

## Analysis of Arlington County's "Missing Middle" Housing Plan's Effect on Tree Canopy

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### Summary

Arlington County aims for a tree canopy of at least 40%, meaning 40% of its land covered by tree crown. The most recent data (2016) calculated its **canopy at 41%, a decrease from 43%** in 2008. The County is now rapidly moving to boost development by "upzoning" all single-family homes, where more than half of Arlington's canopy exists. The re-zoning **cuts in half** tree canopy replacement standards for those areas, after they already experienced an **8% drop** in canopy over the last 8-year period measured.

Specifically, the County's May 2, 2022 ["Missing Middle" Housing Plan](#) calls for re-zoning all single-family residences across-the-board, and allowing up to 8-unit buildings on any lot up to the maximum lot coverage, setback, and height requirements of areas now zoned for single-family detached homes. This cuts canopy replacement standards. Currently, the state law standard for development is 20%. That means it must be shown that a lot's tree canopy will cover at least 20% of the lot in 20 years. The County's "Missing Middle" Plan emphasizes the re-zoned areas will have a replacement standard of "10% or 15%", and curiously states, without analysis, that "50%" coverage is "achievable." In other words, it claims cutting the standard *in half* creates *392% more* canopy. In general, the "Missing Middle" plan is missing any meaningful or data-driven analysis of the re-zoning's overall impact on the tree canopy. This analysis aims to fill that void.

Applying Arlington County's most recent (from 2016) satellite and data analysis of tree canopy to its proposed "Missing Middle" re-zoning plan, reveals the following context and canopy impact:

- **70%** (4,408 acres) of Arlington's tree canopy is in residential areas;
- **59%** (3,713 acres) of Arlington's tree canopy will be re-zoned by the "Missing Middle" Plan;
  - Tree canopy in the single-family areas to be rezoned is **47%** (as of 2016) and was **52%** eight years before that, an 8% decline;
  - On average, existing "missing middle" multi-family zones with townhouses and duplexes have at least **29%** less tree canopy than single-family zones (apartments are even lower);
- **10.16%** will be the weight-averaged new canopy replaced in the rezoned areas (formerly 20%), which means, on the whole, considering different rates in differently-sized zones, the effective result will be 10.16% canopy coverage; this is a **49.2%** cut;

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- **96.8%** of rezoned land (7,570 acres; R-5, R-6, R-8, R-10) will have its tree canopy replacement cut in half from 20% **to 10%**;
  - **3.2%** of rezoned land (250 acres; R-20) will be subject to a 25% cut from 20% **to 15%**;
  - If the County achieves what its consultant projects will be 20% of single-family lots redeveloped under the “Missing Middle” Plan (over an undefined time period), then, compared to today, Arlington:
    - **Loses 34,000 trees—4.5% of all Arlington trees** valued at **\$62 million**—and loses **583.8 acres of canopy**, equivalent to **368 Wakefield soccer fields** or **9 Pentagon parking lots**;
    - Loses **9,116 tons** of carbon storage and **430 tons** per year of carbon sequestration;
    - Leaves **11 tons** more pollution and **99 tons** more carbon emissions in the air per year;
    - Increases storm runoff by **480,000 cubic feet** per year; and
    - Produces **924 tons** less oxygen per year.

Tree canopy impact may be far more severe. The County stated its reductions apply only to multi-family buildings and that new single-family homes would remain at the 20% canopy replacement standard. The Virginia Code, however, sets canopy standards based on how many housing units can be built “per acre” in a zoning district, not by the type of building constructed on any given lot. Applying the statute, were 20% of single-family lots also redeveloped as single-family homes under the “Missing Middle” Plan, Arlington would lose another 34,000 trees for a cumulative loss of nearly **one-tenth** of its tree canopy.

## Data

Arlington County’s Urban Forest Master Plan (pp. 10-12, 14) calls for a tree canopy goal of at least 40%, meaning 40% of the County is covered by tree crown.<sup>1</sup>

### Tree canopy coverage

In December 2017, Davey Resource Group produced a report for Arlington County titled, “Urban Tree Canopy Assessment” (the “**Davey Report**”).<sup>2</sup> The Davey Report used multiple GIS (Geographic Information Systems) to calculate area and percentage of Urban Tree Canopy by County limits, civic association, census block, zoning, parks, and watershed. Table 4 of the Davey Report (appended here as Appendix A), shows the number of acres in Arlington County (16,691) and tree canopy in areas classified as commercial, industrial, public, and residential. Its Table 5 (also Appendix A) shows the same metrics but by zoning district.

Overall, the Davey Report found Arlington’s tree canopy covers 41% of its land (excluding the airport and Department of Defense). Davey Report at 3, 6. That figure was 43% in 2008 and 40% in 2011. *Id.*

Davey Report Table 4 shows that tree canopy cover across all residential zones (10,252 acres) is 43%; 11% for commercial; 12% for industrial; and 34% for public lands. Applying those figures to the number of total acres (16,691) yields 6,304 acres of total tree canopy, 70% of which (4,408 acres) are in residential areas (non-material differences between this analysis and the Davey Report arise from its use of rounded figures).

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<sup>1</sup> <https://arlingtonva.s3.dualstack.us-east-1.amazonaws.com/wp-content/uploads/sites/31/2014/04/Urban-Forest-Master-Plan.pdf>

<sup>2</sup> <https://www.arlingtonva.us/files/sharedassets/public/parks-amp-recreation/documents/tree-canopy-report-2017.pdf>

Single-family tree canopy. The Davey Report found the areas with the greatest ratio of tree canopy are zones with single-family dwellings. Collectively, canopy coverage in these zones (R-5, R-6, R-8, R-10, and R-20) is 47%, and ranges from 68% to 36%.<sup>3</sup> Davey Report, Table 5. These amounts are reflected in Table 1 below, based on Tables 4 and 5 of the Davey Report. The data show the land to be rezoned under the “Missing Middle” Plan is 59% of the County’s overall tree canopy.

**Table 1. Tree Canopy Cover for Single-Family Zoned Areas**

	Zone	Total acres	Tree canopy	Acres of tree canopy	% of County tree canopy
One-Family, Restricted Two Family Dwelling District	R-5	494	36%	178	2.8%
One-Family Dwelling District	R-6	4,486	45%	2,019	32.0%
One-Family Dwelling District	R-8	562	52%	292	4.6%
One-Family Dwelling District	R-10	2,028	52%	1,055	16.7%
One-Family Dwelling District	R-20	250	68%	170	2.7%
<b>Total</b>		<b>7,820</b>	<b>47%</b>	<b>3,713</b>	<b>58.9%</b>

**Figure A. Arlington Tree Canopy Acres.**

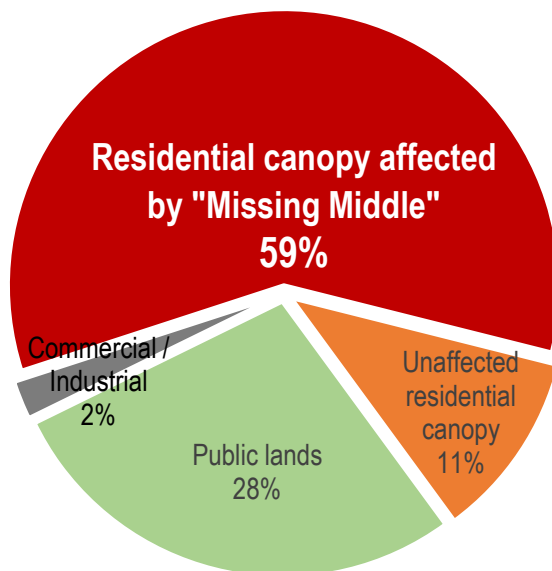


Figure A shows, proportionally, how the Missing Middle Plan affects Arlington’s 6,304 acres of tree canopy based on Tables 4 and 5 of the Davey Report. As calculated in Table 1, 59% of Arlington’s overall tree canopy is in the area that will be re-zoned by the plan (3,713 acres). Other residential areas not affected total 695 acres (11% of total canopy).

Davey Report Table 5 provides prior analyses of tree canopy as of 2008 and 2011. The number of canopy acres and percentages were mathematically derived from the report as shown in Table 1a below. Overall, single-family zones lost 321 acres of canopy from 2008-2016, from 52% canopy coverage to 47% coverage, an 8% decline. Relatedly, Davey Report Table 3 provides similar data by civic association. Of the 30 largest civic associations, six had an increase

in tree canopy from 2008-2016 (from 644 to 660, a gain of 16 canopy acres), one had no change, and the other 25 had losses (from 3,316 to 3,059, a loss of 257 canopy acres).

<sup>3</sup> The Davey Report identifies R-5 as not limited to one-family dwellings. The Missing Middle Plan, however, treats R-5 as subject to the Plan, so it is treated as such here. More generally, it is important to note that the Davey Report uses 2016 data. There appears some debate as to whether it fully captures tree canopy, and whether canopy has deteriorated since 2016. This analysis uses the Davey Report because it is the most recent data used by the County.

**Table 1a. Tree Canopy Cover for Single-Family Zoned Areas**

Zone	Total acres	2008		2011		2016		2008-2016	
		Canopy acres	Canopy %	Canopy acres	Canopy %	Canopy acres	Canopy %	Change in canopy acres	% change' in canopy
R-5	494	212	43%	166	34%	178	36%	-34	-16%
R-6	4,486	2,243	50%	2,022	45%	2,019	45%	-224	-10%
R-8	562	308	55%	301	54%	292	52%	-15	-5%
R-10	2,028	1,099	54%	1,056	52%	1,055	52%	-44	-4%
R-20	250	173	69%	163	65%	170	68%	-3	-2%
<b>Total</b>	<b>7,820</b>	<b>4034</b>	<b>52%</b>	<b>3,709</b>	<b>47%</b>	<b>3,713</b>	<b>47%</b>	<b>-321</b>	<b>-8%</b>

Multi-family tree canopy. The Davey Report also shows tree canopy for residential areas that are not limited to single-family. Canopy coverage in these zones (R2-7, R-5, R-10T, RA14-16, RA7-16, R15-30T, RA8-18, RA6-15, RA4.8), shown on Table 2, range from 14% to 43%. Davey Report, Table 5.

**Table 2. Tree Canopy Cover for Multi-Family Zoned Areas**

	Zone	Total acres	Tree canopy (2016)	Acres of tree canopy
One Family Residential-Town-House Dwelling District	R-10T	83	43%	36
Residential Town House Dwelling District	R15-30T	61	30%	18
Two-Family and Town House Dwelling District	R2-7	282	32%	90
Apartment Dwelling District	RA14-16	757	39%	295
Apartment Dwelling District	RA4.8	68	14%	10
Apartment Dwelling District	RA6-15	406	26%	106
Apartment Dwelling District	RA7-16	109	32%	35
Apartment Dwelling District	RA8-18	521	27%	141
	<b>Total</b>	<b>2,287</b>	<b>32%</b>	<b>730</b>

A fair case could be made that “Apartment Dwelling Districts” are distinct given their likely far greater building size, and thus smaller (the smallest) amount of tree canopy. Excluding those districts, RA7-16, RA8-18, RA6-16, RA4.8, yields the following totals for non-apartment multi-family units as shown in Table 3. On the whole, these multi-family zones of townhouses and duplexes have 29% less canopy coverage than single-family zones, and 50% less coverage than the R-20 single-family zone.

**Table 3. Tree Canopy Cover for Multi-Family Zoned Areas (excluding “Apartment Dwellings”)**

	Total acres	Tree canopy (2016)	Acres of tree canopy
Multi-family (non-apt.)	426	34%	144

### Tree count and environmental impact

A year before the Davey Report, Arlington County posted a report that quantifies the number of trees in Arlington and their environmental and financial impact (the “**i-Tree Report**”).<sup>4</sup> Page 2 of the i-Tree Report

<sup>4</sup> i-Tree Ecosystem Analysis: Arlington, VA; Urban Forest Effects and Values (Oct. 2016), <https://www.arlingtonva.us/files/sharedassets/public/Environment/Documents/iTree-2016-Written-report.pdf>

estimated tree canopy coverage at 31.2% with 755,400 trees having a structural value of \$1.38 billion. The Davey Report states a higher canopy coverage (38%, not 31.2%), but did not estimate the number of trees. Arlington's Urban Foresters use the i-Tree Report's tree count today,<sup>5</sup> so that figure is used here.

Now having an estimate of the total number of trees, it can be estimated how many trees are in each zoning district by using tree canopy coverage as a proxy for the number of trees. This assumes, for example, that an area that has 25% of the County's canopy would have 25% of its trees.

In Table 4 below, the data from Table 1 is carried forward, with a column added to show the percent each zone represents of all County-wide tree canopy (dividing each zone's canopy acreage by the County-wide canopy acreage of 6,304 determined from Table 4 of the Davey Report). Next, those ratios are applied to the total number of trees (755,400) to determine trees per zone, as well as trees per acre in each zone. As shown in Table 4, the single-family residential zones affected by the "Missing Middle" Plan are 58.9% of Arlington's tree canopy and home to 444,967 trees at an average of 57 trees per acre.

**Table 4. Trees by Zoning District**

	Zone	Total acres	Tree canopy	Acres of tree canopy	% of all canopy	Est. no. of trees	Est. trees per acre
One-Family, Restricted Two Family Dwelling District	R-5	494	36%	178	2.8%	21,310	43
One-Family Dwelling District	R-6	4,486	45%	2,019	32.0%	241,900	54
One-Family Dwelling District	R-8	562	52%	292	4.6%	35,019	62
One-Family Dwelling District	R-10	2,028	52%	1,055	16.7%	126,367	62
One-Family Dwelling District	R-20	250	68%	170	2.7%	20,371	81
<b>Total</b>		<b>7,820</b>	<b>47%</b>	<b>3,713</b>	<b>58.9%</b>	<b>444,967</b>	<b>57</b>

The i-Tree report also determined a number of environmental and financial metrics related to the 755,400 trees it identified. This included 235 tons per year of pollution removal; 204,000 tons of carbon stored; 9,630 tons of carbon sequestered per year; 20,687 tons of oxygen produced per year; 10.7 million cubic feet of runoff avoided per year; and 2,210 tons of carbon emissions avoided per year.

## Arlington's "Missing Middle" Plan

Arlington County's May 2, 2022 document, "Missing Middle Housing Study: Expanding Housing Choice; Phase 2 Analysis and Draft Framework" (the "**Missing Middle Plan**") proposes an across-the-board change in the County's zoning of residential areas.<sup>6</sup> All "single household development (R-5 to R-20 zones)" would be rezoned to allow by-right development of "buildings with 2-8 units" each where the zoning ordinance currently allows only one, subject to "the same design standards as required for single-household development (height, setbacks, lot coverage). Missing Middle Plan at 13. "[T]o conserve trees," the "Missing Middle" Plan states it "[r]educe[s] parking requirements," meaning it would reduce the amount of off-street parking a developer would need to have. Missing Middle Plan at 13. It is otherwise missing any analysis of the likely effect such a requirement may actually have on tree canopy.

<sup>5</sup> <https://www.arlingtonva.us/Government/Programs/Sustainability-and-Environment/Trees/Tree-Statistics/i-Tree-Eco>

<sup>6</sup> [https://www.arlingtonva.us/files/sharedassets/public/housing/documents/missing-middle/mmhs-phase-2-public-presentation\\_05.02.pdf](https://www.arlingtonva.us/files/sharedassets/public/housing/documents/missing-middle/mmhs-phase-2-public-presentation_05.02.pdf)

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Geographic spread. The “Missing Middle” Plan states that redevelopment will be “geographically dispersed.” Missing Middle Plan at 23. There is no citation for this conclusion. A search of the County’s website and related materials found no explanation of that conclusion. Relatedly, the County retained a consultant who prepared a report (the “**Consultant’s Report**”) for the “Missing Middle” Plan.<sup>7</sup> On page 9, in a section on “Implications for Developer Choices,” it states:

Within each lot size category, we estimate that up to 20 percent of the eligible single-family lots might be developed for Missing Middle Housing rather than conventional large single-family units depending on the relative returns from developing large single-family houses.

There is, however, no analysis or explanation of how the County or its Consultant determined the 20% figure, or how long it may take to achieve. Nor did the Consultant explain what is an “eligible” lot, or identify “single-family lots” by zone. The analysis here applies those stated conclusions and assumes development under the “Missing Middle” Plan will be geographically dispersed and proportionate across re-zoned areas, reaching 20% of all land (as a proxy for 20% of “lots”).

Canopy Coverage. The “Missing Middle” Plan states: “Tree canopy of 20% to 50% is achievable; minimum canopy requirements set by state code would be 10% or 15%, compared to 20% minimum for single-detached [homes].” As before, there is no citation for this projection of what is “achievable,” or how likely it may be to achieve any outcome in that range. Similarly, a review found no analysis on the County’s website to support the likelihood of its projections. At best, the County states: “canopy of 20% to 50% on individual lots is achievable, if the builder or a subsequent property owner chooses to exceed the minimum requirement.”<sup>8</sup> By that standard, the County might well as claim “100% canopy replacement” is “achievable,” because someone could always plant enough trees to reach that amount. Baseless as these claims are, they are striking. In effect, the County is cutting tree canopy replacement by 49% down to 10% (see below), yet repeatedly emphasizes how canopy coverage may be 392% higher (*i.e.*, at 50%). Missing Middle Plan at 23.

The “Missing Middle” Plan identifies an area for “further study” as “[p]olicies to support tree canopy goals in R-5 to R-20 districts.” Missing Middle Plan at 27.

## Virginia’s tree canopy requirements for development

County Staff responded to certain questions from civic society about the “Missing Middle” Plan in a document titled, “Missing Middle Housing Study: Responses to Phase 2 Questions” (the “**County Responses**”).<sup>9</sup> The County’s response to tree canopy (question Q1) states:

The [Virginia] state code allows only a 20% minimum tree canopy for single-detached housing in Arlington’s R-5 to R-20 zoning districts . . . [B]ecause

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<sup>7</sup> [https://www.arlingtonva.us/files/sharedassets/public/housing/documents/missing-middle/mmhs\\_consultantanalysis\\_2022-04-28.pdf](https://www.arlingtonva.us/files/sharedassets/public/housing/documents/missing-middle/mmhs_consultantanalysis_2022-04-28.pdf)

<sup>8</sup> <https://www.arlingtonva.us/Government/Programs/Housing/Housing-Arlington/Tools/Missing-Middle/Community-Engagement> (“**ArlCo Engagement Comment**”).

<sup>9</sup> <https://www.arlingtonva.us/files/sharedassets/public/housing/documents/missing-middle/mmhs-responses-to-phase-2-questions-updated-05-26.pdf> (dated May 26, 2022).



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state code sets minimum tree canopy requirements based on the number of dwelling units per acre, the minimum canopy requirements for missing middle housing types would likely be 10% or 15%. However, the missing middle housing type building design analysis demonstrates that tree canopy of 20% to 50% is achievable.

Virginia Code on tree canopy replacement. Section 15.2-961 of the Code of Virginia, "Replacement of trees during development process in certain localities," requires of County ordinances:

B. The ordinance shall require that the site plan for any subdivision or development include the planting or replacement of trees on the site to the extent that, at 20 years, minimum tree canopies or covers will be provided in areas to be designated in the ordinance, as follows:

1. Ten percent tree canopy for a site zoned business, commercial, or industrial;
2. Ten percent tree canopy for a residential site zoned 20 or more units per acre;
3. Fifteen percent tree canopy for a residential site zoned more than 10 but less than 20 units per acre; and
4. Twenty percent tree canopy for a residential site zoned 10 units or less per acre.

...  
H.... "Tree canopy" [means] all areas of coverage by plant material exceeding five feet in height ... at 10 or 20 years maturity ... based on published reference texts generally accepted ....

J. In no event shall any local tree replacement or planting ordinance adopted pursuant to this section exceed the requirements set forth herein.

Arlington County is bound to use the above numbers, as it admits: "The state does not grant Arlington the ability to impose requirements above these minimums." ArlCo Engagement Comment. Thus, the "minimum" is also the maximum.

Extent of the zoning coverage. The statute for residential areas is based on the number of units "per acre" for which a "residential site [is] zoned." The "Missing Middle" Plan calls for the by-right development of up to 8 units on any lot. Thus, every "residential site" (in R-5, -6, -8, -10) will become a "site zoned 20 or more units per acre" under the plan, regardless of what is built. Va. Code § 15.2-961(B)(2); Table 5.

Arlington County, however, has stated its view that under the "Missing Middle" Plan: "the tree requirements for single-detached housing on other lots would be the same as they are today," namely, 20%. ArlCo Engagement Comment. It provides no analysis or explanation of how it reconciles that claim with the Virginia Code or with practice.

Impact of the Plan. The Arlington County Zoning Ordinance identifies minimum lot sizes by zoning district as shown below in Table 5. To calculate “units per acre,” the square feet per acre is divided by each of the minimum lot sizes per district, which currently allow one “unit”—a single family home—per lot. Under current law, all zones in Table 5 are less than 10 units per acre, so the 20% coverage standard applies. To determine the impact of the Missing Middle Plan, the units per acre under current law were multiplied by eight, as the “Missing Middle” Plan will allow up to eight units per lot. In that scenario, all zones exceed 20 units per acre, except R-20, meaning a 10% canopy replacement will apply for them and 15% for R-20.

**Table 5. Housing Units Per Acre**

	Zone	Lot min. (sqft)	Sqft/acre	Current law		“Missing Middle” Plan	
				Units/ acre	Repl. tree canopy	Units/ acre	Repl. tree canopy
One-Family, Restricted Two Family Dwelling District	R-5	5,000	43,560.04	8.7	20%	69.7	10%
One-Family Dwelling District	R-6	6,000	43,560.04	7.3	20%	58.1	10%
One-Family Dwelling District	R-8	8,000	43,560.04	5.4	20%	43.6	10%
One-Family Dwelling District	R-10	10,000	43,560.04	4.4	20%	34.8	10%
One-Family Dwelling District	R-20	20,000	43,560.04	2.2	20%	17.4	15%

Source for lot sizes: Arlington Co. Zoning Ord. §§ 5.7.3, 5.6.3, 5.5.3, 5.3.3, 5.2.3.

Based on the requirements of Virginia Code § 15.2-961, Table 6 shows tree canopy replacement in R-20 would drop 25% down to 15% (as a percent change); the others would be cut in half (50%) from 20% to 10%.

## Analysis

### Tree canopy standards under the “Missing Middle” Plan

The “Missing Middle” Plan and related materials make no apparent effort to calculate the weighted-average impact the plan will have when it comes to tree canopy. Instead, they emphasize tree canopy replacement under the plan will be “10% or 15%,” devoid of context. It is important for policymakers and the public to understand the relative impact of such change. For example, if only 3% of affected land is subject to the 15% requirement, and 97% of it is subject to the 10% requirement, it becomes far less useful to be giving the 15% figure the same weight as the 10% one. In fact, the analysis below shows that to be the case here.

Weighted-average impact of the “Missing Middle” Plan: Table 6 takes the data calculated in Table 1 (2016 tree canopy coverage) and Table 5 (coverage requirements) and shows for the rezoned areas:

- **96.8%** of the land will have a 10% tree canopy requirement (acres: 7,570 / 7,820);
- **3.2%** of the land (*i.e.*, R-20) will have a 15% tree canopy requirement (acres: 250 / 7,820).

To put that stark difference into perspective, consider how Arlington County disclosed and advertised the impact its Missing Middle Plan will have on tree canopy in the Plan itself (“10% or 15%”) (Figure B) versus how extensive each those different standards will be (Figure C). Figure C shows 7,570 acres (96.8%) of affected land will be at 10% and only 250 acres (3.2%) will be at 15%. (As noted above, the County has no explanation of how “20% to 50% is achievable,” or even likely.)



**Figure B. Arlington County’s Description of Tree Canopy Impact**

- **Tree canopy of 20% to 50% is achievable**; minimum canopy requirements set by state code would be 10% or 15%, compared to 20% minimum for single-detached

Source: Missing Middle Plan, p. 23.

**Figure C. Acres of Tree Canopy Covered by the Missing Middle Plan’s New Canopy Replacement Standards**

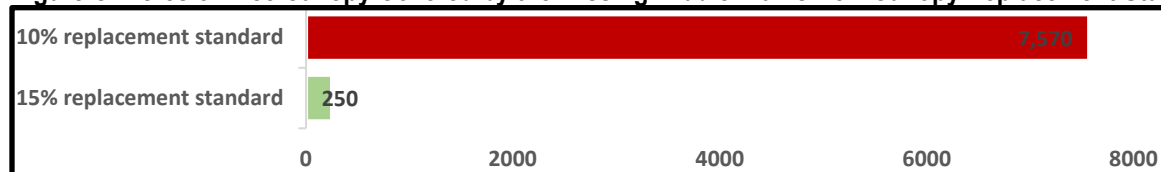


Table 6 also shows that the weighted-average tree canopy replacement coverage under the “Missing Middle” Plan will be **10.16%**, compared to 20% today. This is a **49.2%** decrease.

**Table 6. Impact on Tree Canopy Cover of the “Missing Middle” Plan versus Current Zoning**

Zone	Total acres	Tree canopy	Canopy acres	Current law		“Missing Middle” Plan		
				Coverage %	Acres of repl. canopy	Coverage %	Acres of repl. Canopy	Change in canopy acres
R-5	494	36%	178	20%	99	10%	49	<b>-49</b>
R-6	4,486	45%	2,019	20%	897	10%	449	<b>-449</b>
R-8	562	52%	292	20%	112	10%	56	<b>-56</b>
R-10	2,028	52%	1,055	20%	406	10%	203	<b>-203</b>
R-20	250	68%	170	20%	50	15%	38	<b>-13</b>
<b>Total</b>	<b>7,820</b>	<b>47%</b>	<b>3,713</b>	<b>20.00%</b>	<b>1,564</b>	<b>10.16%</b>	<b>795</b>	<b>-770</b>

Comparative example. Putting this report’s findings into tangible and localized comparisons can assist in understanding its impact. For example, the Wakefield High School soccer field is approximately 69,084 square feet (GIS measurements in AC Maps), which translates to 1.59 acres. The Department of Defense’s headquarters at the Pentagon has 67 acres of parking lots.<sup>10</sup> Those sizes are referenced below.

### “Missing Middle” Plan impact models

The following scenarios were modeled to show the “Missing Middle” Plan’s impact on tree canopy.

Scenario A: All rezoned lots redeveloped under the “Missing Middle” Plan versus canopy today. Tree canopy coverage is 47% for single-family zones. The “Missing Middle” Plan results in a **78.6% loss** of tree canopy in those zones if they are all redeveloped as the plan allows. This is a loss from 3,713 acres of tree canopy down to 795 acres of canopy (shown in Table 6); a **loss of 2,918 acres of canopy** that exists today and 399,452 trees (53% of all County trees). That loss in canopy is equivalent to 43.6 Pentagon parking lots.

Scenario B: All rezoned lots redeveloped under the “Missing Middle” Plan versus redevelopment under current law. Table 6 shows the resulting amount of tree canopy replacement (“Acres of repl. Canopy”) if all

<sup>10</sup> [https://media.defense.gov/2020/Jan/03/2002230480/-1/-/1/1/PENTAGON\\_SELF\\_GUIDED\\_TOUR\\_BROCHURE\\_2020.PDF](https://media.defense.gov/2020/Jan/03/2002230480/-1/-/1/1/PENTAGON_SELF_GUIDED_TOUR_BROCHURE_2020.PDF)

rezoned lots were redeveloped in two scenarios: (1) under current law; and (2) under the “Missing Middle” Plan. It shows the “Missing Middle” Plan results in a comparative **loss of 770 acres of canopy** (1,564 acres versus 795 acres), representing 12% of all County canopy and an area equal to 11.5 Pentagon parking lots. This is a comparative **49.2% loss** of tree canopy.

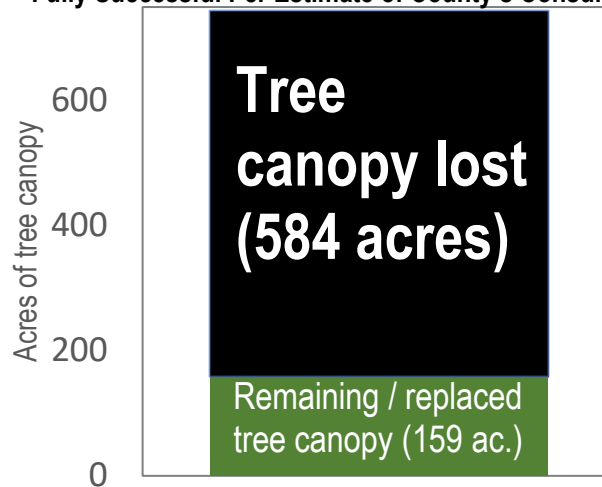
Scenario C: County Consultant’s 20% redevelopment projection. The two prior examples reflect total redevelopment of all rezoned areas. A more modest approach evaluates the “Missing Middle” Plan based on the 20% of all lots that the County’s Consultant says may be redeveloped. Table 7 shows the result of comparing the redevelopment of 20% of the land zoned for single-family homes: (a) under current law, and (b) under the “Missing Middle” Plan. Table 7 shows the “Missing Middle” Plan will result in a **loss of 583.8 acres of canopy** compared to the current tree canopy, an amount equal to 368 Wakefield soccer fields or 9 Pentagon parking lots. Table 7 also shows, alternatively, that the “Missing Middle” Plan results in a loss of 153.9 acres of canopy from 312.8 acres to 158.9 acres compared to current law, equal to 97 Wakefield soccer fields (or 2.3 Pentagon parking lots). The ratio is the same 49.2% decrease as the prior scenario.

**Table 7. Impact on Tree Canopy Cover of the “Missing Middle” Plan versus Current Zoning**

			Current law at 20% of land		“Missing Middle” Plan at 20% of land		Change in canopy acres under the Missing Middle Plan	
Zone	Canopy acres	20% of land	Coverage %	Acres of repl. canopy	Coverage %	Acres of repl. canopy	Versus current law	Versus current canopy
R-5	178	98.8	20%	19.8	10%	9.9	-9.9	25.7
R-6	2,019	897.2	20%	179.4	10%	89.7	-89.7	314.0
R-8	292	112.4	20%	22.5	10%	11.2	-11.2	47.2
R-10	1,055	405.6	20%	81.1	10%	40.6	-40.6	170.4
R-20	170	50.0	20%	10.0	15%	7.5	-2.5	26.5
Total	3,713	1,564	20.00%	312.8	10.16%	158.9	-153.9	-583.8

Applying the Arlington-wide count of trees from the i-Tree Report (755,400) to the tree canopy coverage ratios by zone from the Davey Report, one may estimate the number of trees in those zones and the number of trees lost under the “Missing Middle” Plan. Table 8 models the County Consultant’s conclusion that 20% of single-family lots become multi-family units (Scenario C, above), and finds a loss of nearly 34,000 trees.

**Figure D. Missing Middle Plan’s Impact on Tree Canopy If Fully Successful Per Estimate of County’s Consultant**



**Table 8. Trees lost due to the “Missing Middle” Plan.**

Zone	Total acres	Tree canopy	Canopy acres	Est. no. of trees	Est. trees per acre	Change in tree count due to “Missing Middle” Plan
R-5	494	36%	178	21,310	43	-1,108
R-6	4,486	45%	2,019	241,900	54	-16,933
R-8	562	52%	292	35,019	62	-2,942
R-10	2,028	52%	1,055	126,367	62	-10,615
R-20	250	68%	170	20,371	81	-2,159
<b>Total</b>	<b>7,820</b>	<b>47%</b>	<b>3,713</b>	<b>444,967</b>	<b>57</b>	<b>-33,757</b>

Finally, Table 9 reflects the environmental impact data from the i-Tree Report reduced to a per tree basis, and then applied to the number of trees lost from “Missing Middle” redevelopment in Table 8.

**Table 9. Environmental impact of the “Missing Middle” Plan on trees.**

Trees lost	33,757	
Carbon storage lost	9,116	tons
Carbon sequestration lost	430	tons/yr
Pollution not removed	11	tons/yr
Carbon emissions left in the air	99	tons/yr
Increased storm runoff	479,504	cubic feet/yr
Less oxygen	924	tons/yr
Structural value of trees lost	\$61,668,677	

## Conclusion

The “Missing Middle” Housing Plan exclusively targets those zoning areas in Arlington County with the highest tree canopy percentage, 47% (and up to 68%), representing 59% of all Arlington tree canopy. Enacting the Plan will cut tree canopy replacement coverage by 49.2%, down to 10.16% as a weighted average. This will have an outsized impact on tree canopy loss as these zones are home to a disproportionately higher amount of existing canopy. Applying the “Missing Middle” Plan to different models, including what its consultant projects might be developed, yields substantial loss of tree canopy compared to today (584 acres of canopy and 34,000 trees lost) as well as compared to redevelopment of lots under existing law (154 acres of canopy lost). Policy changes that wreak consequences of this magnitude should be carefully examined using the best available data, a process that appears missing from the County’s “Missing Middle” Plan.

\*Views expressed in this analysis are solely those of Arlington Transparency. Nothing herein should be construed as legal advice.

## APPENDIX A

Excerpts from December 2017 "Urban Tree Canopy Assessment" by Davey Resource Group

Table 4. Land Cover Results Based on Land Use

Land Use	Acres	Tree Canopy		Impervious		Pervious		Bare Soils		Open Water	
		Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage
Commercial	1,140	122	11%	935	82%	77	7%	5	<1%	1	<1%
Industrial	143	17	12%	110	77%	10	7%	3	2%	3	2%
Public	5,156	1776	34%	1835	36%	1380	27%	98	2%	67	1%
Residential	10,252	4,441	43%	3,466	34%	2,320	23%	20	<1%	5	<1%

Table 5. Tree Canopy Cover by Zoning in Arlington County

Zoning	Zone Code	Total Acres	Canopy Percent 2016	Canopy Change 2011-2016	Canopy Change 2008-2016	Preferred Plantable Percent	UTC Potential
One-Family Dwelling District	R-20	250	68	4	-2	16	84
One-Family Dwelling District	R-8	562	52	-3	-5	19	71
One-Family Dwelling District	R-10	2,028	52	-0.11	-4	17	69
One-Family Dwelling District	R-6	4,486	45	-0.16	-10	22	66
One Family Residential-Town-House Dwelling District	R-10T	83	43	9	4	17	59
Apartment Dwelling District	RA14-26	757	39	0.70	-7	23	62
One-Family, Restricted Two Family Dwelling District	R-5	494	36	7	-16	26	62
Special District	S-3A	4,978	35	9	25	14	49
Two-Family and Town House Dwelling District	R2-7	282	32	2	-10	27	59
Apartment Dwelling District	RA7-16	109	32	-6	-7	20	52
Special Development District	S-D	51	30	7	7	13	43
Residential Town House Dwelling District	R15-30T	61	30	30	20	12	42
Apartment Dwelling District	RA8-18	521	27	-4	-9	21	48
Apartment Dwelling District	RA6-15	406	26	-6	-6	17	43
Commercial Office Building, Hotel, and Apartment District	C-O-1.0	24	24	18	15	12	35
Commercial Office Building, Hotel, and Apartment District	C-O-1.5	192	18	23	22	12	30
Public Service District	P-S	122	18	68	14	16	34
Limited Commercial - Professional Office Building District	C-1-O	3	18	-36	-32	14	32
Hotel District	RA-H	30	16	11	76	11	26
Limited Industrial District	CM	38	15	81	61	9	24
Apartment Dwelling District	RA4-8	68	14	-3	-20	11	25
Commercial Town House District	C-TH	6	13	76	81	3	16
Apartment Dwelling and Commercial District	RC	46	12	12	20	7	19
Multiple-Family Dwelling and Hotel District	RA-H-3.2	70	12	-2	8	8	19
Light Industrial District	M-1	94	11	16	24	7	18
Service Commercial - Community Business Districts	C-2	239	10	8	19	6	17
Local Commercial District	C-1	92	10	-5	17	6	16
Columbia Pike - Form Based Code District	CP-FBC	3	10	-62	-69	31	42
Commercial Office Building, Hotel, and Apartment District	C-O-2.5	232	10	2	-3	8	18
Service Industrial District	M-2	8	10	65	34	14	24
C-O-CRYSTAL CITY	C-O-CC	6	10	-5	-6	5	14
Commercial Redevelopment District	C-R	14	8	123	126	1	9
General Commercial District	C-3	62	7	14	0.33	3	11
Commercial Off. Bldg., Hotel, and Multiple-Family Dwelling	C-O	198	7	-17	7	5	12
Restricted Local Commercial District	C-1-R	3	7	-15	-4	7	14
C-O-ROSSLYN	C-O-ROSS	29	6	-4	19	4	10
Commercial Off. Bldg., Hotel, and Apartment District	C-O-A	42	5	-9	4	2	7
Mixed Use-Virginia Square	MU-VS	4	2	-78	-68	0.00	2

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## APPENDIX B

Excerpt from October 2016 “i-Tree Ecosystem Analysis: Arlington, VA; Urban Forest Effects and Values”

### Summary

Understanding an urban forest's structure, function and value can promote management decisions that will improve human health and environmental quality. An assessment of the vegetation structure, function, and value of the Arlington, VA urban forest was conducted during 2016. Data from 201 field plots located throughout Arlington, VA were analyzed using the i-Tree Eco model developed by the U.S. Forest Service, Northern Research Station.

- Number of trees: 755,400
- Tree cover: 31.2 %
- Most common species of trees: Flowering dogwood, White oak, Red maple
- Percentage of trees less than 6" (15.2 cm) diameter: 56.4 %
- Pollution removal: 235 tons/year (\$3.59 million/year)
- Carbon storage: 204,000 tons (\$27.1 million)
- Carbon sequestration: 9,630 tons/year (\$1.28 million/year)
- Oxygen production: 20,687 tons/year
- Avoided runoff: 10,730,168 cubic feet/year (\$717 thousand/year)
- Building energy savings: \$1,020,000/year
- Avoided carbon emissions: 2210 tons/year ( \$294,000/year)
- Structural values: \$1.38 billion

Ton: short ton (U.S.) (2,000 lbs)

Monetary values \$ are reported in US Dollars throughout the report except where noted

Pollution removal and avoided runoff estimates are reported for trees and shrubs. All other ecosystem service estimates are reported for trees.