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# The Value of Proximity to External Amenities and Mountain Views in the Metropolitan Denver Residential Housing Market

Tabatha Rose Waldron

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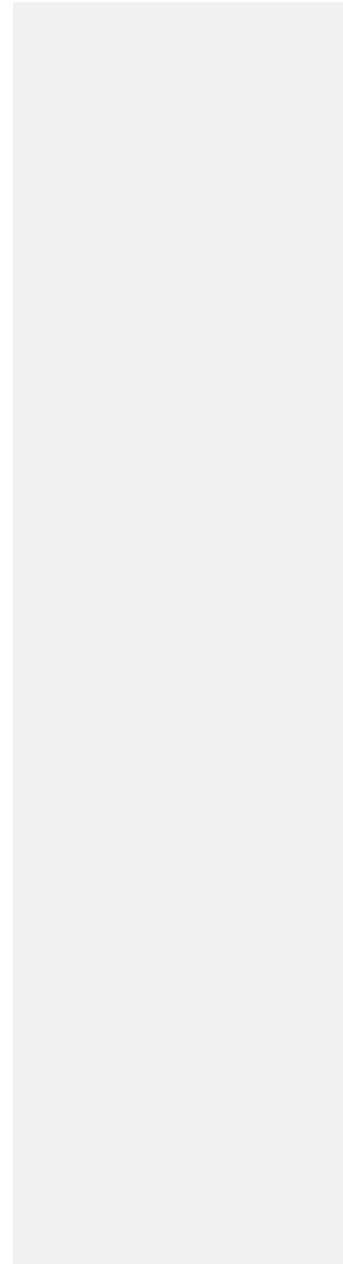
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Capstone Project

The Value of Proximity to External Amenities and Mountain Views in  
the Metropolitan Denver Residential Housing Market

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May 30, 2013



**ABSTRACT**

This research examines how natural amenities, such as views of Colorado's Front Range mountains and proximity to lakes, parks and recreational areas, as well as proximity to community amenities such as hospitals, active wastewater treatment plants, fire and a police stations impact residential housing prices in Adams, Arapahoe and Denver Counties using a hedonic pricing model. Views of the mountains produced the most impact on home sale value in 2000 followed by proximity to a lake of 250 feet. These results demonstrate the importance of environmental amenities to single-family home buyers and can be used to inform parties involved in the future development of the area.

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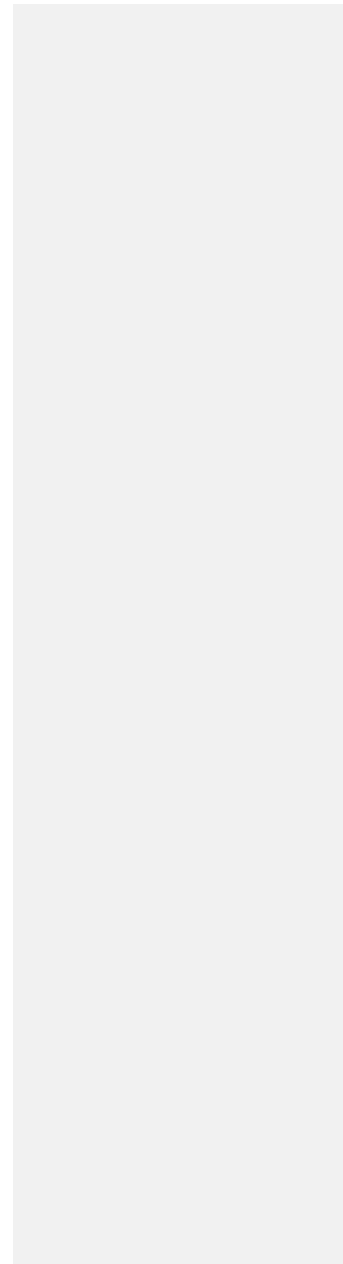
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**I. Introduction: What is the Value of Proximity to External Amenities and Mountain Views in the Metropolitan Denver Residential Housing Market?**

Once the basic need of shelter is met, humans in the developed world often enjoy furnishing and decorating their homes to make it more comfortable and pleasing to the eye. Most home buyers understand that the internal amenities, such as the number of bedrooms, bathrooms, square footage and floor location (Hui et al. 2006, 2333-2343; Ben-Shahar and Sulganik 2009, 25-33), plus the extra amenities, such as a fireplace, garage, swimming pool or balcony (Chau, Wong and Yiu 2004, 250-264) add value to homes (Sirmans and Macpherson 2003, 1-76).

Views of external amenities, such water and open space (Sander and Polasky 2008, 837-845; Geoghegan 2002, 91-98; Fraser and Spencer 1998, 94-98; Shultz and King 2001, 239-252), and easy access to such geographic features also add value to single-family homes (Benson, et al. 1998, 55-73).

What is pleasing to the eye varies among cultures (Jim and Chen 2009, 226-234), so this current research analyzes the price premiums of the subjective variables of view of the mountains as well as proximity to various amenities.

Proximity (Sirmans and Macpherson 2003, 1-76; Hui et al. 2003, 2333-2343; Bourassa, Hoesli and Sun 2004, 1427-1450) to the mountains and open spaces for attractive views as well as recreation are often important factors for home buyers. This study addresses the variable of proximity to such amenities as lakes, parks and recreational areas specifically in the

Colorado counties of Denver, Adams and Arapahoe. It also determines the price effect of places known for noise from sirens, such as hospitals, fire and police stations, or foul smells, such as active wastewater treatment plants.

Several studies have indicated that aircraft noise reduces the value of properties between 0.2% and 4.1% based on decibel of noise increases over a specific threshold level (Verhoef 1994, 273-286; Vainio 1995; Maddison, 1996, 357-379). This current study will evaluate if ambulance, fire truck and police car sirens have a similar effect on residential values within a half mile distance from the centroid of the hospital or station parcel. Also considered are wastewater treatment plants which when operating may emit offensive odors. Often the plants install systems to prevent odors from permeating the air in the surrounding communities. For this study, an expansion analysis is performed to review proximity to an active wastewater treatment plant in order to determine if being within a mile or less of a plant would decrease housing prices in the three counties observed.

Evaluated is the distance at which proximity no longer positively affects price if it has an effect on housing price at all (Benson, et al. 1998, 55-73; Burt, Fisher-Gewirtzman and Shach-Pinsly 2005, 22-37) or if the variable is actually having a negative effect on price.

This paper will present the relationships between humans and their environment and why views and proximity may impact home values. It will present the data requirements for the study, including geographic

information analysis data. It will also explain the hedonic pricing model, which is used to statistically analyze the data. The paper then follows with information about the three study areas in Colorado and finally concludes with results and a discussion of the findings.

**II. The Relationships between Humans and the Environment - Why Views and Proximity May Impact Home Value**

Distance to or views of geographic features such as mountains, lakes and beautifully manicured parks and recreational areas which are viewed as positive elements by community residents may cause the home price premium to increase. In this case, the results of the study will provide important insight into economic and social inequalities (McGranahan 2008, 228-240) that may arise among the Denver metropolitan area population. It was discovered that exposure to natural settings reduces stress (McGranahan 2008, 228-240), but can everyone gain easy access to those stress-reducing features? Is there a noticeable discount in home price due its location near a hospital, fire station, police station or active wastewater treatment plant? Is there a hidden premium assigned to homes which is implicit in the amount people are willing to pay for properties located nearest to lakes, parks and recreational areas?

McGranahan stated that recent migration patterns in the United States suggest a preference for landscape as a major factor. People are most often drawn to areas with a combination of forest and open land, water bodies, minimal crop land and some topographical variation. This could describe the



views of many homes in this paper's study area. Do views of the Front Range Mountains carry a price premium as well?

The value of this study is multifaceted. It provides not only a model for appraisers to aid homeowners and developers in accurately valuing residential properties and communities, but it also provides a better understanding of what various economic groups (Filippova 2009, 91) among the Denver metropolitan area population believe are beneficial, negative or inconsequential view and proximity factors.

This research answers questions for a variety of interest groups given the amount of research that has been previously conducted worldwide on view and proximity valuation. The subject's audience includes professionals and researchers in the fields of urban planning, landscape planning, land use, economics, agriculture, real estate, finance, environment, ecology, water management, population growth and urban development. This preliminary study aims to answer the following questions:

A. What is the price premium of proximity to external amenities such as lakes, parks and recreational areas, hospitals, fire and police stations, and active wastewater treatment plants?

Proximity to lakes, parks and recreational areas will be limited to "within 250 feet" and "within a quarter mile". Proximity to a hospital, fire or police station will be limited to "within a half of a mile".

Proximity to a wastewater treatment plant will be limited to "1 mile or less".

For all variables a 1 indicates it is "within the distance parameter set" and a 0 indicates it is "outside the distance parameter set".

B. What is the value of the view of X home in Y neighborhood with Z view? Mountain views will be given a score of 1 for "mountain view available" and 0 for "view of mountains not available".

### **III. Geographic Information Analysis: Data**

In order to perform spatial analysis, data which could be geocoded was required. The data acquired included longitude and latitude coordinates based on addresses for residential sales data from 2000, polygons for county boundaries, lakes, parks and recreational areas. Point data was collected for hospitals, fire stations, police stations and active wastewater treatment plants. After the view and distance factors for the external amenities were determined, I statistically analyzed the data with a hedonic pricing model.

The residential sales data for this study is compilation of housing sales information provided by Metroscan, a division of Core Logic, a commercial provider of housing information for appraisers and local data from various assessors' databases. The *Metroscan* data contains sales data from 1985 to 2000. These data contained physical, legal, and sales price information that was then prepared for statistical software input in conjunction with additional data gained from geographic analysis using ESRI's ArcMap software. Any records which were lacking significant data were deleted. An example would be a record which contained no sales price information which is necessary

for hedonic pricing method analysis. Also deleted were properties which were not single-family residences and homes which were quit claim deeds.

The ArcMap Geographic Information System (GIS) software was used to geolocate the sales in each county by address. Then the point and polygon data for lakes, parks and recreational areas, hospitals, fire houses, police stations and active wastewater treatment plants were added as separate layers which could then be buffered as required at varying distances and then analyzed using the spatial analysis clip feature to determine which properties were within vicinity of each amenity in question.

In order to determine if the random 450 homes I selected from the 2000 home sales data had views of the mountains, I chose to combine data I created through drive-by neighborhood visits with the street views provided by Google and Bing web-based mapping applications.

The final data set for 2000 is comprised of 586 single family sales observations for Adams County, 3,332 sales for Arapahoe County and 2,304 sales records for Denver County. The average home price in Adams County was \$176,603 with an average of 1,750 square feet and an average year for building completion of 1982. The average price of homes sold in 2000 in Arapahoe County was \$246,811. The average square footage of the homes was 2,077 feet and an average year for building completion of 1983. In Denver County the average home sold for \$226,805 and was an average of 1,865 square feet with an average year for building completion of 1954.

Waldron-11

Based on these averages, homes in Arapahoe County were larger, newer and priced higher than Adams and Denver County homes. Denver County homes were built on average 28 years before Adams County homes, but they were slightly larger and held significantly more value in comparison.

Below are three codebooks and three maps which depict the geospatial processes used on the layers of data to determine the binary code of 0 or 1 for each property analyzed across all three counties. Figures 1 through 3 show the list of potential variables available for statistical analysis and the form in which it was stored in the tables. It has been truncated because of the depth of data for certain items were insufficient, such as building quality, where the data did not span all the categories. Figure 4 shows an analysis performed to determine which Denver County properties were within a half mile radius of either a fire department or a police department. Figure 5 shows an analysis performed to determine which homes in the three counties were within a half of a mile of a hospital. Figure 6 shows the Adams County homes within 1 mile of an active water treatment plant.

ADAMS COUNTY DATA		
ProxLake250ft*	Distance to a lake is 250 feet or less	1,0
ProxLake.25mile*	Distance to a lake is .25 mile or less	1,0
ProxPark250ft*	Distance to a park is 250 feet or less	1,0
ProxPark.25mile*	Distance to a park is .25 mile or less	1,0
MountainView*	Residence house view of a mountain	1,0
Hospitals.50mile*	Distance to a hospital is within .50 mile or less	1,0
ExistingWaterTrtmnt1mi*	Distance to an active water treatment plant is 1 mile or less	1,0
Bedrooms	Number of Bedrooms	Number
Bathtot	Total number of Bathrooms	Number
BasementBinary*	States if there is or isn't a basement in the house	1,0
Adams*	States if the property is located in this county	1,0
Arapahoe*	States if the property is located in this county	1,0
Denver*	States if the property is located in this county	1,0
County	County Name	Name
Drywall*	States if the walls are constructed of drywall	1,0
Plaster*	States if the walls are constructed of plaster	1,0
FireplaceBinary*	States if there is or isn't a fireplace in the house	1,0
GarageBinary*	States if there is or isn't a garage	1,0
Attached*	States if the garage is attached to the house	1,0
Detached*	States if the garage is detached from the house	1,0
Basement*	States if the garage is in the basement of the house	1,0
Forced*	Type of air system for the home	1,0
Warm \ Cool Air*	Type of air system for the home	1,0
Elec Baseboard*	Type of air system for the home	1,0
Wall \ Floor*	Type of air system for the home	1,0
Cool \ Air Seprtr*	Type of air system for the home	1,0
Hot Water*	Type of air system for the home	1,0
LotAcres	The acreage of the residential lot	Number
Patio*	States if there is a patio	1,0
Spa*	States if there is a spa	1,0
Sauna*	States if there is a sauna	1,0
Pool*	States if there is a pool	1,0
Porch*	States if there is or isn't a porch	1,0
PriorPrice*	Price of the home when previously sold	Number
Excel Quality*	Quality class of the home's construction	1,0
Very Good Plus Quality*	Quality class of the home's construction	1,0
Very Good Quality*	Quality class of the home's construction	1,0
Good Plus Quality*	Quality class of the home's construction	1,0
Avg Plus Quality*	Quality class of the home's construction	1,0
Good Quality*	Quality class of the home's construction	1,0
Fair Quality*	Quality class of the home's construction	1,0
Low Quality*	Quality class of the home's construction	1,0
Bldgcond	Building condition	See table
Totalrms	Total number of rooms	Number
Price	Price of the home when sold in 2000	Number
1stflrsf	Total square footage of the 1st floor	Number
2ndflrsf	Total square footage of the 2nd floor	Number
TotalSf	Total square footage of the home excluding basement footage	Number
FinBsmSf	Total square footage of the finished basement	Number
GarageSf	Total square footage of the garage	Number
LotSf	Total square footage of the lot	Number
PatioSf	Total square footage of the patio	Number
PorchSf	Total square footage of the porch	Number
NoStory	Number of Stories	Number
TaxYear	Year of tax assessment	Year
TaxAmt	Amount of taxes assessed in the TaxYear	Number
ln of Price	Log of Price	Number
Age	Age of the home	Number
Yrblt	Year home was built	Year

\* 1 = yes, 0 = no

Bldgcond	Code
WORN OUT	1,0
BADLY WORN	1,0
AVERAGE	1,0
GOOD	1,0
VERY GOOD	1,0
EXCELLENT	1,0

Figure 1. Adams County Data Codebook  
 Author: Tabatha Waldron

ARAPAHOE COUNTY DATA		
ProxLake250ft	Distance to a lake is 250 feet or less	1, 0
ProxLake_25miles	Distance to a lake is .25 mile or less	1, 0
ProxPark250ft	Distance to a park is 250 feet or less	1, 0
ProxPark_25mille	Distance to a park is .25 mile or less	1, 0
MountainView	Residence house view of a mountain	1, 0
HospitalIn_50mille	Distance to a hospital is within .50 mile or less	1, 0
FireORPolice	A fire or police station is within .50 mile or less	1, 0
AirMthod	Heating method - 1 for Gas, 0 for Electric	1, 0
BathTot	Total number of Baths	Number
Bedrooms	Total number of Bedrooms	Number
Ranch*	If the home is a ranch style home	1, 0
2Story*	If the home is a 2-story style home	1, 0
Tri-Level*	If the home is a tri-level style home	1, 0
BldgCond	Condition of the Building	See table
NrStory	Total number of Building Stories	Number
DeckSqFt	Total square footage of the deck	Number
DeckBinary*	If the home has a deck	1, 0
FireplaceCount	Total number of fireplaces	Number
FireplaceBinary*	If the home does or doesn't have a fireplace	1, 0
SubFlooring*	Flooring material type in the home	1, 0
Hardwood*	Flooring material type in the home	1, 0
Softwood*	Flooring material type in the home	1, 0
Wood Joist*	Flooring material type in the home	1, 0
Carpets*	Flooring material type in the home	1, 0
Resilient*	Flooring material type in the home	1, 0
GarageBinary*	If there is or isn't a garage	1, 0
GarageSqFt	Total square footage of the garage	Number
GarageDetached*	If the home has a detached garage	1, 0
GarageNBasement*	If the home has a garage in the basement	1, 0
GarageAttached*	If the home has an attached garage	1, 0
HeatingSourceBinary	Heating source for home: 1 for gas, 0 for electric	1, 0
Wall or Floor*	Type of air system for the home	1, 0
Hot Water / Steam*	Type of air system for the home	1, 0
Gravity*	Type of air system for the home	1, 0
Electric*	Type of air system for the home	1, 0
Forced*	Type of air system for the home	1, 0
LotSqFt	Total Square Footage of the lot	Number
LotAcres	Lot acreage	Number
PatioBinary*	States if there is a patio	1, 0
PatioSqFt	Total square footage of the patio	Number
Spa	If the home has a spa or not	1, 0
Pool	If the home has a pool or not	1, 0
PricePrice	Price of the home when it was last sold	Number
RoofMat	Roofing material	Text
Aluminum*	Type of roofing material on the home	1, 0
Asbestos Shngl*	Type of roofing material on the home	1, 0
Built-up*	Type of roofing material on the home	1, 0
Concrete/Barltle*	Type of roofing material on the home	1, 0
Slate/Mission*	Type of roofing material on the home	1, 0
Wood Shake*	Type of roofing material on the home	1, 0
Asphalt Shngl*	Type of roofing material on the home	1, 0
PorchBinary*	If there is or isn't a porch	1, 0
PorchSqFt	Total square footage of the porch	Number
BsmTotSqFt	Total square footage of the basement	Number
TotalSqFt	Total square footage of the home	Number
TaxAmt	Taxes assessed for the Tax Year	Number
TaxYear	Year of tax assessment	Year
WallMat	Exterior/Building Envelope Material	Text
Asbestos*	Wall material for the home	1, 0
Stone*	Wall material for the home	1, 0
Block*	Wall material for the home	1, 0
Frame*	Wall material for the home	1, 0
Brick*	Wall material for the home	1, 0
Stucco*	Wall material for the home	1, 0
Wood*	Wall material for the home	1, 0
Price	Price of the home when sold in 2000	Number
Ln of Price	Log of Price	Number
Age	Age of the home	Number
YearBlt	Year the home was built	Year
YearBlt	The year the home was built	Year
Ln of Price	Log of Price	Number
Age	Age of the home	Number
Price	Price of the home when sold in 2000	Number

\* 1 = yes, 0 = no

BldgCond	Code
POOR CONDITION*	1, 0
FAIR CONDITION*	1, 0
AVERAGE CONDITION*	1, 0
NORMAL CONDITION*	1, 0
REHABILITATED CONDITION*	1, 0
GOOD CONDITION*	1, 0
EXCELLENT CONDITION*	1, 0

Figure 2. Arapahoe County Data Codebook  
 Author: Tabatha Waldron

DENVER COUNTY DATA

DenverLake250*	Distance to a lake is 250 feet or less	1, 0	* 1 = yes, 0 = no
Prox Lake25*	Distance to a lake is .25 mile or less	1, 0	
MtnView*	Residence house view of a mountain	1, 0	
Hospital.50mi*	Distance to a hospital is within .50 mile or less	1, 0	
Police.50mi*	A police station is within .50 mile or less	1, 0	
Firestation.50mile*	A fire station is within .50 mile or less	1, 0	
BathTot	Total number of bathrooms in the home	Number	
Bedrooms	Total number of bedrooms in the home	Number	
BldStyle	Building style of the home	Text	
1Story*	Building style of the home	1, 0	
2Story*	Building style of the home	1, 0	
1.5 Story*	Building style of the home	1, 0	
2.5 Story*	Building style of the home	1, 0	
Conversion*	Building style of the home	1, 0	
Tri-level(Basement*	Building style of the home	1, 0	
3Story*	Building style of the home	1, 0	
Bi-level*	Building style of the home	1, 0	
Row House\End*	Building style of the home	1, 0	
Split Level*	Building style of the home	1, 0	
Tri-level*	Building style of the home	1, 0	
BldGrade	Grade of the building	Text	
Avp*	Grade of the building	1, 0	
Fair*	Grade of the building	1, 0	
Excellent*	Grade of the building	1, 0	
Superior*	Grade of the building	1, 0	
DeckBinary*	If the home has a deck	1, 0	
Adams*	States if the property is located in this county	1, 0	
Arapahoe*	States if the property is located in this county	1, 0	
Denver*	States if the property is located in this county	1, 0	
County	County Name	Name	
Fireplace*	If the home has a fireplace	1, 0	
GanagBinary*	If the house has a garage	1, 0	
HeatBinary	Heating source for the home: 1 for gas, 0 for electric	1, 0	
HeatSrc	Heating source for the home	Text	
Electric*	Heating source for the home	1, 0	
Gas*	Heating source for the home	1, 0	
HotWater*	Heating source for the home	1, 0	
SolarHeat*	Heating source for the home	1, 0	
HeatMthd	Heating method for the home	Text	
LotAcres	Lot acreage	Number	
PatioBinary*	If the house has a patio	1, 0	
PoolBinary*	If the house has a pool	1, 0	
PorchBinary*	If the house has a porch	1, 0	
PriorPrice	Price of the home the last time it was sold	Number	
Spa*	If the home has a spa	1, 0	
DecksF	Total square footage of the deck	Number	
1stFlrSf	Total square footage of the 1st floor	Number	
2ndFlrSf	Total square footage of the 2nd floor	Number	
3rdFlrSf	Total square footage of the 3rd floor	Number	
AtticSf	Total square footage of the attic	Number	
SumTotSf	Total square footage of the basement	Number	
TotalSf	Total square footage of the home	Number	
LotSf*	Total square footage of the lot	Number	
PatioSf	Total square footage of the patio	Number	
PorchSf	Total square footage of the porch	Number	
NoStory	Total number of Building Stories	Number	
TaxYear	Year of tax assessment	Year	
TaxAmt	Amount of taxes assessed	Number	
WallMat	Exterior/Building Envelope Material	Text	
Frame*	Exterior/Building Envelope Material	1, 0	
Glass*	Exterior/Building Envelope Material	1, 0	
ConcreteBlock*	Exterior/Building Envelope Material	1, 0	
Concrete*	Exterior/Building Envelope Material	1, 0	
Wood*	Exterior/Building Envelope Material	1, 0	
Masonry\Frame*	Exterior/Building Envelope Material	1, 0	
Brick*	Exterior/Building Envelope Material	1, 0	
Stucco*	Exterior/Building Envelope Material	1, 0	
Stone*	Exterior/Building Envelope Material	1, 0	
Alam\Vinyl\Sst*	Exterior/Building Envelope Material	1, 0	
YearBlt	The year the home was built	Year	
Ln of Price	Log of Price	Number	
Age	Age of the home	Number	
Price	Price of the home when sold in 2000	Number	

Figure 3. Denver County Data Codebook  
 Author: Tabatha Waldron

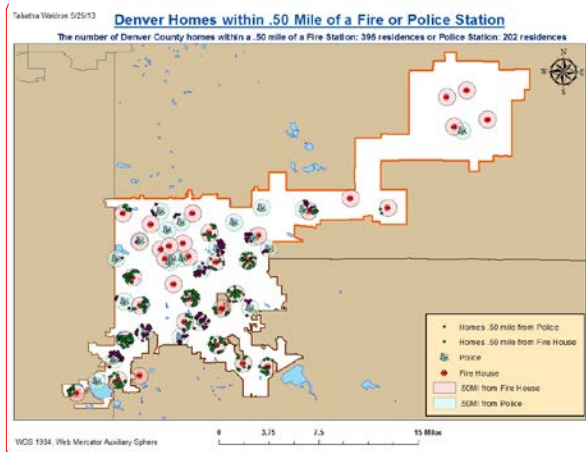


Figure 4. Denver Homes within a .50 mile of a Fire House or Police Station

Author: Tabatha Waldron

Comment [SRH1]: Revise these map titles to Home Sales within... for x time period because as is it is misleading.

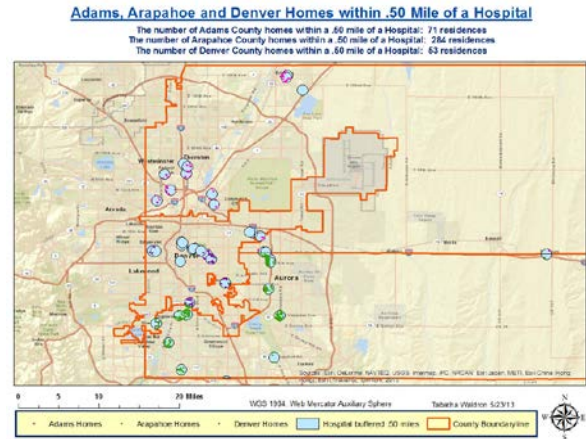


Figure 5. Adams, Arapahoe and Denver Homes within .50 miles of a Hospital

Author: Tabatha Waldron



### Adams County Homes Within 1 Mile of an Active Wastewater Treatment Plant

The number of Adams County homes within 1 mile of an active wastewater treatment plant: 153 residences

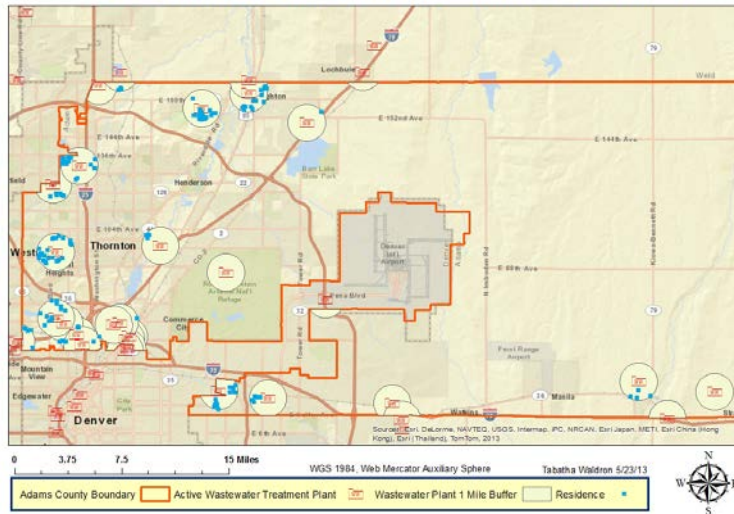


Figure 6. Adams County Homes within 1 Mile of an Active Wastewater Treatment Plant

Author: Tabatha Waldron

#### IV. Hedonic Pricing Model

This study employs the accepted hedonic pricing model first developed by Rosen (1974) and later refined by others, including Halvorsen et al. (1980) and Freeman (2003). This model uses the actual housing price as the dependent variable with a series of independent variables including physical housing attributes (square footage, number of bedrooms, number of bathrooms, existence of deck, porch or patio, building condition, lot size, number of fireplaces, number of garages, spa, pool, sauna) and location

characteristics including a variable of interest (view of the Front Range Rocky Mountains, proximity to lakes, parks and recreational areas, hospitals, fire and police stations, active wastewater treatment plants). The semi log form of the hedonic pricing function, which has previously shown to be less susceptible to dramatic fluctuations in housing prices (Lancaster 1966; Halvorsen 1980; Freeman 2003; Chin and Chau 2003; Rosen 1974; Jim and Chen 2006), is applied to statistically evaluate the sales data. In essence a Hedonic pricing model assumes that price represents the equilibrium of supply and demand for single family housing for the geographic area studied. The model is derived from the idea that housing is a composite good, containing a bundle of attributes. A hedonic pricing function assumes that the price of a bundle of goods is related to its characteristics, so a home's value is based on the characteristics of its internal amenities, such as bedrooms, bathrooms, square footage and number of floors, and in recent research, also the views and convenient access to external amenities the location provides.

The Standard hedonic price function is written as follows:

$$P = f(S,L,D,F)$$

These attributes were grouped in the following manner:

Where P is the sales price of the housing; S is a vector of structural characteristics such as the square footage of the home, number of bedrooms, number of bathrooms, age, etc.; L is a vector of spatial or

neighborhood characteristics, such as distance to a fire department or police station, hospital, active wastewater treatment plant, lake, park or recreation area; D is a variable of interest, view of the Rocky Mountains; F is a also a variable of interest, in this case a dummy variable for whether the property is within a specified distance of an external amenity, including a lake, park or recreation area, hospital, fire department, police station or an active wastewater treatment plant.

The initial model is as follows:

$\ln P_i = \log$  of housing price

S: a set of structural characteristics

L: a set of spatial housing attributes

D: view of the Rocky Mountains

F: proximity to park or other variable

$B_0$ : intercept term

The functional form is then represented as follows:

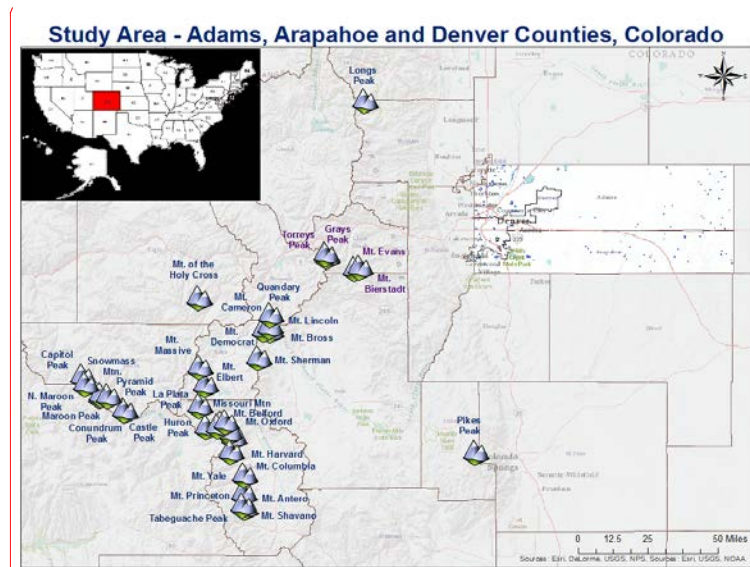
$$\ln P_i = \beta_0 + \sum_{j=1}^J \beta_j S_{ij} + \sum_{k=1}^K \beta_k L_{ik} + \beta_i D_i + \beta_i F_i + \varepsilon_i,$$

(for  $i = 1, 2, \dots, n$ )

Where  $\ln P_i$  is the natural log of the price for observation  $i$ ;  $S_{ij}$  is the  $j^{\text{th}}$  structural variable for the observation  $i$ ;  $L_{ik}$  is the  $k^{\text{th}}$  spatial and neighborhood variable for the observation  $i$ ;  $D_i$  is the view of the Rocky Mountains;  $F_i$  is the dummy variable for the proximity to park or other variable.

### V. Study Area

The study area includes three counties within the metropolitan Denver, Colorado area: Denver County, Adams County and Arapahoe County (Fig. 7). Within these boundaries the study analyzes residential point data in proximity to features such as lakes, parks and recreation areas, hospitals, active wastewater treatment plants, fire and police stations.



Comment [SRH2]: The 14's are the focal point of this map but they are not the theme. Remove them.

Fig 7. Study Area in Colorado consists of Adams, Arapahoe and Denver Counties  
Author: Tabatha Waldron

Adams County in Colorado had an estimated 441,603 citizens according to the United States Census Bureau in 2010. The number of housing units for

Waldron-20

this population was estimated to be 163,419 in 2011. The median home value of owner-occupied housing units during that same time period equaled approximately \$192,300. Median household income was \$56,089. The average number of persons per household was 2.88 between 2007 and 2011.

Arapahoe County had an estimated 572,137 citizens according to the United States Census Bureau in 2010. The housing units for this population were estimated to be 239,767 in 2011. The median home value of owner-occupied housing units during that same time period equaled approximately \$231,200. Median household income was \$59,937. The average number of persons per household was 2.53 between 2007 and 2011.

Denver County had an estimated 600,024 citizens according to the United States Census Bureau in 2010. The number of housing units for this population was estimated to be 286,790 in 2011. The median home value of owner-occupied housing units during that same time period equaled approximately \$243,400. Median household income was \$47,499. The average number of persons per household was 2.24 between 2007 and 2011.

## **VI. Results and Discussion**

For all counties, seasonality was controlled, except for Adams County due to the fact that the sample only covered sales in the first two quarters of the year and not the last two quarters. Figure 7 contains the Adams County



Adams 2

Source	SS	df	MS			
Model	39.5313026	18	2.19618348	Number of obs =	586	
Residual	54.0409414	567	.095310302	F( 18, 567) =	23.04	
Total	93.572244	585	.159952554	Prob > F =	0.0000	
				R-squared =	0.4225	
				Adj R-squared =	0.4041	
				Root MSE =	.30872	

lnofprice	Coef.	Std. Err.	t	P> t	[90% Conf. Interval]	
BasementBinary	.1084926	.0338648	3.20	0.001	.0526989	.1642864
BATHTOT	.0205042	.0259363	0.79	0.430	-.022227	.0632354
BEDROOMS	.0118322	.0234338	0.50	0.614	-.026776	.0504405
FireplaceBinary	.0720038	.0310805	2.32	0.021	.0207972	.1232104
GARAGEBINARY	.0342771	.0539806	0.63	0.526	-.0546584	.1232127
POOL	.0388264	.2202904	0.18	0.860	-.324112	.4017648
TOTALSF	.0002228	.0000282	7.90	0.000	.0001764	.0002693
LOTSQFT	-4.45e-07	1.19e-07	-3.75	0.000	-6.41e-07	-2.50e-07
NOSTORY	-.0492956	.0326124	-1.51	0.131	-.0044348	.1030259
age	-.0032747	.0008987	-3.64	0.000	-.0047553	-.001794
ProxLake250ft	-.0317601	.1272903	-0.25	0.803	-.2414766	.1779564
ProxLake25mile	.056436	.0455963	1.24	0.216	-.018686	.131558
ProxPark25mile	-.0688333	.0275249	-2.50	0.013	-.1141818	-.0234848
ProxPark250ft	-.0762891	.0631075	-1.21	0.227	-.1802616	.0276834
MountainView	-.053795	.1428902	-0.38	0.707	-.2892132	.1816231
HOSPITALS50	.0823165	.0499684	1.65	0.100	-.8.79e-06	.1646418
PROPOSEDwaterTrtmnt1-e	-.0306239	.2234372	-0.14	0.891	-.3987467	.337499
EXISTINGwaterTrtmnt1MI	.069802	.0370778	1.88	0.060	.0087146	.1308894
_cons	11.38918	.0951777	119.66	0.000	11.23237	11.54599

Figure 9. Adams County Hedonic Pricing Method Analysis

In Figure 9 Arapahoe County is statistically analyzed using the Hedonic Pricing Method. Among the highly significant variable is the total number of bathrooms, the number of stories, the garage, porch, total square footage of the home as well as mountain views. Also significant were fireplaces and decks. With a coefficient of .42, it can be assumed that mountain views do have a positive impact on housing values in Arapahoe County which is what was expected. The coefficient of the semi log equation can be interpreted as roughly a percentage, thus a result is that the mean house price of \$176,603 times 0.42 is a dollar estimate of the view of the

mountains, \$74,173.26.

Variable	Obs	Mean	Std. Dev.	Min	Max
bathtot	3332	2.470288	.9020738	0	9.5
bedcount	3332	3.089436	1.021731	0	7
adama	3332	0	0	0	0
denver	3332	0	0	0	0
arapahie	3332	1	0	1	1
noatory	3332	1.567902	.4947411	1	2
deck	3332	.5060024	.500039	0	1
fireplcount	3332	.9264706	.652682	0	6
fireplace	3332	.7881152	.408705	0	1
garage	3332	.9696879	.1714705	0	1
porch	3332	.8043217	.3967815	0	1
totalaf	3332	2076.706	846.6221	0	9553
qtone	3332	.1836735	.3872758	0	1
qttwo	3332	.2791116	.4486298	0	1
qthree	3332	.2929172	.4551691	0	1
qtfour	3332	.2442977	.4297345	0	1
price	3332	246810.6	176080.8	4000	3100000
lnofprice	3332	12.29116	.4747567	8.29405	14.94691
year	3332	1982.939	16.11391	1906	2007
age	3332	17.06122	16.11391	-7	94
procpark25	3332	.2232893	.4165132	0	1
procpark250	3332	.0006002	.0244961	0	1
proclake250	3332	.0006002	.0244961	0	1
proclake25	3332	.0288115	.1673016	0	1
mtnview	3332	.005102	.0712568	0	1
hospitalha-a	3332	.0348139	.1833358	0	1
firecpoli-a	3332	.1239496	.3295735	0	1
AB	0				

Comment [SRH3]: Where are you pasting from?  
Too fuzzy.

Figure 10. Arapahoe County Descriptive Statistics



Source	SS	df	MS				
Model	462.443669	18	25.691315	Number of obs = 3332			
Residual	288.343368	3313	.087033917	F( 18, 3313) = 295.19			
Total	750.787038	3331	.225393887	Prob > F = 0.0000			
				R-squared = 0.6159			
				Adj R-squared = 0.6139			
				Root MSE = .29502			

	lnofprice	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
	bathtot	.0704504	.0100081	7.04	0.000	.0508277	.0900731
	bedcount	-.0053622	.0063453	0.85	0.398	-.0070789	.0178033
	nostory	.050057	.0137871	3.63	0.000	.0230248	.0770891
	deck	.0339441	.0105611	3.21	0.001	.0132372	.054651
	fireplace	.0493473	.014281	3.46	0.001	.0213468	.0773477
	garage	.1190024	.0310746	3.83	0.000	.0580751	.1799296
	porch	.054884	.0135448	4.05	0.000	.0283271	.081441
	totalsf	.0003239	.0000101	32.15	0.000	.0003041	.0003436
	qtrone	-.1599664	.0158589	-10.09	0.000	-.1910606	-.1288721
	qtrtwo	-.0745717	.0142216	-5.24	0.000	-.1024557	-.0466877
	qtrthree	-.0273699	.01403	-1.95	0.051	-.0548782	.0001384
	age	-.0001099	.0004152	-0.26	0.791	-.0009239	.0007042
	proxpark25	-.0156946	.0132807	-1.18	0.237	-.0417338	.0103446
	proxpark250	.1002284	.2089624	0.48	0.632	-.3094801	.509937
	proxlake250	0	(omitted)				
	proxlake25	.0770348	.0329854	2.34	0.020	.0123611	.1417086
	mtnview	.4218931	.0752025	5.61	0.000	.274445	.5693412
	hospitalhalfmile	-.0111639	.0289982	-0.38	0.700	-.0680202	.0456923
	fireorpolicehalfmile	-.0133647	.0156546	-0.85	0.393	-.0440583	.017329
	_cons	11.19504	.041196	271.75	0.000	11.11427	11.27581

Figure 11. Arapahoe County Hedonic Pricing Method Analysis

In Denver, total square footage was significant as it was for the other two counties in this study. Age of the home and bathrooms were statistically significant and positive, while lot size was significant and negative, similar to other counties. These results suggest a need to determine if some properties could be subdivided as individual lots. Having a home within 250 feet of a lake was also statistically significant, and positive as expected, along with hospitals. Other spatial variables including proximity to parks, fire stations and police stations were not significant.

Comment [SRH4]: I don't get the connection here. Explain.

Comment [SRH5]: Just out of curiosity did you include Cop Shops?

Variable	Obs	Mean	Std. Dev.	Min	Max
BATHTOT	2304	2.030165	.9281981	0	9
BEDROOMS	2304	2.812066	.8427424	0	9
LOTACRES	2304	.1621181	.0828044	.03	2.43
PATIObinary	2304	.3055556	.4607423	0	1
POOLbinary	2304	.0069444	.0830615	0	1
Porchbinary	2304	.8207465	.3836477	0	1
BSMTOTSF	2304	653.6332	549.7316	0	3308
TOTALSF	2304	1864.808	985.5982	369	12725
GARAGESF	2304	359.6662	210.2073	0	1755
LOTSQFT	2304	7061.816	3606.97	1307	105851
qtr1	2304	.219184	.4137834	0	1
qtr2	2304	.2690972	.4435869	0	1
qtr3	2304	.2534722	.4350933	0	1
qtr4	2304	.2582465	.4377653	0	1
YEARBLT	2304	1954.213	32.34091	1882	2006
AGE	2304	45.78733	32.34091	-6	118
PRICE	2304	226805.1	153024	4600	1850000
lnofprice	2304	12.18697	.5243507	8.433812	14.4307
DenverLa-250	2304	.0030382	.055048	0	1
ProxLake25	2304	.0564236	.230788	0	1
MTNview	2304	.0043403	.0657519	0	1
HOSPITALS50	2304	.015191	.1223385	0	1
Police50mile	2304	.0555556	.2291111	0	1
FireStatio-e	2304	.1111111	.3143379	0	1

Figure 12. Denver County Descriptive Statistics

Denver data final

Source	SS	df	MS			
Model	330.392722	17	19.434866	Number of obs =	2304	
Residual	302.802485	2286	.13245953	F( 17, 2286) =	146.72	
Total	633.195207	2303	.274943642	Prob > F =	0.0000	
				R-squared =	0.5218	
				Adj R-squared =	0.5182	
				Root MSE =	.36395	

lnofprice	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
BATHTOT	.0488771	.0152878	3.20	0.001	.0188977	.0788565
BEDROOMS	-.0032861	.0110712	-0.30	0.767	-.0249968	.0184246
PATIObinary	.0099832	.0180617	0.55	0.581	-.0254358	.0454021
POOLbinary	.0729773	.094542	0.77	0.440	-.1124198	.2583745
Porchbinary	.0120251	.0201002	0.60	0.550	-.0273914	.0514415
TOTALSF	.0003533	.0000144	24.55	0.000	.0003251	.0003815
LOTSQFT	-4.48e-06	2.35e-06	-1.90	0.057	-9.09e-06	1.34e-07
qtr1	-.1111486	.0221122	-5.03	0.000	-.1545108	-.0677865
qtr2	-.0614218	.0209476	-2.93	0.003	-.1025	-.0203435
qtr3	-.0279599	.0212727	-1.31	0.189	-.0696757	.013756
AGE	.0011798	.0002666	4.43	0.000	.000657	.0017026
DenverLake250	.3895082	.1396085	2.79	0.005	.1157357	.6632808
ProxLake25	-.0388656	.0334036	-1.16	0.245	-.1043701	.0266389
MTNview	-.1611399	.1155998	-1.39	0.163	-.3878314	.0655515
HOSPITALS50	.1324878	.0624442	2.12	0.034	.0100345	.254941
Police50mile	-.00278	.0334287	-0.08	0.934	-.0683338	.0627737
FireStation50mile	.0373564	.0245375	1.52	0.128	-.0107617	.0854745
_cons	11.44605	.0409793	279.31	0.000	11.36569	11.52641

Figure 13. Denver County Hedonic Pricing Method Analysis

In the final analysis all counties were combined. Because the counties did not share all the same variables, the number of variables available to analyze was limited. Mountain views were significant and positively correlated to price and again had a coefficient of .40, or almost 40% of the mean house price. Also highly correlated were the number of bathrooms in the homes, the number of bedrooms and the fireplaces in the home as well as the existence of a patio or porch, and the age of the home. The existence of a pool on the property was also positively correlated with price. Proximity to a park was negatively correlated with housing price while distance to a

lake was significant and positive at a distance of 250 feet as well as a quarter mile away.

Overall the results show that mountain views play an important role in the purchase of a residence because the value of the mountain view is implicit in the prices people are willing to pay for the additional amenity of views.

Variable	Obs	Mean	Std. Dev.	Min	Max
BATHTOT	6224	2.283821	.9298365	0	9.5
BEDROOMS	6224	2.984094	.937842	0	9
TOTALSF	6224	1967.099	895.7564	0	12725
Adams	6224	.094473	.2925092	0	1
Arapahoe	6224	.535347	.4987891	0	1
Denver	6224	.3701799	.4828915	0	1
FireplaceB-y	6224	.6613111	.473302	0	1
GARAGEBINARY	6224	.7851864	.410726	0	1
PATIO	6224	.2657455	.4417649	0	1
SPA	6224	.0465938	.2107842	0	1
SAUNA	588	.0170068	.1294065	0	1
POOL	6224	.0077121	.0874862	0	1
PORCH	6224	.7914524	.4063028	0	1
PRICE	6224	232803	161846.5	4000	3100000
lnofprice	6224	12.22588	.4948333	8.29405	14.94691
LOTSQFT	6223	9352.326	34362.82	0	1990039
NOSTORY	6224	1.458186	.4969868	0	3
YEARBLT	6223	1972.224	27.36172	1882	2007
AGE	6224	27.77105	27.36179	-7	118
ProxLake25~t	6224	.0025707	.0506409	0	1
ProxLake25~e	6224	.0454692	.2083475	0	1
ProxPark25~e	6224	.1539203	.3609013	0	1
ProxPark25~t	6224	.0044987	.0669268	0	1
MountainView	6224	.0053021	.0726278	0	1
HOSPITALS50	6224	.0311697	.17379	0	1

Figure 14. Adams, Arapahoe and Denver Counties Combined Descriptive Statistics

Source	SS	df	MS			
Model	683.682459	19	35.9832873	Number of obs =	6222	
Residual	838.372648	6202	.135177789	F( 19, 6202) =	266.19	
Total	1522.05511	6221	.244664058	Prob > F =	0.0000	
				R-squared =	0.4492	
				Adj R-squared =	0.4475	
				Root MSE =	.36767	

lnofprice	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
BATHTOT	.2723872	.006901	39.47	0.000	.2588589	.2859155
BEDROOMS	.0326869	.0061552	5.31	0.000	.0206206	.0447533
TOTALSF	-.0000192	5.32e-06	-3.61	0.000	-.0000296	-8.76e-06
Arapahoe	.140614	.0176326	7.97	0.000	.106048	.17518
Denver	.1616415	.0201143	8.04	0.000	.1222104	.2010726
FireplaceBinary	.1832518	.0115222	15.90	0.000	.1606643	.2058393
GARAGEBINARY	-.0027971	.0165946	-0.17	0.866	-.0353282	.0297341
PATIO	.0433491	.0111991	3.87	0.000	.021395	.0653032
POOL	.1978566	.0535683	3.69	0.000	.0928441	.3028691
PORCH	.0603802	.0118893	5.08	0.000	.037073	.0836874
LOTSQFT	1.03e-07	1.37e-07	0.75	0.452	-1.65e-07	3.71e-07
NOSTORY	.0314768	.0121961	2.58	0.010	.0075681	.0553854
AGE	.0017153	.0002605	6.59	0.000	.0012047	.0022259
ProxLake250ft	.1922559	.093561	2.05	0.040	.008844	.3756678
ProxLake25mile	.0447482	.0229092	1.95	0.051	-.0001618	.0896582
ProxPark25mile	-.0395283	.0141395	-2.80	0.005	-.0672466	-.01181
ProxPark250ft	-.0286336	.0721649	-0.40	0.692	-.1701017	.1128345
MountainView	.4036597	.0649759	6.21	0.000	.2762845	.5310349
HOSPITALS50	.0028179	.0272764	0.10	0.918	-.0506534	.0562892
_cons	11.13594	.0326934	340.62	0.000	11.07185	11.20003

Figure 15. Adams, Arapahoe and Denver Combined Hedonic Pricing Method Analysis

VII. Significance and Conclusions

A study of this kind has not been conducted on the Denver residential market. I believe the results will be of great interest to realtors, appraisers, investors, architects, planners, developers, builders, homeowners, anthropologists and geographers alike. The resulting data will potentially aid various professionals in making educated decisions as to site location, orientation, architectural design, urban and natural resource planning for view and profit maximization. (f studies such as this were conducted in a

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uniform manner on a national scale. It would enable appraisers to provide more accurate residential appraisals, because it would also include additional view and proximity values.

Comment [SRH6]: Is there any hope of this.

Homeowners will benefit from the additional view factor premium data when involved in community hearings or legal cases regarding the depreciation of their homes due to new development in their immediate vicinity. Geographers and anthropologists will gain a more in-depth understanding of how placement of one's residence is correlated with various social and economic factors. Potentially this information could influence the decisions of urban planners and other development professionals, especially when creating livable, sustainable communities which add value to the lives of their residents.

This quantitative study evaluates the value of amenities which may often be taken for granted by developers as a community is urbanized. The results indicate that people value mountain views and it is implicit in the prices they are willing to pay for their homes in the Metropolitan Denver area. They are willing to pay almost 42% more for nice views of the Front Range Mountains and as much as 38.9% for lakefront property within 250 feet, according to the study area's 2000 sales data. Access to hospitals, firefighting services and law enforcement officers is necessary, but being within a half of a mile of such noisy amenities does not appear to depreciate the value of the surrounding homes, in fact, it appears that in some instances being within a

Comment [SRH7]: Are PDs noisy?

~~h~~Half-~~of-a~~ mile of a hospital may increase home price. It is curious to see how active wastewater treatment plants, which have been known to emit foul odors and lead to additional nuisances, appeared to appreciate housing price in this analysis, perhaps an omitted variable is also within a one-~~mile~~ radius of the homes analyzed which caused such peculiar results.

As development in the Denver Metropolitan area increases, access to views of the mountains and proximity to positively associated amenities, such as parks, recreational areas and lakes, may cause the value they add to residential price premiums to change. In contrast, an increase in the number of parks and recreational areas or open spaces in an area may cause the value they add to a residence to decrease due to saturation. A study of the value of open space in the Denver Metropolitan area warrants further examination in order to better inform land use planners of its benefits. This study did not evaluate the value of proximity to lakes or parks and recreational areas on a neighborhood by neighborhood basis, nor did it evaluate how the size of a lake or park may affect a neighborhood's residential property values. There is much more to discover about the value of various degrees of mountain and lake vistas on property prices in the metropolitan area and it offers additional research opportunities. Studies that examine natural amenity to residential pricing relationships will better inform land use planning and policies, so development in the Metropolitan

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Denver area can occur in an organized and socioeconomically positive manner.

The prices calculated for this research are the values of the amenities as they are reflected by single-family housing and do not include the values of the amenities for businesses or area tourism. It is possible that when considering the worth of these amenities to businesses or area tourism that their price will increase.

Failure to heed the overwhelming amount of research done on the topic of views and proximity to natural features could negatively impact the environment as it is overtaken by urban development and could potentially lead to additional negative social, economic and ecological consequences. Planners need to assess the compromises they are making very carefully and consider the impacts of their choices on the communities they serve.



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