CENTER FOR REGIONAL ANALYSIS RESEARCH BRIEF

Residential Property Value Impacts of Proximity to Electric Substations

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The following reports the findings of our analysis of residential property sales in Fairfax County in 2023 to examine if being close to an electric utility power substation negatively impacts property values.

Electric power substations are a critical component of the power distribution system. The main functions of these stations include:

- Voltage transformation: Step-up voltage levels for long-distance transmission or step-down voltage for local distribution to household, commercial, and industrial users.
- Switching operations: Connect or disconnect parts of the power grid for rerouting power if required for equipment maintenance or repair or service restoration.
- Protection and control: Substations include circuit breakers, relays, and other equipment to detect faults and protect the power system.
- Regulate power flow: Manage the direction and amount of electricity flowing through the power grid.

Electric substations vary greatly in size depending on their positioning in the system and the power demands of their designated service area. Depending on size, the transformers can generate humming noise, and the components are industrial equipment, not art installations. For public safety, electric power substations usually have security fencing at the property perimeters. Electric power substations have been a feature of the urban landscape since the creation of utility scale electric power. Still, it is reasonable to question if the appearance of electric power substations and other negative externalities due to proximity impact the demand and associated property values for nearby homes.

To test for the presence of a negative impact of proximity to electric power substations, the CRA team gathered data for all Fairfax County home sales in 2023. The data are sourced from BrightMLS, the regional realtor multiple listing service. This data set does not include private property transactions that are not posted to the multiple listing service, such as sale-by-owner or transfers of property between family members.

The statistical modeling used in this analysis determines the unique contributions of the characteristics of the homes sold. It is technically called a Robust Multivariate Regression Analysis. In this context, robust means that the findings remain valid even if the distribution of the values of the included variables violate the assumptions of an ordinary least squares regression procedure. The variables used in this analysis include:

- Dependent Variable: Sales Price
- Independent Variables:
  - Age of the home: Years since construction
  - Living Area (FT^2)
  - Lot Size (Acres)
  - Number of Bedrooms
  - Miles to Primary Road (proxy for commuting convenience)
  - Miles to Nearest Metro Station (proxy for commuting convenience)
  - Miles to Dulles Airport (proxy for travel convenience)
  - Miles to Farragut Metro Station (proxy for distance to downtown)
  - Miles to Potomac River (amenity/viewshed)
  - In area of North Fairfax County (yes/no)
  - Miles to Office Land Uses (proximity to commercial)
  - **Miles or Indicator Variable for Distance to Electric Substation**

The regression model was run multiple times to test for the impact of proximity to an electric power substation overall and at key distances. The table shows the *expected* sign if substations negatively impact residential property values. The table also shows the number of home sales in each distance grouping.

Table 1: Variables Used to Test Substation Impact on Residential Property Values

Model	Variable Description	Expected Sign	Notes: Assumed Relationship	# Sold Properties
1	# Miles to Substation	+	Value rises as distance increases	10,727
2	Property within ¼ mile	-	Value lower if closer	375
3	Property within 1000 feet	-	Value lower if closer	213
4	Property within 500 feet	-	Value lower if closer	44
5	Property within 300 feet	-	Value lower if closer	12

Sources: BrightMLS, CRA

The table below shows the regression model output for the control variables. The coefficients in each model remained approximately the same across all models. The coefficient effectively shows the impact of each variable on sales value. For example, older homes are generally less valuable than new homes—on average. The regression coefficient shown below shows that for each additional year of age, the average sales price of the home decreases by $1,345. With an average sales price of the properties included in this analysis of about $711,000, that is not a big percentage age effect. The standard error is a measure of variability and is used to test if the variable's impact on sales price is statistically significant. T-Statistic is the dividend of the coefficient divided by the standard error. For a 2-tailed test with a large sample size, a T-test of 1.96 would usually mean the variable is statistically significant. Prob Level is the probability of saying the variable is statistically significant when it really is not, which is called a Type I error. Five percent is considered an acceptable level of probability of making a Type I error (0.05). The coefficients in the table below are rounded to the nearest dollar. In each of the model runs, the R^2 is at or above 0.87, which means the model explains 87% of the variance observed in the sales prices of homes in 2023. That is a very high explanatory factor given that we have no direct measure of the condition of the homes sold – upgraded appliances, condition of flooring, and other factors.

Table 2: Regression Analysis Findings for Control Home Characteristics

Independent Variable	Regression Coefficient	Standard Error	T- Statistic	Prob Level	Statistically Significant (5%)?
Intercept	528,643	15640.73	33.799	0.0000	Yes
Age	-1,345	89.8876	-14.962	0.0000	Yes
Living Area	172	1.691925	101.436	0.0000	Yes
Lot Size Acres	57,259	2815.858	20.335	0.0000	Yes
Bedrooms	78,045	1675.637	46.576	0.0000	Yes
Miles to Primary Road	-5,244	1339.127	-3.916	0.0001	Yes
Miles to Metro	14,608	1296.64	11.266	0.0000	Yes
Miles to Dulles	-9,719	422.8589	-22.984	0.0000	Yes
Miles to Downtown	-19,259	638.7751	-30.150	0.0000	Yes
North FFX	215,356	6707.151	32.108	0.0000	Yes
Miles to Potomac	-10,002	757.2477	-13.208	0.0000	Yes
Miles to Offices	35,142	2622.694	13.399	0.0000	Yes

Sources: BrightMLS, CRA

Table 3 reports the regression coefficients for our test variables showing the impact of proximity of the home to an electric power substation. In each model iteration, the sign of the coefficient is opposite the expected effect. The value of homes sold was higher if located closer to a substation, though the variables in the designated proximity levels are not statistically significant.

Table 3: Regression Analysis Findings of Test Variables on Home Prices

Proximity to Substation	Coefficient	Standard Error	T-Statistic	Statistically Significant
# Miles	-17,852	2198.419	-8.12	Yes
Within ¼ mile	11,355	6860.848	1.66	No
Within 1,000 feet	9,541	8996.541	1.06	No
Within 500 feet	14,176	19806.96	0.72	No
Within 300 feet	34,398	37329.36	0.92	No

Sources: BrightMLS, CRA

Summarizing the Findings of this Analysis:

- For all 10,727 home sales included in this analysis for 2023 in Fairfax County, values dropped, on average, the farther away the property is from a power substation when other home characteristics are considered. We do not suggest that electric power substations themselves are amenities, but these substations can show where electric power consumption is likely to be higher, which indicates the presence of businesses and services that may be considered amenities. Accounting for these additional factors and exploring how the presence of these amenities interacts with each other to affect home values is beyond this initial analysis. For example, proximity to a hospital and clusters of restaurants may have synergistic positive effects on home values, and both of these land uses would likely require a power substation nearby.

- At every discrete distance measure (one-quarter mile, 1000 feet, 500 feet, and 300 feet), the homes within these proximity zones to a substation in our study sold for higher average prices accounting for other characteristics. However, none of these variables are statistically significant.

- **The analysis of home sales in 2023 shows that there is no systematic negative effect on home values for properties located close to an electric power substation in Fairfax County.**