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Steven Shultz
University of Nebraska at Omaha

Nick Schmitz
University of Nebraska at Omaha

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Extended Abstract of a paper to be presented at the:
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Session # 3: 'Waterborne Diseases' (Tuesday July 24)

Title:

The Impact of Rural Water Supply Systems on Property Values

Authors:

Steven Shultz and Nick Schmitz
Real Estate Research Center
University of Nebraska-Omaha
Email: sshultz@mail.unomaha.edu

The Impact of Rural Water Supply Systems on Property Values

Executive Summary:

As part of a USGS/NIWR 104G research project, the impact of rural water supply systems on rural-residential property values was quantified both in North Dakota and Nebraska. Rural water pipelines and service areas along with residential sale locations were digitized into a geographic information system (GIS) database and hedonic multiple regression models were used to measure the marginal impact of rural water on sale prices while accounting for varying housing characteristics.

The study area in North Dakota included seven agricultural counties in the south central part of the State (188 sales) while in Nebraska the focus was a single semi-rural county just North of Omaha (145 sales). A combination of surveys with the buyers/sellers of properties and drive-by inspections were used to collect needed information on the characteristics and condition of homes sold over the 2000 to 2005 time-period.

Homes with rural water supply hook-ups sold for less than those on public water systems in both states, but the rural water homes were also smaller and older than the public water homes. In North Dakota, water quality of private wells is higher among non-connected versus connected homes (this was not evaluated in Nebraska).

However, based on a hedonic based multiple regression model it was found that egression results indicate that rural water supply connections ***do not*** have a statistically significant impact on housing prices in ***any*** of the study locations. This is shown to be the result of relatively small sample sizes (few arms-length rural residential sales) and highly heterogeneous housing and drinking water conditions across the study areas. It is also likely due to the fact that most lending institutions require rural water connections for the financing of all new home construction. This research also demonstrated that the water quality of private wells is higher among non-connected versus connected homes which implies that property owners decisions to sign up for rural water services is likely to be influenced by property specific rather than regional water quality measures. Such factors should be quantified and evaluated prior to the funding and implementation of rural water supply projects to avoid lower than expected customer sign-ups.

Finally, difficulties associated with hedonic price modeling of rural water supply systems are contrasted to more successful water-based hedonic valuations: the contribution of irrigation to agricultural land values and the impact of man-made lakes and flood risk on urban property values.

Background:

In 1986, the federal government authorized for North Dakota, the 'municipal, rural and industrial (MR&I) water supply program', funded partially by a $200 million federal grant, which has helped many North Dakota water systems obtain a clean, reliable supply of water for residences, farms, schools, hospitals and industries. Much of the focus of these funds, which have been matched by State and local funds, has been rural water projects. Similar rural water supply projects are being implemented in nearby northern great plain states and many of the economic benefits associated with the large investments are unknown.

It is hypothesized that access to improved water supplies though the implementation rural water supply projects across North Dakota positively impact agricultural and rural-residential property values. The overall goal of this research project is to quantify such indirect economic benefits associated with rural water supply projects. Such information is considered necessary to justify the substantial financial investments in rural water supply projects across North Dakota. Specifically, comparing the costs and benefits of rural water supply projects is needed to ensure the wise use of public funds and to convince local governments and property owners to provide matching funds (cost-sharing) for such projects. At the same time, by demonstrating that rural property values will increase with improved water services, it is expected that property owners and local decision-makers will further support local cost-sharing required of many Federal rural water supply projects. Finally, properties with rural water supply infrastructure are worth more than similar properties without such water supplies, adjustments should be made to the tax liabilities of particular properties.

With funding over the 2005-2007 time period with a USGS/NIWR 104G research grant, the impact of rural water supply systems on rural-residential property values was quantified both in North Dakota and Nebraska. Rural water pipelines and service areas along with residential sale locations were digitized into a geographic information system (GIS) database and hedonic multiple regression models were used to measure the marginal impact of rural water on sale prices while accounting for varying housing characteristics.

The study area in North Dakota included seven agricultural counties in the south central part of the State (152 sales) while in Nebraska the focus was a single semi-rural county just North of Omaha (176 sales). Figures 1 and 2 depict the locations and the sample populations of houses in each of these two study areas.

Populations in both study locations rely on groundwater for their drinking water needs. Most sources of groundwater in these states consist of shallow glacial fluvial aquifers composed of gravel and sand. These aquifers tend to be near the surface, small, and highly localized, and subject to contamination from nitrates and other agricultural contaminates including arsenic. In addition to potential health risks from private wells, the taste and color of this water is also often poor. The Washington County rural water supply project in Nebraska differs from the North Dakota sample as the Nebraska location is more urbanized with rapidly growing residential developments due to its close proximity to the Omaha metropolitan area.

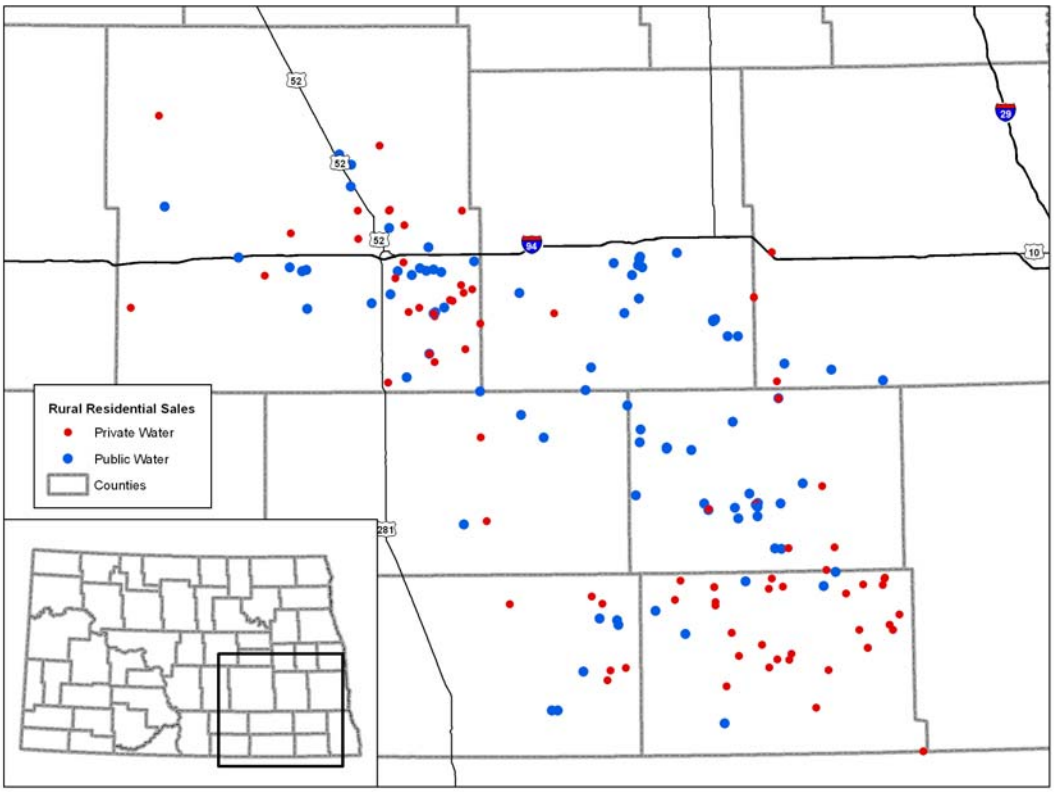

Figure 1. Rural Water Study Location in North Dakota

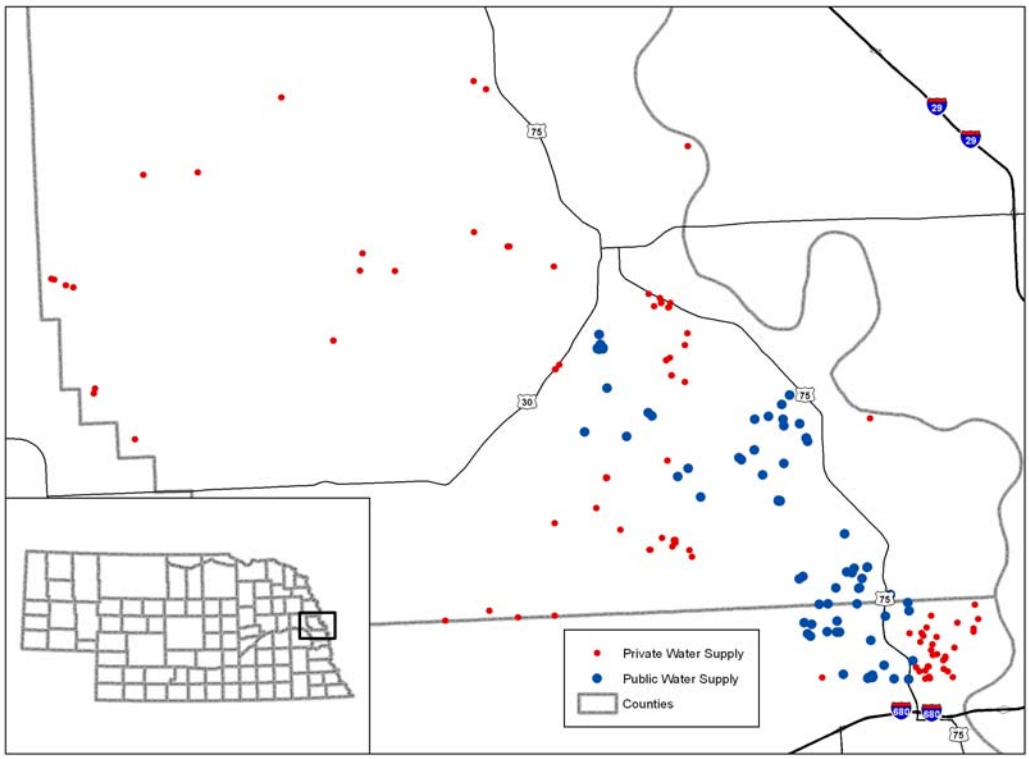

Figure 2. Rural Water Study Location in North Dakota

Methods and Results:

Differences in Homes with Rural and Public Water Systems

In North Dakota a listing of homes sold over the 2000 to 2005 time-period was obtained form county tax directors. A combination of surveys with the buyers/sellers of properties and drive-by inspections were used to collect needed information on the characteristics and condition of homes (but these inspections did not allow researchers to collect data on the interior of the home). Sale locations were digitized into a GIS database and 'Near' function were used to calculate the distance of the sale to the nearest of a variety of features (cities, interstates and State Highways, Other Paved Roads (lines), groundwater testing sites, and rural water service areas. The water supply status of all homes was confirmed either through phone surveys with homeowners and/or reviews of water utility customer records. Summary characteristics of the resulting 188 sales are summarized in Table 1.

Rural water homes are less expensive and smaller than homes on public water and rural water homes have higher water quality compared to the wells near homes on public water).

Table 1. Summary Characteristics of the Sample of Sold Rural Properties in North Dakota

Variable	Private (n=92)	Public (n=96)	All (n=188)
Sale Price ($)	59,206*	71,956	66,168
Total Dissolved Solids* (in nearby test wells)	1,756*	2,479*	2,151
Lot Size (acres	12.2	9.5	10.8
House Sq. Ft.	1,255**	1,483**	1,380
D Central Air	0.26**	0.47**	0.38
Bathrooms	1.32	1.73	1.55
Bedrooms	2.83	3.04	2.94
Age	37	32	34
D Oil Furnace	0.03	0.17	0.11
D Gable Roof	0.84	0.75	0.79
D Gas Fireplace	0.09	0.20	0.15
Outbuilding Sq. Ft.	680	863	780
Distance to Hospital [miles]	14.28	11.03	12.51
Dist to Large City [Miles]	9.29	9.38	9.34
D Block Basement	0.38	0.34	0.36
D 2001	0.14	0.12	0.13
D 2002	0.16	0.22	0.19
D 2003	0.23	0.18	0.20
D 2004	0.16	0.19	0.18
D 2005	0.14	0.14	0.14
Latitude	5,151,653	5,163,143	5,157,927
Longitude	568,240	567,437	567,802

Bold Variables Tested for Difference Using a paired t-test
* Different across Water Supply Types at the 5% level
**Different across Water Supply Types at the 1% level

In Nebraska, multiple listing service sales data was used to identify homes sold during the 1996 to time-period. Home locations were geo-coded to measure the same distance and water supply status variables as in North Dakota. These variables are summarized in Table 2. As in North Dakota, rural water homes are less expensive and smaller than homes on public water.

Table 2. Summary Characteristics of the Sample of Sold Rural Properties in North Dakota

Variable	Private (n= 103)	Public (n= 84)	All (n=187)
Sale Price ($)	222,710*	228,116 *	225,137
D Rural Water	0.00	1.00	0.45
Age	29.48 **	24.12**	27.18
House Sq. Ft.	2,543**	2,649**	2591
Garage Spaces	2.21	2.17	2.19
D Metal Siding	0.09	0.06	0.07
Bedrooms	3.53	3.43	3.49
Bathrooms	2.70	2.74	2.72
D Updated HVAC	0.72	0.70	0.71
Basement Finished Sq. Ft.	572	572	572
D Vinyl Siding	0.29	0.13	0.22
D Brick	0.09	0.14	0.11
D 1997	0.03	0.04	0.03
D 1998	0.04	0.08	0.06
D 1999	0.11	0.08	0.10
D 2000	0.12	0.14	0.13
D 2001	0.11	0.17	0.13
D 2002	0.05	0.12	0.08
D 2003	0.12	0.10	0.11
D 2004	0.12	0.07	0.10
D 2005	0.20	0.13	0.17
D 2006	0.09	0.04	0.06

Bold Variables Tested for Difference Using a paired t-test
* Different across Water Supply Types at the 5% level
**Different across Water Supply Types at the 1% level

Multiple Regression Modeling.

A hedonic based multiple regression model was estimated for each sample (state) to quantify whether rural water supply systems have a statistically significant impact on the sale prices of rural homes while accounting for an array of other housing and location-based characteristics. The results are summarized in Tables 3 and 4. Due to heteroskedacity in each model both ordinary least square (OLS) and variance weighted least (VWLS) squares results are reported.

Regression results indicate that rural water supply connections ***do not*** have a statistically significant impact on housing prices in ***any*** of the study locations. This may be the result of relatively small sample sizes (few arms-length rural residential sales) and highly heterogeneous housing and drinking water supply conditions across the study areas. It is also likely due to the fact that most lending institutions require rural water connections for the financing of all new home construction.

Table 3. Multiple Regression Results (North Dakota)

	OLS		VWLS	
Variable	Coef.	P>t	Coef	P>z
D Rural Water	-702	0.904	878	0.862
LN Lot Size	5,922	0.003	5,287	0.001
LN House Size	10,607	0.162	9,663	0.153
D Central Air	26,361	0.000	25,807	0.000
Bathrooms	8,199	0.073	5,940	0.166
Bedrooms	1,622	0.576	3,201	0.210
Age	-283	0.014	-312	0.001
D Oil Furnace	-15,719	0.092	-14,909	0.041
D Gable Roof	-15,193	0.025	-12,440	0.037
D Gas Fireplace	7,366	0.240	9,661	0.132
Outbuilding Sq. Ft.	2.01	0.328	1.50	0.454
Distance to Hospital [miles]	-1,168	0.051	-1,032	0.023
Dist to Large City [Miles]	-1,817	0.018	-1,505	0.017
D Block Basement	8,523	0.137	4,966	0.335
D 2001	-8,657	0.379	-7,427	0.384
D 2002	-5,671	0.541	-2,600	0.742
D 2003	-5,443	0.545	-1,802	0.813
D 2004	9,667	0.291	10,720	0.162
D 2005	16,439	0.087	17,214	0.034
Latitude	0.26	0.025	0.25	0.011
Longitude	-6.58	0.004	-5.45	0.003
Longitude^2	0.00	0.003	0.00	0.002
Constant	450,857	0.621	137,172	0.858
Obs.	152			150
F-Value	9.86		Chi^2	259.92
Prob> F	0.000		$Prob>Chi^2$	0.000
R^2	0.627			
Adj. R^2	0.5634			
Root MSE	30036			

Table 4. Multiple Regression Results (Washington County, Nebraska)

	OLS		VWLS	
Variable	Coef.	P>t	Coef.	P>z
D Rural Water	-1,770	0.855	-8,309	0.253
Age	-157	0.393	-27.77	0.813
House Sq. Ft.	79.10	0.000	82.44	0.000
Garage Spaces	16,686	0.000	18,780	0.000
D Metal Siding	-25,592	0.159	-29,558	0.017
Bedrooms	-26,163	0.000	-31,604	0.000
Bathrooms	21,609	0.006	14,360	0.022
D Updated HVAC	-14,603	0.191	-21,461	0.015
Basement Finished Sq. Ft.	-7.86	0.455	-8.18	0.441
D Vinyl Siding	11,297	0.370	7,121	0.462
D Brick	34,440	0.034	41,186	0.006
D 1997	21,559	0.556	19,596	0.413
D 1998	-6,251	0.841	15,226	0.457
D 1999	49,320	0.102	31,732	0.146
D 2000	21,871	0.447	18,693	0.370
D 2001	22,175	0.444	28,522	0.186
D 2002	13,014	0.674	5,503	0.810
D 2003	57,628	0.050	41,074	0.060
D 2004	78,906	0.010	58,988	0.012
D 2005	50,880	0.069	41,811	0.039
D 2006	79,370	0.013	76,314	0.002
Constant	-11,585	0.752	24,284	0.316
Obs.	176			175
F-Value	31.02		Chi^2	1163.01
Prob> F	0.000		$Prob>Chi^2$	0.000
R^2	0.8001			
Adj. R^2	0.7743			

Conclusions:

This research has demonstrated that the water quality of private wells is higher among non-connected versus connected homes (In North Dakota) which implies that property owners decisions to sign up for rural water services is likely to be influenced by property specific rather than regional water quality measures. Such factors should be quantified and evaluated prior to the funding and implementation of rural water supply projects to avoid lower than expected customer sign-ups.

However, difficulties associated with hedonic price modeling of rural water supply systems are not as statistically robust and informative for water policy decision-making as with other recent applications. For example, the authors have recently used hedonic multiple regression modeling to successfully quantify the impact of reservoir views on housing values, and the impact of low impact housing developments (from a storm water runoff perspective) on property values. Both studies were conducted in the metropolitan area of Omaha, NE and were hence able to take advantage of much larger sample sizes and more heterogeneous housing characteristics.