, an experimental auction mechanism can be used to estimate consumer values for goods or attributes of goods by eliciting bids over a series of negotiating "rounds" (Lusk and Shogren, 2007). There are several types of auction mechanisms, from the second-price (or Vickrey) auction (Vickrey, 1961) to the random nth-price (Shogren et al., 2001). Considerations in choosing an auction format include the duration of bidding and the revelation of bid values. Repeated rounds of bidding with pricing feedback can help participants learn the mechanism (Lusk et al., 2004; Shogren et al., 2001), but can also run the risk of bid affiliation (where revealed bid prices can influence a number of participants to bid similarly, e.g., Harrison et al., 2004).

Auction oriented techniques have been used to examine environmental attributes of market goods in various contexts ranging from non-durable or low-cost goods such as pork chops (Fox et al., 1995) or coffee cups (Corrigan and Rousu, 2006) to more complex environmental attributes such as the impact of tree density in park settings (Brookshire and Coursey, 1987), subsidized abatement of non-point source pollution (Cason et al., 2003), and land conservation contracts for preserving ecological function (Stoneham et al., 2002).

1.2.3. Spatial hedonic price models

Hedonic price models are a revealed preference method based primarily on Rosen's (1974) extension of Lancaster's consumer theory (1966) that describes the hedonic price function in a housing market as a sum of the supply and demand functions of the individual housing attributes such as structural characteristics (e.g., size, number of bedrooms, condition), as well as neighborhood and environmental characteristics (Freeman, 1993). Such models have been used to examine how environmental features influence housing prices. Public parks and nearby open space have been shown to positively influence housing prices by both proximity and amount of use (Bolitzer and Netusil, 2000; Bowman et al., 2009; Kitchen and Hendon, 1967; Lutzenhiser and Netusil, 2001). Among open spaces studied, greenbelts, forests, and streams have had generally positive effects (Bolitzer and Netusil, 2000; Bowman et al., 2009; Cho et al., 2006; Geoghegan, 2002; Irwin, 2002; Ready and Abdalla, 2005; Thorsnes, 2002). The legal status of open space also positively affects home values, with permanently protected spaces more valuable than developable open space (Geoghegan, 2002; Irwin, 2002).

Recent hedonic price model studies have focused on methods to incorporate spatial effects into regression models, using either a spatial lag or spatial error model (Anselin, 1988). A spatial lag model assumes that the value of the dependent variable for an observation is indirectly affected by the values of the observations' neighbors (Kim et al., 2003), in addition to the direct effects of other chosen explanatory variables. The spatial error model assumes that there are missing explanatory spatial variables that are influencing the error term within the model (Kim et al., 2003).

1.2.4. Public purchase referenda

Another method for eliciting consumer willingness to pay is through a survey-based hypothetical referendum that asks respondents whether they would support a certain level of payment for the provision of a public good (Arrow et al., 1993; Mitchell and Carson, 1993). Use of this method is appropriate given recent increases in public open space referenda which indicate that municipalities and grassroots organizations are increasingly using ballot initiatives as a vehicle for public conservation efforts (Banzhaf et al., 2010; Kotchen and Powers, 2006; Nelson et al., 2007). Since a referendum typically lacks a voluntary payment mechanism, issues of group size, fair share and free rider questions are not concerns (Bohara et al., 1998). Hypothetical referenda are, however, vulnerable to the effects of respondent anchoring which may lead to inflated willingness to pay estimates (Green et al., 1998). Despite this concern, past studies have demonstrated that hypothetical referenda can be good predictors of real voting behavior (Vossler et al., 2003).

1.3. Study area

Ames, Iowa (United States) was chosen as the study area because prior analyses of urban infill and growth indicated Ames is a Midwestern town experiencing increasing housing development pressure. The 2000 city population for Ames was 50 731, a 7.5% increase over the 1990 population (U.S. Census Bureau, 2003). Urban land cover within Ames municipal limits during that same time period increased by 80% (Bowman et al., 2012). Recent controversy over both commercial (Anderson, 2003) and residential (Anderson, 2004) development illustrates the concerns that Ames' citizens' have regarding potential social and environmental effects of development. There is no current market information available on consumer preferences for conservation or low-impact features in Ames that would guide developers or city officials to formulate effective development plans and policies.

1.4. Research questions

In this study, we examine Ames residents' preference for and valuation of alternative subdivision designs using four different methods. First, we used a contingent valuation survey of recent Ames homebuyers to investigate consumer preference and willingness to pay for CSD and LID features and factors that may be related to it. Second, we employed a series of experimental real estate negotiations to elucidate nuances in consumer willingness to pay for specific features and to explore how residents would value such features in an interactive and competitive environment. Third, we developed a spatial hedonic model to examine how property sales values are influenced by different aspects of existing private and public open spaces in Ames. Finally, a hypothetical referendum was used to determine the value Ames residents would place on the purchase of public land for conservation and recreation purposes. This combination of valuation techniques allowed us to examine in more detail factors important to residents with respect to the embedded attributes of specific subdivision features (CV and negotiation methods) and to "anchor" estimates of willingness to pay by evaluating elements of the existing market (hedonic model and hypothetical referendum methods). In addition, use of the four methods allowed us to determine whether certain features are consistently assigned greater value regardless of the valuation technique.

2. Methods

2.1. Resident survey

2.1.1. Survey administration

Two versions of a mail-return survey were created and disseminated using the Dillman tailored design approach (Dillman, 2007) with assistance from the Center for Survey Statistics and Methodology (http://cssm.iastate.edu/) and reviewed by the Office for Responsible Research at Iowa State University. Surveys queried residents on their opinions of and their willingness to pay for four different subdivision features. The first version of the survey included a description of Conservation Subdivision Design (CSD) and questions about two features typically associated with CSD, and the second version included a description of Low-Impact Design (LID) and questions about two features often used in LID. The CSD features used in the survey included clustered housing patterns and a stream with a forest buffer. The LID features included pervious pavers and rain gardens. All other items on both versions of the survey were identical, and included questions about whether residents had previously heard of CSD or LID designs, their preferences for general neighborhood characteristics, their rating of the attractiveness and marketability of alternative subdivision design features, willingness to buy and pay for those features, a hypothetical additional tax to purchase public land for conservation, and several general demographic questions.

The City of Ames Assessor's Office records were used to identify and randomly select 2000 households for which a single-family detached home was purchased between 2003 and 2008 to receive a survey. Homebuyers with recent purchasing experience were chosen because they would be knowledgeable about the Ames housing market. The two versions of the survey (CSD and LID features) were evenly and randomly divided among the 2000-household sample. Households that had moved or were incorrectly listed in the Assessor's database were removed from the sample and were not replaced, resulting in an eligible sample of 1804.

Previous knowledge about CSD and LID designs was measured using a 3-point scale where "1" indicated a respondent had not previously heard of the design, and "3" indicated they had heard of the design. An open-ended question asked participants to identify where they may have previously heard of either design. Residents' opinions of each feature were queried about whether it was attractive, whether a house would be easier to sell with the addition of the feature, and whether they would purchase a home that included the feature. Questions used a rising 5-point Likert-scale (Likert, 1931) for which "1" indicated strong disagreement and "5" indicated strong agreement. Willingness to pay for each feature was investigated using three survey items. The first was a rising 5-point Likert-scale question for which "1" indicated no willingness to pay and "5" indicated strong willingness to pay. The second item was an eight-point ordered-scale question where "0" indicated no willingness to pay, response options 1–7 indicated US dollar ranges of \$1500 (i.e., "1" = \$1–\$1500, "2" = \$1501–\$3000), and "8" indicated an amount greater than \$9000. The third item was an open-ended question that asked respondents to indicate the greatest amount they would be willing to pay for a particular feature. Participants were provided space to comment on the feature and their willingness to pay for it.

2.1.2. Survey data analysis

Likert-scale questions measuring subjective attractiveness, opinions on marketability, and willingness to buy and pay more for each feature were analyzed using means and t-tests to test for differences from the neutral point (scaled neutral = 3). A histogram was created to graphically assess the responses to the 8-point scaled willingness to pay question. The general form of the ordered probit model was specified and estimated using maximum likelihood estimation as per Greene (2003). A total of four ordered probit models were fit to estimate effects of variables on willingness to pay for the CSD and LID features included in the surveys, using gender, age, income, presence of children under age 18 in the household, and whether the respondent had a college education as household characteristics. Other factors included 3-point scale ratings of whether residents had previously heard about LID/CSD, and 5-point Likert-scale ratings of each features' attractiveness and effect on marketability of a home, as variables likely to be related to value of individual subdivision features.

2.1.3. Public purchase referendum

A probit model was also fitted using responses to a referendum question that used randomly generated tax increases to assess the likelihood of passage for public purchase of land to be used for conservation purposes. Each of the two responses were coded "1" if a respondent indicated support of a particular tax value and coded "0" otherwise. The resulting model was evaluated at a z-score of 0 to estimate the tax increase that would result in 50% support for passage of the referendum.

2.2. Experimental real estate negotiations

2.2.1. Experimental real estate negotiation methods

Individuals in a randomly-selected set of 36 households were solicited by telephone to participate in a subsequent experimental real estate negotiation process. This sample was a subset of residential survey respondents who purchased a home within the previous five years with a sale price between U.S. \$185 000 and \$215 000 (to ensure uniformity with respect to the market segment where these features are usually present, e.g., Bowman et al., 2009). The negotiation protocol was reviewed and approved by Iowa State University's Office for Responsible Research.

The experimental negotiation was modeled after Black and Diaz (1996) and Black (1997), and modified to include a competitive bidding process (Brookshire and Coursey, 1987; Hayes et al., 1995; Lusk and Shogren, 2007) to better simulate the interaction between multiple buyers in the same housing market. The negotiations were facilitated by staff members from Iowa State University's Center for Survey Statistics and Methodology, acting as real estate brokers, with four rounds of sealed bidding on properties located in subdivisions with different features. Participants were asked to make hypothetical bids and were instructed to remember the context of their most recent home purchase (which in our sample was within the last five years), and to make bids that would most accurately reflect their true value for the property (to constrain their bidding), assuming that they were in fact a motivated buyer.

Within each round participants bid on three subdivision properties which included one standard subdivision property that contained no CSD/LID features, one property that included a feature with negligible environmental benefits (e.g., a flower garden), and a property with a conservation feature that had a similar appearance but included a positive environmental externality (e.g., a rain garden) (Table 1). Features included a neighborhood prairie versus a neighborhood forest, a stream versus a stream with a forest buffer, a flower garden versus a rain garden, and clustered housing with open space versus clustered housing with neighborhood forest. The different combinations of subdivision attributes used in each round were designed to allow comparisons of value for specific features within as well as between rounds.

The appearance and characteristics of the house (i.e., exterior appearance, size, style, number of bedrooms) were the same for all properties. Each property was offered at an initial asking price of \$200 000 to reflect the valuation for similar house and lot sizes in the 2009 Ames market. Features were described using sales sheets with a format and language similar to those used by local real estate agents to advertise available properties. Each sale sheet contained one picture of the house (with the CSD or LID feature visible where applicable), two pictures with the feature highlighted, and an image of the subdivision layout with the location of the feature indicated. Information also included descriptions of the aesthetic or environmental benefits. For example, the rain garden description read "Professionally designed rain gardens installed in every yard throughout the neighborhood provide lovely landscaping and help control water runoff, pollution and flooding." Because of possible negative connotations associated with the term "clustered" housing (as per feedback from the residential surveys) the subdivision layout, presence of open space or forest, and smaller listed

Table 1
Description of properties available for participant bidding in experimental real estate negotiations by round.

Round	Property 1	Property 2	Property 3
1	**Standard** lot design with no unique subdivision features	Standard lot design with neighborhood association owned **prairie outlot**	Standard lot design with neighborhood association owned **forested outlot**
2	**Standard** lot design with no unique subdivision features	Standard lot design featuring a **stream without a vegetated buffer** behind property	Standard lot design featuring a **stream with forested buffer** running behind property
3	**Standard** lot design with no unique subdivision features	Standard lot design with a **flower garden** provided with each property	Standard lot design with a **rain garden** that reduce flooding and help clean water provided with each property
4	**Standard** lot design with no unique subdivision features	**Clustered** lot design interspersed with neighborhood association owned **open space**	**Clustered** lot design interspersed with neighborhood association owned **forest**

lot sizes were explicitly highlighted to differentiate the properties without use of the term "clustered". Participants were informed that all open space features would be owned and maintained by a neighborhood association.

Participants were asked to bid on each of the three properties side-by-side and simultaneously. Within each round, three cycles of bids were collected and recorded: an opening blind bid, an optional second blind bid, and an optional third bid after the highest and second-highest bids were revealed. All participants were advised that the "selling party" rejected their opening bids. Participants were given the opportunity to offer another bid for the property but were not required to make any additional bid past the opening offer. The highest bidders were informed confidentially of their bid status while all others were informed their bid was rejected. Participants were then informed of the current first- and second-highest bid amounts and offered a final opportunity to place a bid on the property. After the bidding process was complete, participants were asked to rate their interest in purchasing each property using a rising 5-point Likert-scale ("1" = not at all interested, "5" = very interested). After the final round, a brief focus group session was conducted to query participants about the properties offered and the overall negotiation process.

2.2.2. Experimental real estate negotiation data analysis

The standard subdivision property offered in each round allowed control for progressive bid inflation and for the comparison of features across rounds by using the ratio of the bid for a home with a particular feature to the bid for the standard property offered in each round. Bids were log-transformed to achieve uniform distribution of residuals and were fitted using the REML (restricted maximum likelihood) technique. Both participant identification and subdivision feature were selected as class variables, and least square means were used for multiple comparisons with a Tukey adjustment. Effects of each subdivision feature were then back-transformed from log-scale (Kalbfleisch, 1985).

2.3. Spatial hedonic price model

Home sale prices for properties sold at arms-length in Ames between 2003 and 2008 were fitted to a spatial lag model (Anselin, 1988). A preliminary OLS model was estimated to test for spatial dependence and multicollinearity. Moran's I was used to detect the presence of spatial autocorrelation in housing prices (Moran, 1950) and robust Lagrange Multiplier tests were used to evaluate and determine the optimal model choice for minimizing spatial dependence (Anselin et al., 1996). The spatial lag model was specified as:

$$\mathbf{P} = \rho W_s \mathbf{P} + \sum X\beta + \varepsilon$$

where $\mathbf{P}$ is a vector of n housing sale prices, n is the number of observations in the model, ρ is a spatial autocorrelation factor, W_s is a $n*n$ matrix of spatial weights, X is a $n*m$ matrix of all variables (structural, neighborhood, environmental) included in the model, m is the number of variables in the model, and ε is a vector of error terms.

Spatial weights for properties within the sample were created using inverse distance with a threshold of 1600 m (Ready and Abdalla, 2005) and were standardized. The choice of distance thresholds for spatial weights is generally ad-hoc, but prior studies found significant spatial effects of private and public open space with thresholds of 1600 m (Ready and Abdalla, 2005). At this threshold, it was determined that there were no properties without neighbors (islands). A spatial lag model using the log-transformed last recorded sale price for each house was estimated using a spatial two-stage least squares approach as per Kelejian and Prucha (1998) to account for spatially distributed endogenous variables. A preliminary Box-Cox analysis (Box and Cox, 1964) for sale prices indicated that logarithmic transformation was appropriate. Coefficients in the spatial lag model were adjusted using a spatial multiplier (Kim et al., 2003). Coefficients of dummy variables were also adjusted to account for the semi-log functional form (Kennedy, 1981). Standard errors were adjusted to be robust against heteroskedasticity (White, 1994). Independent variables to describe home characteristics included house and lot sizes, number of bedrooms, the presence of a fireplace, and an external condition rating (0 = Poor, 3 = Good) (Table 4).

Distance to nearest commercial center and railroad tracks, neighborhood income, and school district performance were used as neighborhood factors. Because US Census income data was not available for neighborhoods built after the 2000 census, a neighborhood income surface for Ames was created with demographic information from the residential survey using a Spatial Analyst tool (ArcGIS 9.3, ESRI). Data for some factors, such as neighborhood vacancy and unemployment were unavailable at the time of this study and could not be included. Mean scores on the Iowa Test of Basic Skills were used to control for the influence of school district on home value. Houses in school districts with a score less than 80 were rated as being present in a poor performing school district.

Environmental variables used in the model included amount of open space owned by a neighborhood association, presence of neighborhood association-owned forest and water features, presence of a stream adjacent to property, amount of publicly-owned open space within walking distance, and presence of publicly owned forests and water features within walking distance. Neighborhood association-owned properties were identified using the City of Ames Assessor's database. Aerial photographs and land cover maps were used to determine the type of vegetation present in each open space property.

2.4. Public purchase referendum

As part of the residential survey, participants were asked to respond to a hypothetical referendum scenario to indicate whether they would support a yearly property tax increase in order to allow the city to purchase land that would be "open to public use and recreation, and would help protect water quality, wildlife habitat and biodiversity." Each survey contained a randomly-generated tax value between $1 and $150 and asked participants to respond to two rising Likert-scale questions ("1" = not at all support, "5" = strongly support) about whether they would support a tax increase of that amount and twice that amount. A probit model was fitted using responses to each randomly generated tax increase question to assess the likelihood of passage for a referendum for public purchase of land for conservation purposes. Each of the two responses from each survey were coded "1" if a respondent indicated support of a particular tax value (4 or 5) and coded "0", otherwise (3, 2, or 1). The resulting model was evaluated at a z-score of 0 to estimate the tax increase that would result in 50% support for passage of the referendum.

3. Results and discussion

3.1. Resident survey

3.1.1. Survey response and respondent demographics

Overall, 777 of 1804 eligible surveys (43%) were returned. About half of responses were to the CSD format (clustered housing, stream with forest buffer) of the survey ($n = 383$) and the other half to the LID format (pervious pavers, rain garden) ($n = 394$). Respondents were 52% male and 94% white, with an average age of 42 years. Overall, 84% of respondents held at least one college degree and, on average, had a household income between $75 000 and $100 000.

3.1.2. General knowledge and preference for CSD and LID features

Only half or fewer of respondents had previously heard of either CSD (39%) or LID (50%) designs. Fifty-seven percent of respondents thought that CSD design features were used in Ames, while about 47% thought LID features had been used (Fig. 1). This is despite the fact that there are no current subdivisions in Ames that have any CSD or LID features. Responses to open-ended questions asking for examples revealed that many respondents were either misinformed (by specifically naming either a well-known "New Urbanist"-inspired planned urban development or a large park that features an artificial lake), or had a case of "wishful thinking" believing that given the progressive nature of Ames at least one subdivision in town must have these features despite the lack of any explicit knowledge about its existence.

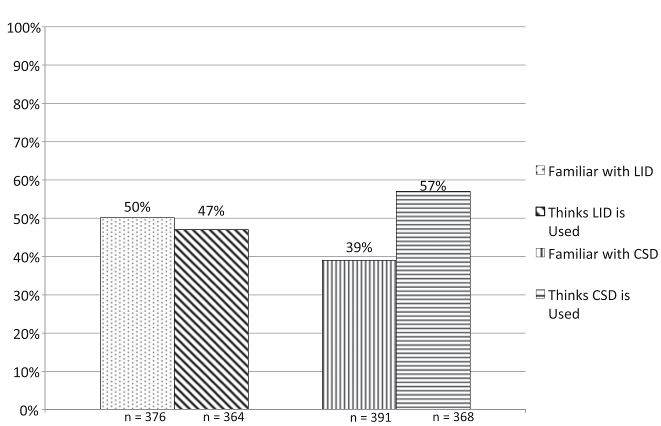

Fig. 1. Percentage of survey respondents (n = 364–391 as indicated) that were previously familiar with conservation subdivision design (CSD) and low-impact development (LID) and believed that CSD and LID features were used in residential development in Ames, IA.

In terms of attractiveness, re-sale advantage, and willingness to buy and pay more, clustered housing was rated significantly lower than any of the other subdivision features (Fig. 2). Clustered housing in the context of the survey was presented with specific information about the inclusion of common open space within clustered subdivision layouts. Based on open-ended comments, the phrase "clustered housing" had a negative connotation that may have influenced responses (comments focused on perceptions of small lots with little privacy). With regard to the remaining three features, respondents indicated that streams with a forest buffer, pervious pavers, and rain gardens were visually attractive but expressed neutral opinions as to whether presence of these features in a subdivision would make a house easier to sell, and whether they would either buy or pay more for those features (Fig. 2). Overall lack of knowledge about these alternative subdivision designs may have been a driving factor in ambivalence about CSD and LID subdivision features.

3.1.3. Willingness to pay for CSD and LID features

A majority of respondents indicated some willingness to pay for three of the four features (streams with forest buffer, pervious pavers, and rain gardens) on the ordered response questions (Fig. 3). For both clustered housing and streams with forest buffers, many respondents indicated they would not pay more to have these included in their subdivisions (over 73% of respondents indicated they would not be willing to pay more for clustered housing alone, see Fig. 3). However, the small proportion that indicated willingness to pay for these features were willing to pay larger amounts than respondents indicated they would pay for other features. A majority of respondents indicated they would be willing to pay for pervious pavers and rain gardens in their neighborhood, although they were not willing to pay a large amount for either feature (responses were largely in the US $1–$1500 range, Fig. 3). There were no respondents indicating willingness to pay more than US $9000 for either of these features. Respondents indicated mean maximum willingness to pay of US $1269 for clustered housing, $2720 for streams with forest buffers, $1396 for rain gardens, and $1424 for pervious pavers; responses consistent with their choices to the ordered response questions (Fig. 3). The maximum value for streams with forest buffers was significantly higher ($p < 0.05$) than any of the other features. There was greater variance in maximum willingness to pay for CSD features (clustered housing and buffered streams) than for LID features (Fig. 3). Responses for CSD features demonstrated a wider spectrum of values, with lower overall willingness to pay in contrast to higher maximum payment values.

One overall difference that may be driving different patterns in willingness to pay for CSD and LID features may be related to the difference in the scale of the features not directly associated with individual lots. CSD features, such as streams with forest buffers are neighborhood-scale features and influence the overall design of the housing development. LID features, such as rain gardens, are implemented on a lot-level scale, and are customizable and "ownable". Another issue that arose with both the CSD and LID features is the responsibility and costs associated with owning and maintaining features. For CSD features, maintenance would likely be the responsibility of a neighborhood association (that collected dues from neighborhood property owners). For LID features, the small scale of pervious pavers and rain gardens would require individual homeowners to maintain features on their own property. Pervious pavers were singled out by respondents as a maintenance concern during winter weather. Upkeep concerns may also affect respondents' attitudes toward CSD features. For example, at least one previous study found that residents believed maintenance was a negative issue associated with vegetated stream buffers (Kenwick et al., 2009).

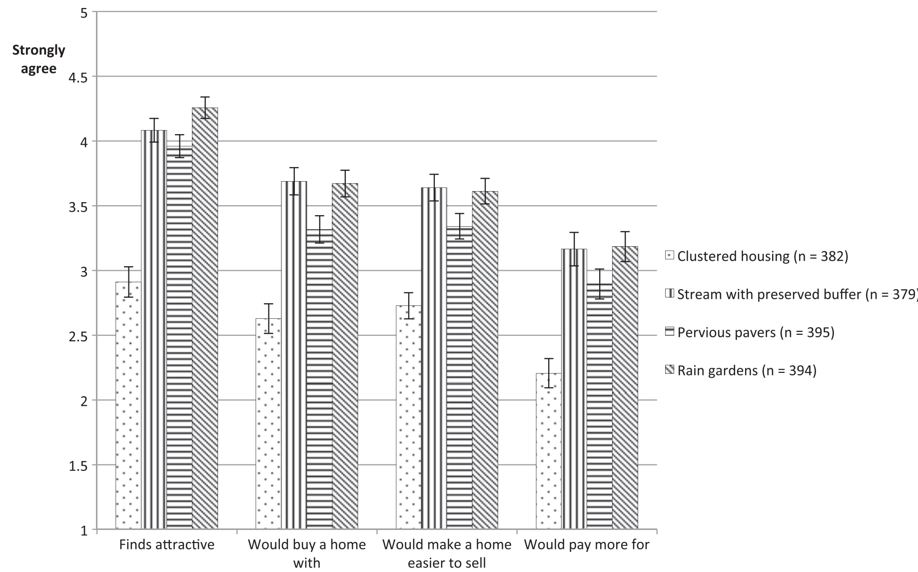

Fig. 2. Respondent ratings ($n = 379–395$ as indicated) of attractiveness, willingness to buy, effect on ease of selling a home and willingness to pay more for individual conservation subdivision design and low-impact development features based on 5-point Likert-scale (1 = strongly disagree, 5 = strongly agree). Error bars are the 95% confidence interval for the sample mean.

3.1.4. *Probit analysis of willingness to pay for CSD and LID features*

Across all four models, respondent ratings of the attractiveness and the effect of the feature on marketability were both positive and significant ($p < 0.001$; $p < 0.10$ for clustered housing) (Tables 2 and 3). In general, the major factors related to the valuation of a feature in our model were the respondents' assessment of that feature's appeal as well as their assessment of its appeal to future home buyers.

Different factors were correlated with willingness to pay for the different CSD and LID features. With regard to CSD features, a college education and gender were significant positive factors ($p < 0.05$) only for clustered housing, with both college-educated and female respondents reporting greater likelihood of willingness to pay more for clustered housing than non-college-educated or male respondents (Table 3). Age was an important factor ($p < 0.07$) for a stream with a forested buffer, with older respondents reporting greater willingness to pay (Table 2). Knowledge about CSD features (which was low overall, Table 1) was not significantly correlated with willingness to pay in any of the models (Table 2).

Both income and familiarity with LID affected ($p < 0.05$) willingness to pay for pervious pavers and rain gardens – higher incomes and greater prior knowledge correlated with a greater willingness to pay (Table 3). A number of comments about both of these LID features mentioned maintenance costs; it is possible that households with higher reported incomes would be more likely to be able to afford extra costs (if any) associated with installation and maintenance of pavers and rain gardens. Greater familiarity with LID features increases the likelihood that respondents understand the environmental benefits and thus may be more likely to invest in neighborhoods that incorporate LID features.

3.2. *Experimental real estate negotiations*

3.2.1. *Participant demographics*

Real estate negotiation participants were 54% male, 92% white, and had a mean age of 49.5 years. Eighty percent of participants had a college education and the average household income was between \$75 000 and \$100 000. There were no significant

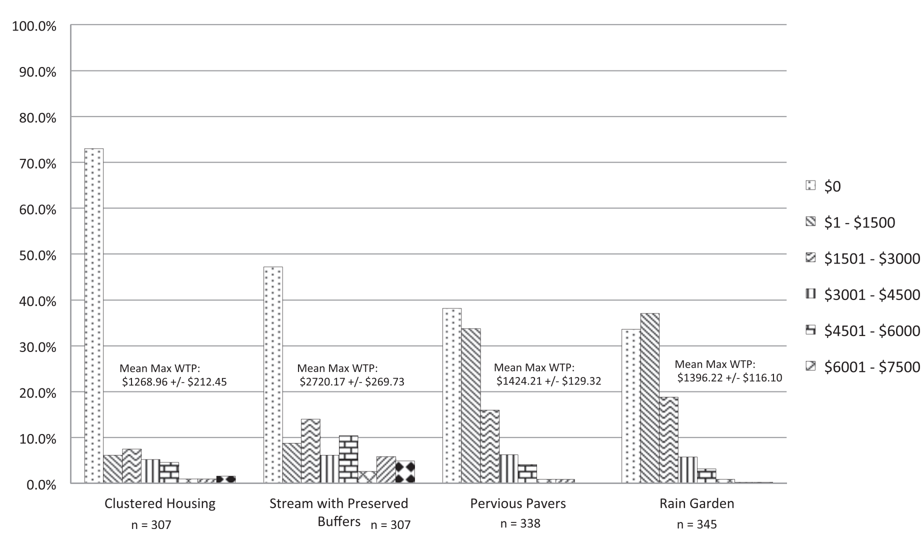

Fig. 3. Percentages of survey respondents ($n = 307–345$ as indicated) with willingness to pay for individual conservation subdivision and low-impact development subdivision features based on ordered contingent valuation queries and mean maximum willingness to pay for features based on open-ended follow-up questions.

Table 2
Variables in ordered probit regressions for residential survey responses to willingness-to-pay questions about various subdivision features in Ames, IA.

		Mean	St. Dev.
Dependent variable	Measured on an 8-point scale where 0 = \$0, 1 = \$1–\$1500, 2 = \$1501–\$3000 … 8 = >\$9000		
PERVIOUS	Willingness to pay for use of pervious pavers in current subdivision	1.11	1.23
RAINGARDEN	Willingness to pay for use of rain gardens in current subdivision	1.13	1.16
CLUSTERED	Willingness to pay for use of clustered housing in current subdivision	0.77	1.54
STREAMBUFFER	Willingness to pay for presence of a stream with forest buffer in current subdivision	1.80	2.20
Independent variables			
GENDER	Respondent gender (0 = male, 1 = female)	0.48	0.51
AGE	Age of respondent	41.97	12.86
CHILDREN	Presence of children in home (dummy, 1 = yes)	0.50	0.50
COLLEGE	Level of respondent education (dummy, 1 = college, 0 = no college)	0.84	0.37
INCOME	Household income (\$25,000s of US dollars)	4.07	1.63
LIDKNOWLEDGE	Respondent's having previous heard of LID practices (0 = none, 1 = maybe, 2 = yes)	1.87	0.92
CSDKNOWLEDGE	Respondent's having previous heard of CSD practices (0 = none, 1 = maybe, 2 = yes)	1.68	0.89
PERVIOUSATTRACT	Respondent's rating of attractiveness of pervious pavers (0 = not at all attractive, 4 = very attractive)	2.96	0.91
PERVIOUSMARKET	Respondent's rating of effect of pervious pavers on house market value (0 = will decrease, 4 = will increase)	1.90	1.18
RAINATTRACT	Respondent's rating of attractiveness of rain gardens (0 = not at all attractive, 4 = very attractive)	3.26	0.84
RAINMARKET	Respondent's rating of effect of rain gardens on house market value (0 = will decrease, 4 = will increase)	2.18	1.18
CLUSTERATTRACT	Respondent's rating of attractiveness of clustered housing (0 = not at all attractive, 4 = very attractive)	1.91	1.18
CLUSTERMARKET	Respondent's rating of effect of clustered housing on house market value (0 = will decrease, 4 = will increase)	1.21	1.12
STREAMATTRACT	Respondent's rating of attractiveness of stream with forest buffer (0 = not at all attractive, 4 = very attractive)	3.08	0.91
STREAMMARKET	Respondent's rating of effect of stream with forest buffer on house market value (0 = will decrease, 4 = will increase)	2.17	1.28

differences between the sub-sample of real estate negotiation participants and all survey respondents in terms of stated willingness to pay for either CSD or LID features on the preceding survey.

3.2.2. Preferences for subdivision features

Based on a 5-point rising Likert-scale question, participants reported greater interest in purchasing clustered housing with included forest (4.6) compared to homes featuring clustered housing with unspecified open space (3.8) (Fig. 4). In addition, participants' interest in houses with buffered streams (3.7) was greater than for houses with streams that lacked a buffer (2.5) (Fig. 4).

Overall, features with environmental benefits were rated more highly than similar features with only aesthetic attributes (Fig. 4). Mean ratings for both streams with forest buffers and rain gardens were statistically similar to survey responses ($n = 777$) for the same features (i.e., Fig. 2). Other studies have demonstrated similar preferences for added environmental amenities. For example, Kuo et al. (1998) found that people preferred areas with greater tree density and Kenwick et al. (2009) found that suburban residents strongly favored the natural appearance of vegetated stream buffers over streams without buffers.

Consistent attention to landscape features rather than "clustered housing" per se appeared to have shifted negotiation participants' focus to the embedded subdivision features (compared to reactions of survey respondents). Homes offered in clustered housing designs were in fact the most preferred of all options in the real estate negotiations. Thus, while the term "clustered housing" in and of itself may have negative connotations, perceptions of alternative subdivision layouts can be changed by focusing on very explicit descriptions of open space or forest components and their function.

3.2.3. Experimental real estate negotiations analysis

Generally, houses with CSD or LID features had significant positive effects on participants' bids compared to houses in standard subdivisions (Table 4). Bids for houses near unbuffered

Table 3
Estimated coefficients for ordered probit model using survey responses to scaled willingness to pay questions about various subdivision features for Ames, IA.

Dependent variable	CLUSTERED			STREAMBUFFER			PERVIOUS			RAINGARDEN		
	β			β			β			β		
Independent variables[a]	Coeff.	S. E.	Pr.	Coeff.	S. E.	Pr.	Coeff.	S. E.	Pr.	Coeff.	S. E.	Pr.
GENDER	0.2333	0.137	0.089*	0.1987	0.1259	0.115	−0.0608	0.2797	0.657	−0.0651	0.1326	0.624
AGE	0.0056	0.006	0.351	0.01	0.0055	0.069*	0.0006	0.137	0.920	−0.005	0.0055	0.361
CHILDREN	0.0123	0.1442	0.932	−0.0706	0.1294	0.586	0.0067	0.0057	0.962	0.0063	0.1381	0.964
COLLEGE	0.4565	0.2093	0.029**	0.151	0.1761	0.391	0.1547	0.139	0.457	0.2312	0.2036	0.246
INCOME	−0.0577	0.0451	0.201	−0.017	0.0401	0.671	0.0907	0.0443	0.041**	0.1286	0.0427	0.002***
CSDKNOWLEDGE	−0.0526	0.0797	0.509	−0.0494	0.0726	0.497	–	–	–	–	–	–
LIDKNOWLEDGE	–	–	–	–	–	–	0.1533	0.0712	0.031**	0.2903	0.0711	<0.001***
CLUSTERATTRACT	0.4428	0.0792	<0.001***	–	–	–	–	–	–	–	–	–
CLUSTERMARKET	0.1469	0.0891	0.099	–	–	–	–	–	–	–	–	–
STREAMATTRACT	–	–	–	0.3411	0.0975	<0.001***	–	–	–	–	–	–
STREAMMARKET	–	–	–	0.3832	0.0861	<0.001***	–	–	–	–	–	–
PERVIOUSATTRACT	–	–	–	–	–	–	0.6503	0.102	<0.001***	–	–	–
PERVIOUSMARKET	–	–	–	–	–	–	0.5302	0.088	<0.001***	–	–	–
RAINATTRACT	–	–	–	–	–	–	–	–	–	0.5261	0.1296	<0.001***
RAINMARKET	–	–	–	–	–	–	–	–	–	0.634	0.0982	<0.001***
Model Statistics	$n = 336$			$n = 328$			$n = 309$			$n = 314$		
Log likelihood:	−413.0			−566.5			−354.2			−349.1		

*, **, and *** denote statistical significance at 0.10, 0.05, and 0.01 levels respectively.
[a] Intercept variables were included in the model but are not listed in this table.

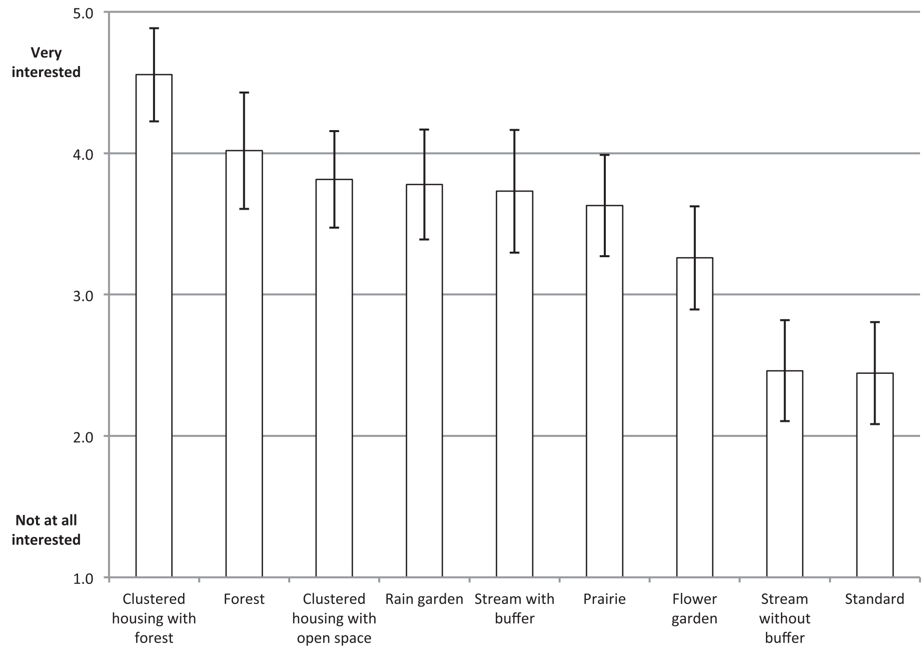

Fig. 4. Auction participant ($n = 27$) ratings of interest in purchasing a property with a particular conservation subdivision design or low-impact development feature based on a 5-point Likert-scale (1 = not at all interested, 5 = very interested). Error bars are the 95% confidence interval for the sample mean.

streams, however, were not significantly different than houses in standard subdivisions (Table 4). Clustered housing with interspersed preserved forest had the greatest estimated value (+22%) over a house in a standard subdivision. This value was significantly greater ($p < 0.04$) than most other features (except for clustered housing with open space, Table 4). Clustered housing with open space had the second largest effect on bidding price (+17.2% over a house in a standard subdivision), which was significantly greater ($p < 0.04$) than a flower garden, a neighborhood-owned forest associated with a standard subdivision design, and a stream without buffers (Table 4). The clustered housing designs (with interspersed forest or open space) had the largest mean effects on bid price over a standard home, demonstrating that as with preferences, while clustered housing alone may not be preferred (as indicated in the survey), a design with interspersed open space components can be highly valued. Moreover, features with well-defined environmental benefits consistently increased the mean amount that participants were willing to bid, although this difference was not always statistically significant. For example, adding a forested buffer to a stream within a subdivision increased the average bid value for a house from 3.5% to 12.9% compared to a home in a standard subdivision (Table 5). In all cases with comparable features (such as flower gardens versus rain gardens) participants valued features with embedded environmental benefits more than those without.

Table 4
Estimates for effects on participant bids for individual subdivision features in experimental real estate negotiations in Ames, IA.

Subdivision feature (variable name)	Estimate	Mean effect[a]	S.E.	Prob.	
Clustered housing with forest	0.1992	22.0%	0.0239	<0.001	***
Clustered housing with open space	0.1587	17.2%	0.0239	<0.001	***
Rain garden	0.1268	13.5%	0.0239	<0.001	***
Flower garden	0.0848	8.8%	0.0239	<0.001	***
Stream with forest buffer	0.1209	12.9%	0.0239	<0.001	***
Stream without buffer	0.0341	3.5%	0.0239	0.1550	
Standard design with forest	0.0843	8.8%	0.0239	<0.001	***
Standard design with prairie	0.1108	11.7%	0.0239	<0.001	***

** and *** denote statistical significance at 0.05 and 0.01 levels respectively.
[a] The estimated effect that the feature has on the price of home with respect to a house in a standard subdivision without any features.

3.3. Spatial hedonic price model

All structural and house quality characteristics applied to the model (Table 6) had significant marginal effects on house prices and the variables had expected signs (Table 7). Year of sale (2004–2008) was significant and positive indicating consistent growth in home values in Ames between 2003 and 2008 (Table 7). Most neighborhood characteristics, such as average household income, distance to commercial district and distance to railroad tracks, also had significant effects on house value (Table 7). The presence of a low performing school district did not have an effect on the house price (Table 7).

Overall, marginal effects of environmental amenities on home value were not consistently significant. The effects of neighborhood association-owned forest and water features were positive and significant (Table 7). The marginal effect of these features was approximately 8% at the mean sale price with a value of $14 488 for association-owned forests, and $14 681for a water feature (Table 7). These findings are similar to other studies (e.g., Lorenzo et al., 2000; Ready and Abdalla, 2005) with the presence of private forests associated with higher home prices. Natural features preserved during and after subdivision development can have both economic and environmental benefits and home buyers have revealed that they are willing to pay a premium for such neighborhood amenities. The economic impacts of these features are also additive, affecting all homes with access within the neighborhood association bounds (Bowman et al., 2009).

The overall amount of privately held open space within a neighborhood did not appear to have an effect on house value (Table 7). Private open space within subdivisions is rare in Ames (occurring in only 14% of the houses in our model with a variety of sizes from 2 acres up to 34 acres). Similar to the findings of Acharya and Bennett (2001), the spatial nature and degree of open space

Table 5
Estimated least square means comparisons estimates for differences in bids between individual subdivision features in experimental real estate negotiations by round in Ames, IA.

Round	Feature 1	Feature 2	Estimated Diff.	Mean effect[a]	Prob.	
1	Prairie	Forest	0.0264	2.7%	0.435	
2	Stream with buffer	Stream without buffer	0.0868	9.1%	0.011	***
3	Rain garden	Flower garden	0.0413	4.2%	0.223	
4	Clustered housing with forest	Clustered housing with open space	0.0405	4.1%	0.232	

*** denotes statistical significance at the 0.01 level.
[a] The estimated effect that feature 1 has over feature 2 with respect to the price of a home in a standard subdivision without either feature.

integration within neighborhoods may be what is most important to home purchasers. It could be also be the case that the value of private open space in Ames (based largely on the novelty of its occurrence) is captured just on the basis of its presence rather than specifically the features included or the overall size of the area.

However, for publically-held open space size did matter -open space within walking distance (500 m) of a house had a marginal effect (at $p < 0.057$) of 0.02% per acre, which at the mean price of a home in Ames is an increase in home price of approximately $18 for every acre of public park within walking distance (Table 7). As Peiser and Schwann (1993) found, this effect is miniscule when compared with the marginal effect of a similar amount of additional lot space ($24 659 at the mean sale price). Ames has a diversity of park sizes, ranging from ½ acre to 440 acres, with larger parks having more recreation opportunities and affording a higher value to neighboring residences. This is corroborated by the findings of our hypothetical referendum which shows a willingness to pay for public open space. Homebuyers find greater value in larger park areas and this finding should encourage parks and recreation decision makers to consider ways of increasing park connectivity and reducing fragmentation when designing new parks.

Interestingly, the presence of a public lake within walking distance had a large and significant negative effect of about −11%, or −$19 974 on house value (Table 7). There is one “constructed” public lake (an abandoned quarry) in Ames that serves as a high-use park with several hard-surface trails that extend beyond its boundaries connecting into neighboring subdivisions. Although the housing is adjacent to the park, other than the trails there was no

Table 7
Spatial 2SLS estimation coefficients for spatial lag hedonic price model using housing sales (2003–2008) for Ames, IA.

Dependent variable	LN(SALEPRICE)		
	β		
Independent variables	Coefficient[a]	St. Err. (robust)	Prob.
LOTSIZE	0.00000313	0.0000007	<0.001***
HOUSESIZE	0.000413	0.0000115	<0.001***
BEDROOMS	−0.060396	0.0070837	<0.001***
FIREPLACE	0.060631	0.0065059	<0.001***
AGE	−0.003403	0.0001516	<0.001***
CONDITION	0.032548	0.0078911	<0.001***
INCOME	0.040579	0.0041951	<0.001***
COMMERCE	0.00000536	0.0000032	0.098*
RAILROAD	0.000003	0.0000011	0.009***
POORSCHOOL	−0.006654	0.0082158	0.422
ASSOC_SPACE	0.000254	0.0010304	0.807
ASSOC_FOREST	0.080210	0.0277992	0.006***
ASSOC_WATER	0.081278	0.0172009	<0.001***
CITY_SPACE	0.000101	0.0000526	0.057**
CITY_FOREST	0.009098	0.0080485	0.262
CITY_WATER	−0.110584	0.0261143	<0.001***
STREAM	−0.001174	0.0214577	0.965
YR2004	0.049192	0.0099126	<0.001***
YR2005	0.093940	0.0093327	<0.001***
YR2006	0.079035	0.0098260	<0.001***
YR2007	0.094448	0.0090149	<0.001***
YR2008	0.096442	0.0166619	<0.001***
CONSTANT	11.37412	0.0367565	<0.001***
W_LN(SALEPRICE) (ρ)	0.076780	0.0043584	<0.001***
Model Statistics	$n = 2093$		
Prob > χ^2 (Wald)	<0.001		
Variance ratio	0.886757		
Pseudo-R^2	0.8379		
Lag coefficient (ρ)	0.076780		

*, **, and *** denote statistical significance at 0.10, 0.05, and 0.01 levels respectively.
[a] Coefficients have been adjusted to account for spatial lag as per Kim et al. (2003) and dummy variable have been adjust as per Kennedy (1981).

Table 6
Variables in hedonic price model regression for sales (2003–2008) in Ames, IA.

		Mean	St. Dev.
Dependent variable			
SALEPRICE	Value of last private arms-length sale (US dollars)	180628.40	74372.12
Independent variables			
LOTSIZE	Size of the housing lot (sq. ft)	11396.73	8839.15
HOUSESIZE	Size of the housing structure (sq. ft)	1541.14	530.69
BEDROOMS	Number of bedrooms	2.97	0.68
FIREPLACE	Presence of fireplace (dummy, 1 = yes)	0.58	0.49
AGE	Age of housing structure	36.41	27.25
CONDITION	External condition of housing structure (0 = poor, 3 = good)	2.11	0.36
INCOME	Mean household income of neighborhood residents ($25,000s of U.S. dollars)	3.36	1.10
COMMERCE	Distance from nearest commercial district (ft)	1618.42	967.06
RAILROAD	Distance from nearest railroad track (ft)	3515.13	3180.51
POOR SCHOOL	Presence in poor performing school district (dummy, 1 = yes)	0.33	0.47
ASSOC_SPACE	Amount of neighborhood association owned open space in subdivision (acres)	3.36	9.43
ASSOC_FOREST	Presence of neighborhood association owned forest (dummy, 1 = yes)	0.10	0.30
ASSOC_WATER	Presence of neighborhood association owned water feature (dummy, 1 = yes)	0.07	0.25
CITY_SPACE	Amount of public open space with walking distance (500 m) of house (acres)	61.11	99.54
CITY_FOREST	Presence of public forest within walking distance of house (dummy, 1 = yes)	0.34	0.47
CITY_WATER	Presence of publicly owned water feature within walking distance of house (dummy, 1 = yes)	0.04	0.20
STREAM	Presence of stream within 150 ft of house (dummy, 1 = yes)	0.04	0.20
YR2004	Year of sale 2004 (dummy, 1 = sold)	0.17	0.38
YR2005	Year of sale 2005 (dummy, 1 = sold)	0.19	0.39
YR2006	Year of sale 2006 (dummy, 1 = sold)	0.20	0.40
YR2007	Year of sale 2007 (dummy, 1 = sold)	0.24	0.43
YR2008	Year of sale 2008 (dummy, 1 = sold)	0.03	0.18

attempt to integrate the housing and park components from a design standpoint. We surmise that the lack of carefully designed integration as well as the high-use nature of the park and intrusion by park visitors into surrounding properties may be driving the large negative effect on sale price. Alternatively, there may be other disamenities associated with the area that we are unaware of.

The presence of public forest within walking distance had no significant effect on home price (Table 7). Fewer opportunities for recreation development within preserved forest areas may limit the effect of those areas on home prices. Likewise, the aesthetic impact of a public forest on home prices would be limited to adjacent residences within close distance. Similar to findings from the survey and experimental real estate negotiations, the adjacency of a stream without forest buffers had no effect on home price; however, it should be noted that the sign on the effect of stream adjacency was negative as predicted (Table 7).

3.4. Public purchase referendum

Probit regression ($n = 777$) estimated that an added annual property tax of $49.31 would result in 50% support for the hypothetical city referendum to purchase and preserve open space. A referendum including a tax value lower than $49.31 would most likely pass, while a higher value would be likely to fail. In response to an open-ended maximum WTP follow-up question, residents ($n = 602$) indicated that they would support a mean maximum property tax increase up to $90.72. The expressed support for any property tax increase indicates a valuation among respondents for land conservation within city limits that may not benefit them in a direct monetary manner. Nevertheless, previous hedonic price model studies identify the value of public open space and the significant positive effect they have on home prices within a community (Bolitzer and Netusil, 2000; Correll et al., 1978). This finding is consistent with those studies as well as the hedonic model for Ames presented in this study (section 3.3) by demonstrating a stated willingness to pay for public open space.

Referenda concerning purchase and development of public recreation areas have a recent history in Ames with two consecutive bond issue measures for construction of an aquatic recreation center. The first measure, presented in 2003, was proposed to be financed with a mean total tax increase of $138.91 per year for the average home owner, and failed with only 43% support. The second measure, presented in 2007, passed with 76% support and was financed with a mean total of $40.78 per year for the average home owner. Strong public support for the second referendum indicates that there is a willingness to pay for public recreation goods. The similarity of the amount of increase in property tax values to the hypothetical tax referendum values determined in this analysis indicates that our survey estimate is plausible.

4. Conclusion and implications

In this study, we examined consumer preferences and willingness to pay for conservation subdivision and low-impact development features in residential neighborhoods by employing multiple approaches to valuation including contingent valuation surveys (with multiple choice, open-ended and referendum questions), experimental real estate negotiations, and spatial hedonic price models. Although we report on a single market in Ames, IA, we believe given the characteristics of our study area that the underlying relationships are generalizable across similar municipalities and housing markets in the Midwestern United States.

Together, the four approaches allowed us to elucidate how value is determined and expressed for a variety of features associated with standard and alternative subdivision designs. The survey included a larger sample frame than was possible for the other techniques, and provided information on the knowledge and perceptions of recent homebuyers in the Ames market and their hypothetical willingness to pay for alternative features based on those factors. The negotiation technique (although less well-tested than the other methods in this context) more closely simulated consumer interactions in a real market in which they were able to simultaneously compare properties with different attributes as well as doing so in a competitive setting. Further, the use of this technique allowed us to probe participants' values for hypothetical properties, since neither CSD nor LID subdivisions exist in Ames. Both the hedonic model and hypothetical referendum (because of a recent actual public referendum) helped us to “anchor” estimates of stated preference to measures of revealed preference.

The results from all of these methods consistently indicate that residents would value conservation subdivision (CSD) and low-impact development (LID) features, and would be willing to pay an additional amount for the inclusion of these features in their neighborhoods. Although there were differences in the magnitude of valuation estimates (some less constrained stated preference values were somewhat higher, particularly for the auction technique), there is strong evidence based on the combination of methods that alternative subdivision features are valued by homebuyers. Coupled with estimates for implementation of such designs suggesting that they may be less costly to build than standard designs (e.g., owing to less engineered infrastructure, Caraco et al., 1998; Coffman, 2000), developers and planners should seriously consider opportunities to implement these alternatives. Conservation subdivision design can be a useful tool for protecting specific areas of development sites while maintaining overall residential density requirements, and the effectiveness of LID approaches coupled with their demonstrated lower construction costs (Coffman, 2000), could provide more profitable and environmentally sensitive development practices in Ames.

This study suggests that familiarity with LID techniques has a positive effect on willingness to pay for these features. While familiarity with CSD approaches did not have a significant effect in our models, previous CSD experience (39%) was uniformly low among our respondents. There was some indication that residents were confusing CSD and LID approaches with “New Urbanist”-style developments which do not provide explicit environmental benefits. Providing more accurate information to community residents about CSD and LID features would likely increase interest in these features. Our results also consistently indicated that subdivision features with specifically identified environmental benefits were valued more highly than similar features without such positive externalities. Developers and planning officials should be encouraged, when possible, to choose features that provide for additional environmental benefits while maintaining feature aesthetics, and then to explicitly advertise the additional benefits to potential residents. In places with few or no examples of CSD and LID, market information about consumer interest in new subdivision designs and features could lower barriers and encourage use of alternative approaches to residential development. Developers and city officials will be able to assess the suitability and economic viability of these design features using valuation information that demonstrates consumer interest and willingness to buy into developments with low-impact and conservation design features.

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