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TRANSPORTATION PLANNING ORGANIZATION

Identifying Candidate Streets for Conversion from **One-Way to Two-Way**

Oct 2017

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ABSTRACT
For the benefit of the HRTPO member cities, HRTPO staff prepared this study to identify specific opportunities for converting one-way streets to two-way operation.

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Prepared in cooperation with the U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), and Virginia Department of Transportation (VDOT). The contents of this report reflect the views of the Hampton Roads Transportation Planning Organization (HRTPO). The HRTPO is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the FHWA, VDOT or Hampton Roads Planning District Commission. This report does not constitute a standard, specification, or regulation. FHWA or VDOT acceptance of this report as evidence of fulfillment of the objectives of this planning study does not constitute endorsement/approval of the need for any recommended improvements nor does it constitute approval of their location and design or a commitment to fund any such improvements. Additional project level environmental impact assessments and/or studies of alternatives may be necessary.

Prepared with the assistance of a project steering team comprised of staff from Norfolk, Portsmouth, and Newport News.

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The HRTPO assures that no person shall, on the ground of race, color, national origin, handicap, sex, age, or income status as provided by Title VI of the Civil Rights Act of 1964 and subsequent authorities, be excluded from participation in, be denied the benefits of, or be otherwise subject to discrimination under any program or activity. The HRTPO Title VI Plan provides this assurance, information about HRTPO responsibilities, and a Discrimination Complaint Form.

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INTRODUCTION

Although, in the past, one-way operation was applied to various streets across the U.S., some cities have recently converted specific one-way streets to two-way operation and found benefits.

The purpose, therefore, of this study is to help our local governments by identifying one-way streets in Hampton Roads which may be suitable for conversion to two-way operation. During the preparation of the study, HRTPO staff met twice with staff from Newport News, Norfolk, and Portsmouth who had volunteered to provide feedback.

As a basis for identifying two-way candidates, HRTPO staff first explores the existing literature.

LITERATURE REVIEW

HRTPO staff reviews the one-way/two-way literature in two sections below:

1. Pros and Cons of Converting One-way Streets to Two-way
2. Methods of Identifying One-way Streets for Conversion

Pros and Cons of Converting One-way Streets to Two-way

The existing literature[1] identifies several inter-related transportation issues affected by the choice of operating a street as one-way or two-way:

1. Capacity (and Level-of-Service)
2. Confusion (of driver)
3. Cost
4. Crime
5. Economics
6. Freedom (of movement)
7. Parking
8. Safety
9. Travel Time (and Speed)
10. Vehicle Miles Travelled (VMT)

The literature contains a mixture of data: some studies supporting conversion to two-way, some extolling the virtues of one-way operation. HRTPO staff summarized these data below by issue, listed alphabetically.

[1] See Bibliography at end of this document.

Capacity (and Level-of-Service)

Conventional wisdom appears to be that one-way streets have higher capacity per lane than two-way streets:

- According to the before-after study of a conversion project, "assumptions can be made that traffic efficiencies are typically gained by converting two-way streets to one-way operation."[2]
- ITE's *Traffic Engineering Handbook* reads, "One-way streets…are generally used to reduce congestion and increase the capacity of the roadway network…."[3]

Yet at least one study indicates otherwise. In the before-after study of the conversion of Hennepin and 1st Avenues in Minneapolis[4], the local department of public works found:

- While auto volumes were practically unchanged (down 2%), the **number of "failing" (LOS E or F) intersections declined** from four to two.

Confusion

One of the stated disbenefits of one-way operation is confusion of drivers:

- According to a TRB article[5]: "…one-way networks are seen as **confusing**…"
- According to a consultant's paper: "…**the occasional visitors** to downtown…are often confused and disoriented on encountering a one-way street network."[6]

[2] *Hennepin Avenue and 1st Avenue Two-Way Conversion Evaluation Report,* Dept. of Public Works, Minneapolis MN, July 2010, page 14.
[3] *Traffic Engineering Handbook*, ITE, Fifth Edition, 1999, page 226.
[4] *Hennepin Avenue and 1st Avenue Two-Way Conversion Evaluation Report,* Dept. of Public Works, Minneapolis MN, July 2010, page 14.
[5] *Analytical Capacity Comparison of One-Way and Two-Way Signalized Street Networks*, by Vikash V. Gayah and Carlos F. Daganzo, Transportation Research Record No. 2301, TRB, Washington DC, 2012, page 76.
[6] *Downtown Streets: Are We Strangling Ourselves on One-Way Networks?*, by G. Wade Walker, Walter M. Kulash, and Brian T. McHugh of Glatting Jackson Kercher Anglin Lopez Rinehart, Inc. (Orlando), TRB Circular E-C019, Urban Street Symposium, Dec. 2000, page 4.

Cost

Several studies have reported estimated and actual costs of converting one-way streets to two-way operation. The pro-one-way paper by the Center for the American Dream of Mobility and Home Ownership (CAD)[7] includes the following to demonstrate that one-way-to-two-way conversions are "costly":

- "St. Petersburg estimates that restriping, signal changes, and other changes required to convert streets from one-way to two-way cost more than **$140,000 per intersection**;"
- "Conversion of nine one-way streets to two-way in downtown Austin is expected to cost $15 million;" [**$1.7m per street**]
- "San Jose spent $15.4 million converting ten streets to two-way;" [**$1.5m per street**]
- "A plan to turn a one-way couplet in Hamilton, Ontario to two two-way streets is estimated to cost CA$3.2 million (about US$2.0 million);" [**$1m per street**]

Other studies, however, have shown lower costs:

- According to an article for Main Street America[8], "In Greensboro, N.C.…the estimate to convert one street was **$30,000 per intersection**."
- In a feasibility study of the conversion of six one-way streets in Louisville[9], a consultant estimated the proposed conversion of six streets (totaling 2.0 miles) to cost $2.2m (**$400k per street; $1m per mile**).
- In a before-and-after study of the conversion of a 1.25 mile couplet of two of the above Louisville streets (Brook Street and 1st Street, totaling 2.5 miles), Riggs and Gilderbloom[10] reported a cost of $250,000, or **$100,000 per mile**.

Crime

In the aforementioned before-and-after study of the conversion of a 1.25 mile couplet of two Louisville streets—Brook Street and 1st Street—Riggs and Gilderbloom reported a 15% and 30% reduction in overall crime (respectively).[11] The authors theorized that the reduction in speeds made "getaways" more difficult.

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[7] *No Two Ways About It: One-Way Streets are Better Than Two-Way*, by Michael Cunneen and Randal O'Toole, Center for the American Dream of Mobility and Home Ownership, Issue Paper 2-2005, Feb. 2005, page 9.

[8] *Converting One-way Streets to Two-way*, by John D. Edwards, from Main Street Story of the Week, Main Street America (preservationnation.org), June 2002.

[9] *Downtown Louisville Two-Way Study,* by ENTRAN for Downtown Development Corporation, Louisville KY, Oct. 2009, page 18.

[10] *Two-Way Street Conversion: Evidence of Increased Livability in Louisville*, by William Riggs and John Gilderbloom, Journal of Planning and Research 1-14, 2015, DOI: 10.1177/0739456X15593147, page 3.

[11] *Two-Way Street Conversion: Evidence of Increased Livability in Louisville*, by William Riggs and John Gilderbloom, Journal of Planning and Research 1-14, 2015, DOI: 10.1177/0739456X15593147, page 7.

Economics

Commercial Property Values

One recent study saw *positive* economic impacts of converting one-way streets *to two-way* operation. According to an article for Main Street America[12]:

> "Perhaps the most important reason for changing the traffic flow of a downtown street is to **improve the economic well-being of the commercial district**. A **survey of 25 towns and cities** that have converted their main streets [to two-way operation] show that many have experienced significant reductions in vacant floor space after the conversion."
>
> "**All of the communities surveyed reported positive results** after converting their one-way streets to two-way traffic, and many reported substantial private investments stimulated by conversions that were coupled with streetscape projects. West Palm Beach, for example, reported $300 million in private investment in areas where city hall had invested $10 million in public funding."

Likewise, another study saw *negative* impacts of converting two-way streets to *one-way* operation. According to a TRB Circular[13]:

> "In our experience, most of these **retailers** prefer the exposure and accessibility offered by a location on a two-way street. This fact is supported by examples such as **Vine Street in Cincinnati, where 40%** of businesses in this economically depressed downtown corridor closed after the street was converted from two-way to one-way."

However, two articles about converting two-way streets to *one-way* told a different story:

- According to a 1972 ITE article[14] by the Commissioner of the New York City Department of Traffic, "Land values on a pair of north-south Manhattan avenues [assumed therefore to be commercial streets] appreciated 57.5 percent in the fiscal year following conversion to one-way operation."

[12] *Converting One-way Streets to Two-way*, by John D. Edwards, from Main Street Story of the Week, Main Street America (preservationnation.org), June 2002.
[13] *Downtown Streets: Are We Strangling Ourselves on One-Way Networks?*, by G. Wade Walker, Walter M. Kulash, and Brian T. McHugh of Glatting Jackson Kercher Anglin Lopez Rinehart, Inc. (Orlando), TRB Circular E-C019, Urban Street Symposium, Dec. 2000, page 5.
[14] *Traffic Engineering Succeeds in New York City*, by Theodore Karagheuzoff, ITE Traffic Engineering, Sep. 1972, page 20.

- According to a 1998 ITE article[15] (referencing a 1995 ITE article), "Johnson reported that installing a one-way street network in place of a two-way system had **no identifiable effect upon business activity**."

Residential Property Values

In the aforementioned before-and-after study of the 2011 conversion of a 1.25 mile couplet of two Louisville streets—Brook Street and 1st Street—Riggs and Gilderbloom[16] calculated significant increases in property values for homes selling during 2013:

- "The average annual percentage growth rate for 1st Street was 2.78 percent."
- "The average annual percentage growth rate for Brook Street was 38.97 percent." (Note: This annual rate appears to be unreliably high.)

Whereas, for an adjacent couplet of streets—2nd Street and 3rd Street—that remained one-way, property values were practically unchanged:

- "The average annual percentage growth rate for 2nd Street was -0.38 percent..."
- For 3rd Street, "The average annual percentage growth rate…was 0.44 percent."

[15] *One-Way Streets Provide Superior Safety and* Convenience, by John. J. Stemley, ITE Journal, Aug. 1998, page 48.
[16] *Two-Way Street Conversion: Evidence of Increased Livability in Louisville*, by William Riggs and John Gilderbloom, Journal of Planning and Research 1-14, 2015, DOI: 10.1177/0739456X15593147, pages 8 and 9.

Freedom

One-way streets, by definition, reduce freedom of movement:

- According to a TRB Circular[17], a one-way street system "often **forces drivers** to follow **out-of-direction routes**…."

Parking

Given that low-volume one-way streets need only one travel lane—and two-way streets need at least two travel lanes—two-way operation would mean less room for parking on narrow streets.

[17] *Downtown Streets: Are We Strangling Ourselves on One-Way Networks?*, by G. Wade Walker, Walter M. Kulash, and Brian T. McHugh of Glatting Jackson Kercher Anglin Lopez Rinehart, Inc. (Orlando), TRB Circular E-C019, Urban Street Symposium, Dec. 2000, page 3.

Safety

Some studies have found safety benefits of converting one-way streets *to two-way* operation. In a before-after study of the conversion of Hennepin and 1st Avenues in Minneapolis, the local department of public works found:

- Bicycle crashes declined (12/year before, 0/year after) [Note: Even though "after" period length was only 6 months, dramatic decline appears significant.]
- Total crashes declined 9% [Note: Given 6 months "after" period, 9% is likely not statistically significant.][18]

In a before-and-after conversion study of Brook and 1st Streets in Louisville, researchers found:

- Reduction in crashes of 36% and 60%[19] on the two streets (respectively) even though they experienced a 13% and 40% increase in traffic volumes (respectively).[20]

However, other studies (particularly older ones) found one-way operation to be safer than two-way. Some found safety *benefits* from converting two-way streets *to one-way*. A Transportation Research Board (TRB) article[21] summarized four studies (dated 1938, 1959, 1967, and 1972):

- "Most of the [before-and-after] studies report an **accident decrease of 20 to 30 percent**."

A 1998 ITE article[22] reiterated the findings of a 1959 ITE article:

- "…for **New York City**, Wiley found a **25 percent reduction in intersection pedestrian accidents** at one-way street intersections after conversion from two-way operation."

A paper by the Center for the American Dream of Mobility and Home Ownership (CAD)[23] included the following references to two studies (dated 1950 and 1953, respectively):

- "**Sacramento** found **14 percent fewer accidents** on streets converted to one-way operation…"
- "**Portland** found **51 percent fewer accidents** at intersections and 37 percent fewer between intersections."

The above CAD paper also found safety *disbenefits* from converting one-way streets *to two-way*:

- Summary of 1990 **Denver** study: "Accidents **increased an average of 37 percent**…."
- Summary of 1993 **Indianapolis** study: "After three years, accidents on that route had **increased 33 percent**."
- Summary of 1996 **Lubbock** TX study: "…**25 percent more accidents**…."

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[18] *Hennepin Avenue and 1st Avenue Two-Way Conversion Evaluation Report,* Dept. of Public Works, Minneapolis MN, July 2010, pages 14 and 15.

[19] Before data: 5 years; after data: first year post-conversion.

[20] *Two-Way Street Conversion: Evidence of Increased Livability in Louisville*, by William Riggs and John Gilderbloom, Journal of Planning and Research 1-14, 2015, DOI: 10.1177/0739456X15593147, pages 6 and 7.

[21] *Safety of One-Way Urban Streets*, by I. Hocherman, A. S. Hakkert, and J. Bar-Ziv, Transportation Research Record 1270, TRB, 1990, page 22.

[22] *One-Way Streets Provide Superior Safety and Convenience*, by John J. Stemley, ITE Journal, August 1998, page 49.

[23] *No Two Ways About It: One-Way Streets are Better Than Two-Way*, by Michael Cunneen and Randal O'Toole, Center for the American Dream of Mobility and Home Ownership, Issue Paper 2-2005, Feb. 2005, pages 6, 8, 9.

Travel Time (and Speed)

One of the primary costs of transportation is the amount of **time required** for a person or piece of freight to travel from the starting point to the desired location. In a 1998 ITE article, civil engineer John Stemley re-iterated the findings of two New York City studies (1959 and 1972 ITE articles) showing that one-way streets **reduce intersection delay**. According to Stemley:

- "Use of one-way streets [via the **signal progression** allowed by one-way operation] is reported to **reduce the number of stops** by nearly two-thirds…."
- "Intersection delay has been found to be reduced by nearly 50 percent while overall trip **time was reduced by 22 percent to 33 percent**." [24]

Given that higher speeds are associated with higher noise and more impactful crashes, it's important to note that one-way streets can reduce travel times (via reduction of stops) *without* any increase in between-intersection speeds. According to Cunneen and O'Toole, "Two-way streets suffer more delay and therefore have slower *average* [emphasis added] speeds than one-way streets, but not necessarily slower *top* [emphasis added] speeds."[25]

However, after developing and applying a model for comparing one-way networks to two-way networks, Gayah and Daganzo[26] found:

> "Contrary to conventional wisdom and design handbooks, one-way networks are not always more efficient [time-wise] than two-way networks that allow left-turn movements. **When average trip lengths are short**, these **two-way networks may be able to serve trips at a higher rate [per unit time] than one-way networks** because the additional circuity in one-way networks offsets the more efficient intersection control."

[24] *One-Way Streets Provide Superior Safety and* Convenience, by John. J. Stemley, ITE Journal, Aug. 1998, page 50.
[25] *No Two Ways About It: One-Way Streets are Better Than Two-Way*, by Michael Cunneen and Randal O'Toole, Center for the American Dream of Mobility and Home Ownership, Issue Paper 2-2005, Feb. 2005, page 5.
[26] *Analytical Capacity Comparison of One-Way and Two-Way Signalized Street Networks*, by Vikash V. Gayah and Carlos F. Daganzo, Transportation Research Record No. 2301, TRB, Washington DC, 2012, page 84.

Vehicle Miles Travelled (VMT)

One of the stated disbenefits of one-way operation is forced circuitous travel:

- According to a TRB article[27], "…one-way networks…**require vehicles to travel longer distances** on average."
- According to a TRB circular[28], "Our experience shows that a one-way system usually yields approximately 120 to 160% of the turning movements when compared to a two-way system, and the travel distance between portal and destination is usually **20 to 50 percent greater** in a one-way street system."

[27] *Analytical Capacity Comparison of One-Way and Two-Way Signalized Street Networks*, by Vikash V. Gayah and Carlos F. Daganzo, Transportation Research Record No. 2301, TRB, Washington DC, 2012, page 76.

[28] *Downtown Streets: Are We Strangling Ourselves on One-Way Networks?*, by G. Wade Walker, Walter M. Kulash, and Brian T. McHugh of Glatting Jackson Kercher Anglin Lopez Rinehart, Inc. (Orlando), TRB Circular E-C019, Urban Street Symposium, Dec. 2000, page 9.

Conclusions from Review of One-Way/Two-Way Impacts in Literature

Conceptual Structure

Based on the above impacts from the literature—and understanding of transportation causes and effects—HRTPO staff developed the following chart of impacts and issues.

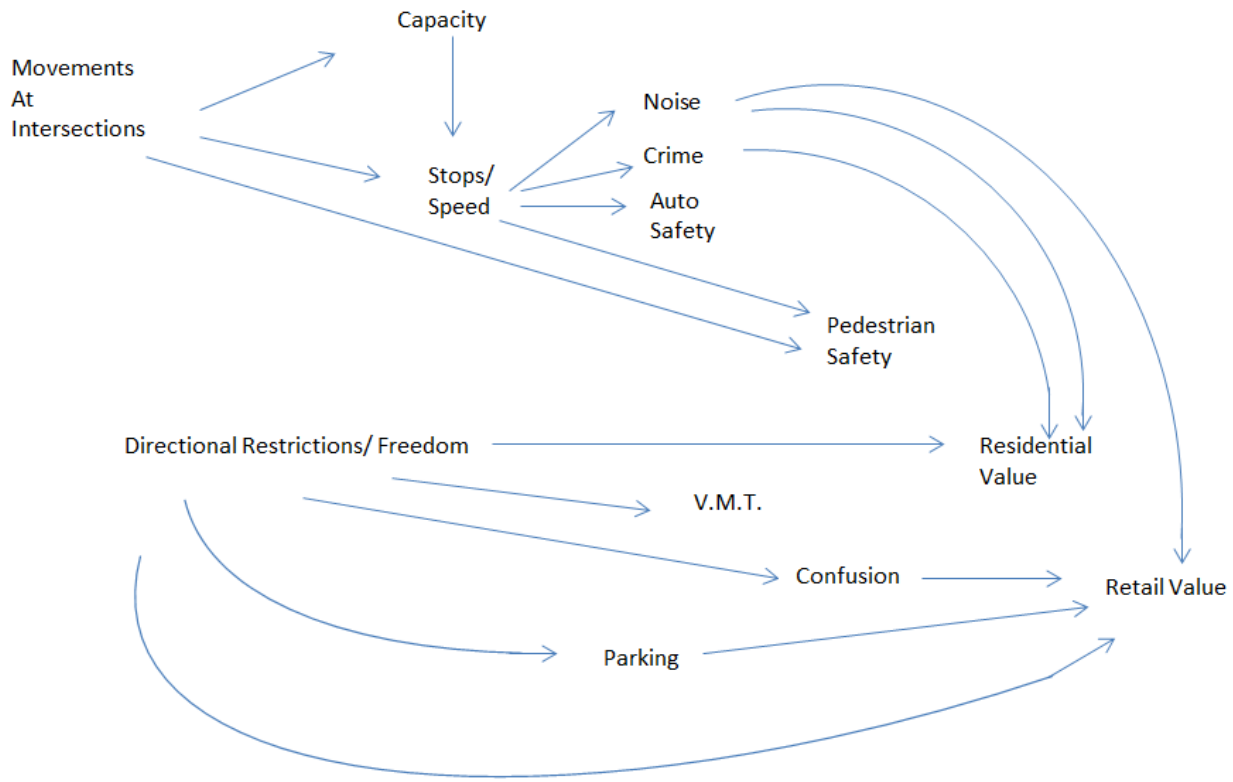

FIGURE 1 Impacts and Issues of Choice of Operation, One-Way or Two-Way
Source: Chart by Shirley.docx

Summary and Assessment of Impacts and Issues

The literature reviewed above contains conflicting evidence for converting one-way streets to two-way:

1. Capacity (and Level-of-Service)
    - Some authors wrote that one-ways have higher capacity per lane than two-ways, yet one author found the opposite.
2. Confusion (of driver)
    - Several authors sited the confusion of one-ways. Given that the vast majority of streets are two-way, this finding seems reasonable.
3. Cost
    - Depending on the point-of-view of the author—whether pro-one-way or pro-two-way—studies estimate conversion costs over a broad range: from $30,000-$140,000 per intersection, from $100,000-$1,000,000 per mile, and from $400,000-$1,700,000 per street.
4. Crime
    - Studying a couplet of streets converted to two-way operation, the research team found a 15% and 30% reduction in crime, respectively, for the two streets. More data is needed for conclusive evidence.
5. Economics
    - For commercial streets, some authors wrote that one-way operation is better than two-way operation, and some authors found the opposite. A study of a couplet of residential streets converted to two-way operation found significant annual post-conversion growth in property value. More data is needed to draw a conclusion.
6. Freedom (of movement)
    - One-way streets, by definition, reduce freedom of movement.
7. Parking
    - Given that low-volume one-way streets need only one travel lane—and two-way streets need two travel lanes at a minimum—two-way operation would mean less room for parking on narrow streets.
8. Safety
    - Some authors wrote that one-way operation is safer than two-way operation, and some authors found the opposite.
9. Travel Time (and Speed)
    - The literature indicates that one-way streets provide lower trip travel times (except for short trips), but—due to fewer stops—not necessarily higher between-intersection speeds.
10. Vehicle Miles Travelled (VMT)
    - One-way streets, by definition, require some circuitous travel, raising VMT.

According to the above literature review, although findings on capacity, cost, commercial values, and safety are mixed, and findings on crime and residential values are inconclusive:

one-way streets (by definition) **provide more room for parking, and usually supply lower trip travel times**, whereas two-way streets (by definition) **provide less confusion, more freedom, and lower VMT**.

Methods of Identifying One-way Streets for Conversion

The literature includes varied methods—from simple to complex—for identifying one-way streets that are good candidates for conversion to two-way.

Pavement Width

Converting streets from one-way to two-way operation using the existing pavement width requires enough pavement for a minimum of two lanes (one in each direction) plus parking as desired.

The main source of recommended widths is *A Policy on Geometric Design of Highways and Streets*[29] known as "the AASHTO green book" which "provides guidance based on established practices that are supplemented by recent research."

Lane Width

According to the AASHTO green book:

- "Lane widths of…**9 to 12 ft are generally used**…." (page 4-7)
- "**In urban areas** where pedestrian crossings, right-of-way, or existing development become stringent controls on lane widths, the use of…**11-ft lanes may be appropriate.** Lanes…**10 ft wide are acceptable on low-speed** facilities, and lanes…**9 ft wide may be appropriate** on low-volume roads in rural and **residential areas**." (pages 4-7, 4-8)

In addition, given that left-turners on two-way streets must deal with on-coming traffic, according to an article on the subject:

> "Streets **less than 22 feet wide** are not good candidates for two-way operations; left-turn movements will cause congestion."[30]

[29] *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2011 (6th Edition).
[30] *Converting One-way Streets to Two-way*, by John D. Edwards, from Main Street Story of the Week, Main Street America (preservationnation.org), June 2002.

Parking Width

According to the AASHTO green book:

- "Curb parking on **urban arterial streets** is acceptable when the available through-traffic lanes can reasonably accommodate traffic demand." (page 4-73)
- "…the desirable minimum width of a parking lane is…**8 ft**." (page 4-73)
- "The desirable parking lane width on **urban collectors is…8 ft** to accommodate a wide variety of traffic operations and land uses." (page 4-73)
- "On **urban collector streets within residential neighborhoods**…**7 ft parking lanes have been successfully used**. In fact, a **total width of…36 ft**, consisting of two travel lanes of…11 ft [totaling 22 ft] and parking lanes of…7 ft [totaling 14 ft], is frequently used." (page 4-73)
- "A…**26-ft wide roadway** is the typical cross section used in many **urban residential** areas. This width assures one through lane even where parking occurs on both sides." "**Random intermittent parking** on both sides of the street usually results in areas where two-way movement can be accommodated." (page 4-74)

Traffic- Rule of Thumb

Some analysts use traffic rules-of-thumb to judge the merits of conversion. Given the conventional wisdom of one-way operation rendering higher capacity than two-way operation, one-way streets with large traffic volumes may *not* be good candidates for conversion. According to an article for Main Street America (MSA)[31]:

> "If traffic volumes **exceed 15,000 vehicles per day (vpd)** on each of the one-way streets and if there are numerous cross streets with no suitable parallel or bypass routes, the conversion to two-way may increase congestion to unacceptable levels…."

Traffic- modeling

Other analysts use off-the-shelf simulation models to judge the merits of conversion. Consultants Walker, Kulash, and McHugh note that one can run TRAF-NETSIM software for each subject scenario (one-way, two-way) to calculate **system VMT and delay** for each, and then use those results to compare the two scenarios.[32] ENTRAN used TransModeler software to

[31] *Converting One-way Streets to Two-way*, by John D. Edwards, from Main Street Story of the Week, Main Street America (preservationnation.org), June 2002.

[32] *Downtown Streets: Are We Strangling Ourselves on One-Way Networks?*, by G. Wade Walker, Walter M. Kulash, and Brian T. McHugh of Glatting Jackson Kercher Anglin Lopez Rinehart, Inc. (Orlando), TRB Circular E-C019, Urban Street Symposium, Dec. 2000, page 9.

estimate the "**traffic impacts** associated with converting one-way streets in the downtown [Louisville] system to two-way traffic."[33]

Still other researchers have developed complex models for comparing the capacity of one-way networks to two-way networks. Gayah and Daganzo[34] propose measuring the relative trip-serving **capacity of each network (C_i)** in this manner:

$$C_i = \left[\frac{N_i^T G_i^T + N_i^L G_i^L}{N_i C}\right]\frac{s_i}{\alpha_i} = \left[\frac{N_i^T g_i^T + N_i^L g_i^L}{N_i}\right]\frac{s_i}{\alpha_i}$$

where

C_i = relative trip-serving capacity of each network;
N_i^T and N_i^L = total number of through and left-turn lanes, respectively, available for discharge in one direction for network i;
N_i = total number of wide lanes that would be available in idealized network using same space;
G_i^T and G_i^L = green time available per cycle for through and left-turning vehicles, respectively, to discharge;
C = length of signal cycle;
s_i = ratio of saturation flows at intersection in network i compared with idealized network;
g_i^T and g_i^L = fraction of green time per cycle available for through and left-turn movements; and
α_i = ratio of average trip lengths in network i compared with idealized network.

Chiu, Zhou, and Hernandez[35] propose using "multiple resolution simulation and assignment" (MRSA) approach for "estimating the **traffic impact**" of conversions. MRSA "entails a logical integration of two traffic simulation assignment methods with different traffic simulation resolutions and traffic assignment capabilities, as well as one origin-destination (OD) demand estimation procedure."

Finally, Zargari and Taromi[36] propose using genetic algorithms to optimize the configuration of one-way and two-way streets in a network based on **minimizing the total travel time** for all users.

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[33] *Downtown Louisville Two-Way Street Study*, by ENTRAN, for Downtown Development Corporation, Oct. 2009, pages 1 and 3.

[34] *Analytical Capacity Comparison of One-Way and Two-Way Signalized Street Networks*, by Vikash V. Gayah and Carlos F. Daganzo, Transportation Research Record No. 2301, TRB, Washington DC, 2012, page 77.

[35] *Evaluating Urban Downtown One-Way to Two-Way Street Conversion Using Multiple Resolution Simulation and Assignment Approach*, by Yi-Chang Chiu, Xuesong Zhou, and Jessica Hernandez, in Journal of Urban Planning and Development (ASCE), Dec. 2007, page 223.

[36] *Selecting an Optimum Configuration of Urban One-Way and Two-Way Streets Using Genetic Algorithms*, by Shahriar Afandizadeh Zargari and Reza Taromi, in International Journal of Civil Engineering, Vol. 4, No. 3 (Sept. 2006), page 244.

Conclusion from Literature Review

Given the above literature review, although one-way streets usually supply lower trip travel times, it **appears reasonable** for the cities of Hampton Roads to pursue **less confusion, more freedom, and lower VMT** by converting one-way streets to **two-way** operation where reasonable traffic volume and adequate pavement width exists.

ONE-WAY CANDIDATES FOR TWO-WAY OPERATION IN HAMPTON ROADS

Method Used in This Study to Identify Candidates for Two-way Operation

Based on the above literature review, HRTPO staff identified one-way street candidates for two-way operation by executing the following steps:

First, HRTPO staff identified the existing one-way streets in Hampton Roads:

- Started with a search of Google Maps
- Examined VDOT data indicating one-way vs. two-way operation, ignoring adjacent pairs (of interstates and arterials with medians), ramps, circles, and forked terminals.
- Finalized list using Google Maps' street view (e.g. one-way signage, direction signs facing, etc.)

HRTPO staff mapped the resulting one-way street segments (approx. 170) on the following pages, and listed them in a four-page table in a following section.

FIGURE 2 One-Way Streets in Chesapeake

Source: one-way.mxd

All of the one-way streets found in Chesapeake are located in South Norfolk.

FIGURE 3 One-Way Streets in Hampton

Source: one-way.mxd

All of the one-way streets found in Hampton are located in Meadow Brook.

FIGURE 4 One-Way Streets in Newport News
Source: one-way.mxd

The one-way streets found in Newport News are in the East End and Downtown/NNS[37] areas.

[37] Newport News Shipbuilding

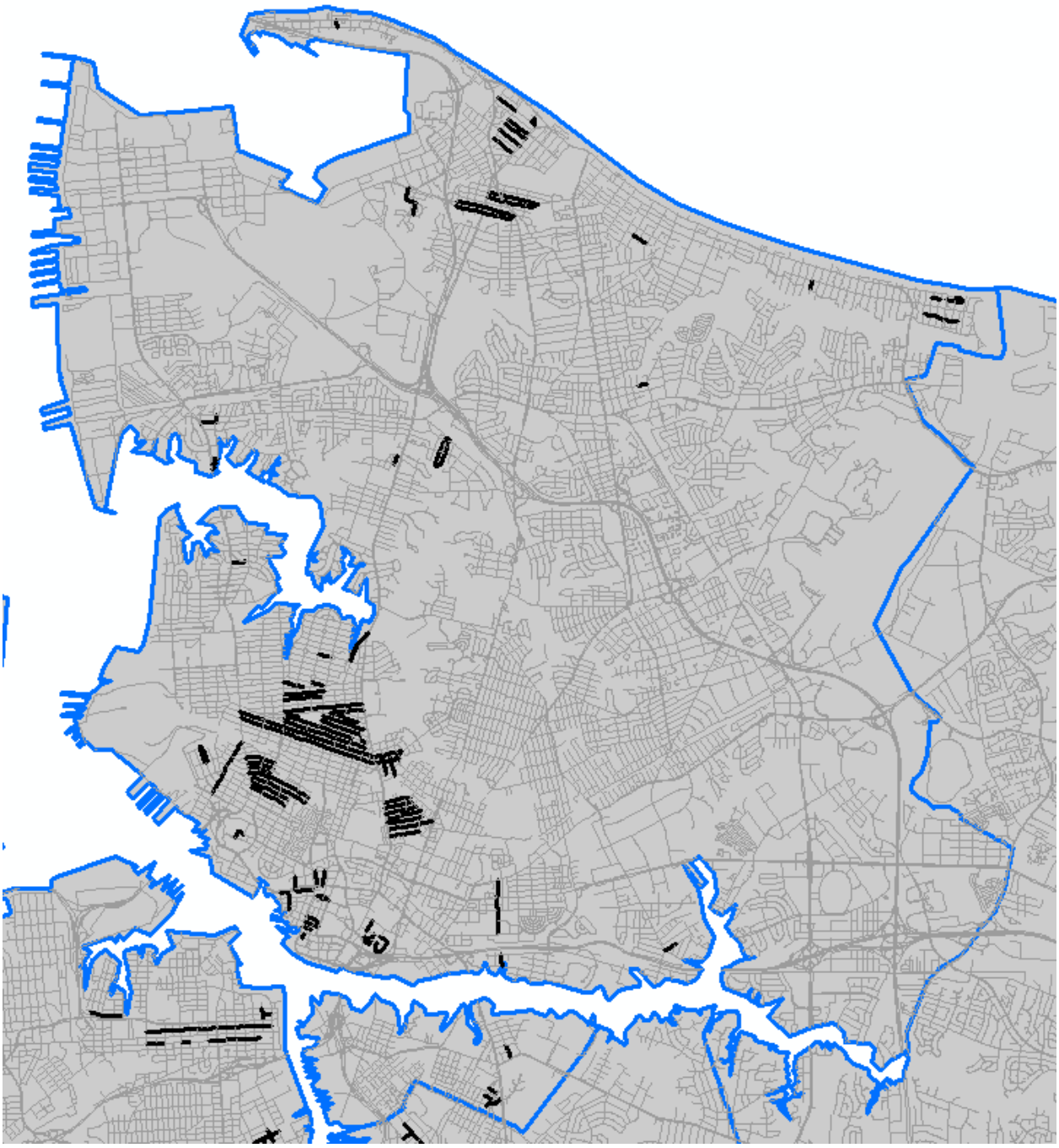

FIGURE 5 One-Way Streets in Norfolk
Source: one-way.mxd

Although concentrated in certain neighborhoods, Norfolk's one-way streets can be found in many different neighborhoods.

FIGURE 6 One-Way Streets in Portsmouth

Source: one-way.mxd

The one-way streets found in Portsmouth are in the eastern part of the city, Downtown and in Effingham Plaza near the Norfolk Naval Shipyard.

FIGURE 7 One-Way Streets in Suffolk

Source: one-way.mxd

All of the one-way streets found in Suffolk are in the Downtown area.

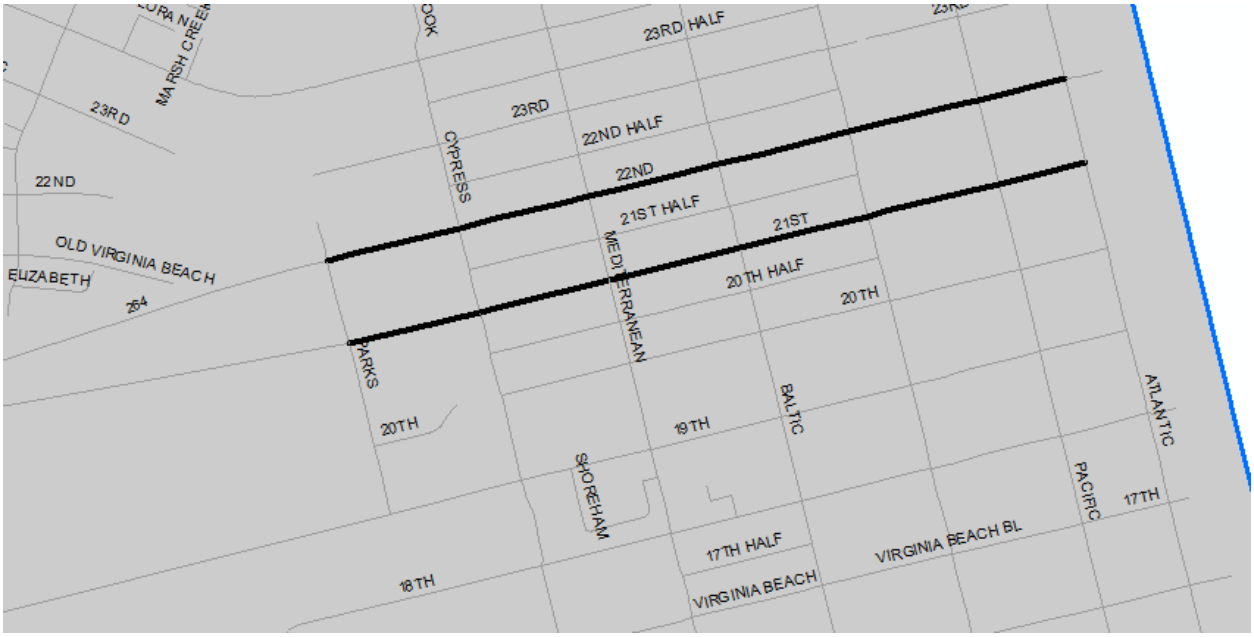

FIGURE 8 One-Way Streets in Virginia Beach

Source: one-way.mxd

Both of the one-way streets found in Virginia Beach are at the oceanfront.

FIGURE 9 One-Way Streets in Williamsburg

Source: one-way.mxd

The only one-way street found in Williamsburg (Boundary Street, between Richmond Road and Prince George Street) is near the Historic Area.

Secondly (i.e. following the above first step of locating the set of one-way streets), HRTPO staff applied the following criteria—based in part on the above review of literature—to that set to identify candidates for two-way operation:

- Lacking fatal flaw (e.g. serving as on-ramp)
- Lacking excessive traffic volume (<15k vpd)
- Having pavement width adequate to serve two lanes (one in ea. dir.) plus existing parking

HRTPO staff considered the following to have pavement width adequate for being a candidate for two-way operation:

- Streets with 2 or more existing (one-way) lanes
- Streets with 1 existing (one-way) lane but with adequate existing pavement width (based on table below)

TABLE 1 Minimum Pavement Width for Consideration as Candidate for Two-Way Operation (one lane in each direction)

Source: pavement width.xlsx

	Roadway Functional Class											
	Local				Collector				Arterial			
Parking	lanes, ft	parking, ft	total, ft	foot-note	lanes, ft	parking, ft	total, ft	foot-note	lanes, ft	parking, ft	total, ft	foot-note
None	9'x2	0	**18**	(1)	10'x2	0	**20**	(1)	11'x2	0	**22**	(2)
On One Side	9'x2	7	**25**	(1)	10'x2	8	**28**	(1)	11'x2	10	**32**	(1)
On Both Sides	9'x2	7'x2	**32**	(1)	10'x2	8'x2	**36**	(3)	11'x2	10'x2	**42**	(1)

Table Footnotes

(1) Calculations by HRTPO staff based on AASHTO and Edwards documents (below).

(2) *Converting One-way Streets to Two-way*, by John D. Edwards, Main Street Story of the Week, Main Street America, June 2002.

(3) *A Policy on Geometric Design of Highways and Streets* , AASHTO, 2011, pg. 4-73.

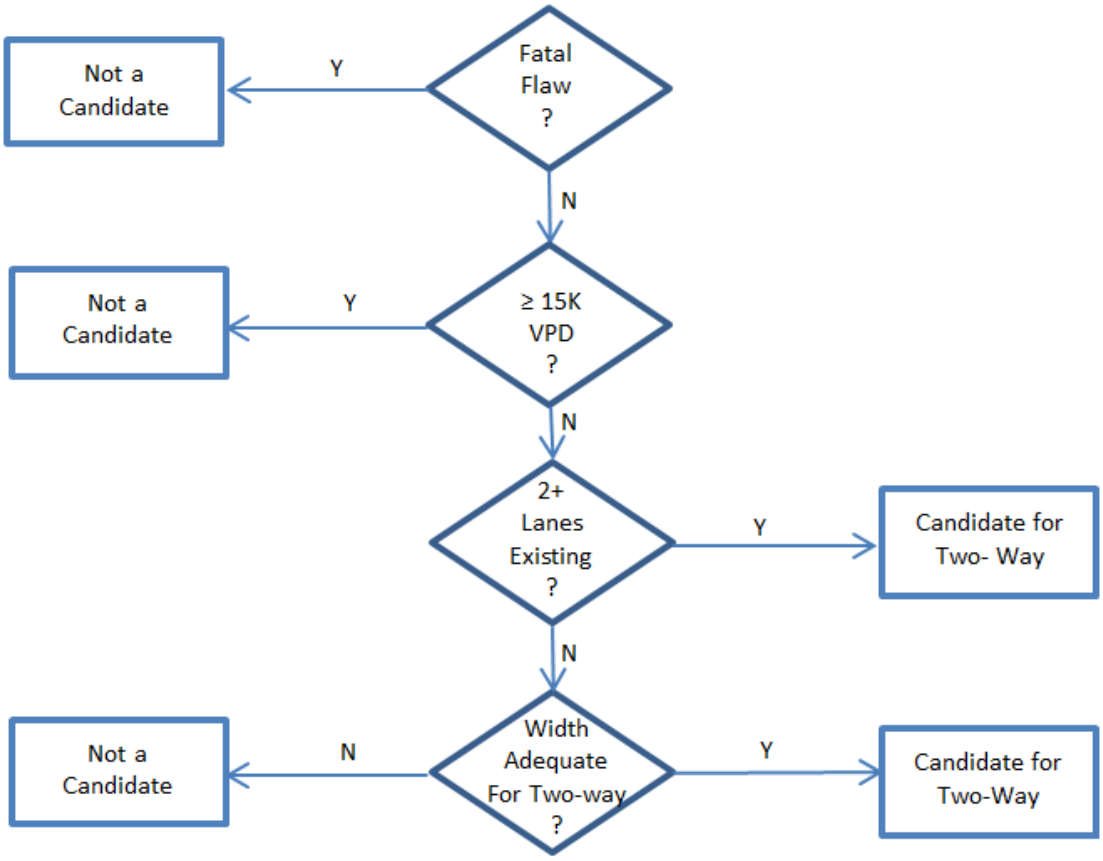

FIGURE 10 Method of Identifying Candidates for Two-way Operation
Source: Flowchart by Shirley.docx

Candidates for Two-Way Operation

Execution of the above steps resulted in a table of one-way streets with identification of candidates for two-way operation.

TABLE 2 One-way Streets and Candidates for Two-way Operation
Source: one-way.xlsx
[table shown on following pages]

City	Neighborhood	Facility Name	From (directionally)	To (directionally)	"Fatal Flaw"	Traffic Volume >15k vpd?	Func-tional Class	2+ Lanes Existing?	Pavement Width-inclg gutter, ft (based on Google Maps)	Parking (existing)	Minimum Pavement Width, ft (for one lane each direction; based on class and parking)	Candidate? (based on fatal flaw, vpd, # of ex. lanes, pave. width)
Chesapeake	South Norfolk	18th Street	B Street	D Street	n.a.	no	Local	no	22	One side	25	no (pave. width)
Chesapeake	South Norfolk	22nd Street	B Street	Rodgers Street	n.a.	no	Local	no	27	Both sides	32	no (pave. width)
Chesapeake	South Norfolk	B Street	22nd Street	16th Street	n.a.	no	Local	no	24	One side	25	no (pave. width)
Chesapeake	South Norfolk	Phillips Street	Poindexter Street	Seaboard Avenue	n.a.	no	Local	no	20	Both sides	32	no (pave. width)
Chesapeake	South Norfolk	Rodgers Street	Grady Street	Poindexter Street	n.a.	no	Local	no	24	One side	25	no (pave. width)
Hampton	Meadow Brook	Armstrong Drive	Stratford Road	Roads View Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Hampton	Meadow Brook	Barksdale Road	Armstrong Drive	Roads View Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Hampton	Meadow Brook	Burns Street	Van Patten Drive	Stratford Road	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Hampton	Meadow Brook	Clyde Street	Roads View Avenue	Stratford Road	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Hampton	Meadow Brook	Roads View Avenue	Armstrong Drive	Clyde Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Hampton	Meadow Brook	Van Patten Drive	Armstrong Drive	Clyde Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Newport News	East End	25th Street	Jefferson Avenue	26th Street	I-664 ramp	no	Collector	yes	2 lanes	Both sides	36	no (fatal flaw)
Newport News	East End	26th Street	Jefferson Avenue	25th Street	I-664 ramp	no	Collector	yes	2 lanes	One side	28	no (fatal flaw)
Newport News	East End	27th Street	Jefferson Avenue	28th Street	I-664 ramp	no	Collector	yes	2 lanes	One side	28	no (fatal flaw)
Newport News	East End	28th Street	27th Street	Jefferson Avenue	I-664 ramp	no	Collector	yes	2 lanes	One side	28	no (fatal flaw)
Newport News	East End	35th Street	Jefferson Avenue	Marshall Avenue	I-664 ramp	no	Arterial	yes	2 lanes	One side	32	no (fatal flaw)
Newport News	NNS/Downtown	23rd Street	Huntington Avenue	Warwick Boulevard	n.a.	no	Collector	no	18	None	20	no (pave. width)
Newport News	NNS/Downtown	26th Street	Huntington Avenue	West Avenue	I-664 ramp	no	Local	yes	2 lanes	Both sides	32	no (fatal flaw)
Newport News	NNS/Downtown	29th Street	West Avenue	Warwick Boulevard	n.a.	no	Local	yes	2 lanes	Both sides	32	yes (2+ ex. lanes)
Newport News	NNS/Downtown	30th Street	Warwick Boulevard	West Avenue	n.a.	no	Local	yes	2 lanes	Both sides	32	yes (2+ ex. lanes)
Newport News	NNS/Downtown	32nd Street	Washington Avenue	Warwick Boulevard	n.a.	no	Local	yes	2 lanes	Both sides	32	yes (2+ ex. lanes)
Newport News	NNS/Downtown	33rd Street	Warwick Boulevard	Washington Avenue	n.a.	no	Local	yes	2 lanes	Both sides	32	yes (2+ ex. lanes)
Newport News	NNS/Downtown	34th Street	West Avenue	Warwick Boulevard	I-664 ramp	no	Collector	yes	2 lanes	Both sides	36	no (fatal flaw)
Newport News	NNS/Downtown	35th Street	Warwick Boulevard	West Avenue	I-664 ramp	no	Collector	yes	2 lanes	Both sides	36	no (fatal flaw)
Newport News	NNS/Downtown	36th Street	Washington Avenue	Warwick Boulevard	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Newport News	NNS/Downtown	37th Street	Warwick Boulevard	Washington Avenue	n.a.	no	Local	yes	2 lanes	Both sides	32	yes (2+ ex. lanes)
Newport News	NNS/Downtown	38th Street	Washington Avenue	Warwick Boulevard	n.a.	no	Local	yes	2 lanes	Both sides	32	yes (2+ ex. lanes)
Newport News	NNS/Downtown	41st Street	Washington Avenue	Huntington Avenue	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Newport News	NNS/Downtown	42nd Street	Warwick Boulevard	Huntington Avenue	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Newport News	NNS/Downtown	42nd Street	Huntington Avenue	Washington Avenue	n.a.	no	Local	yes	2 lanes	One side	25	yes (2+ ex. lanes)
Newport News	NNS/Downtown	43rd Street	Washington Avenue	Warwick Boulevard	n.a.	no	Local	yes	2 lanes	One side	25	yes (2+ ex. lanes)
Newport News	NNS/Downtown	44th Street	Warwick Boulevard	Washington Avenue	n.a.	no	Local	no	30	One side	25	yes (pave. width)
Newport News	NNS/Downtown	45th Street	Washington Avenue	Warwick Boulevard	n.a.	no	Local	no	30	One side	25	yes (pave. width)
Newport News	NNS/Downtown	46th Street	Huntington Avenue	Washington Avenue	n.a.	no	Local	no	30	One side	25	yes (pave. width)
Newport News	NNS/Downtown	47th Street	Washington Avenue	Huntington Avenue	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Newport News	NNS/Downtown	47th Street	Huntington Avenue	Warwick Boulevard	n.a.	no	Local	yes	2 lanes	One side	25	yes (2+ ex. lanes)
Newport News	NNS/Downtown	48th Street	Warwick Boulevard	Washington Avenue	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Newport News	NNS/Downtown	49th Street	Washington Avenue	Warwick Boulevard	n.a.	no	Collector	yes	2 lanes	One side	28	yes (2+ ex. lanes)
Newport News	NNS/Downtown	50th Street	Warwick Boulevard	Huntington Avenue	n.a.	no	Collector	no	30	Both sides	36	no (pave. width)
Newport News	NNS/Downtown	50th Street	Huntington Avenue	Washington Avenue	n.a.	no	Collector	yes	2 lanes	Both sides	36	yes (2+ ex. lanes)
Newport News	NNS/Downtown	51st Street	Huntington Avenue	Warwick Boulevard	n.a.	no	Local	no	30	One side	25	yes (pave. width)
Newport News	NNS/Downtown	Huntington Avenue	Warwick Boulevard	23rd Street	NNS surge	no	Arterial	yes	3 lanes	One side	32	no (fatal flaw)
Newport News	NNS/Downtown	Warwick Boulevard	23rd Street	Huntington Avenue	NNS surge	no	Arterial	yes	3 lanes	One side	32	no (fatal flaw)
Newport News	NNS/Downtown	Washington Avenue	50th Street	49th Street	n.a.	no	Collector	yes	2 lanes	One side	28	yes (2+ ex. lanes)

City	Neighborhood	Facility Name	From (directionally)	To (directionally)	"Fatal Flaw"	Traffic Volume >15k vpd?	Functional Class	2+ Lanes Existing?	Pavement Width- inclg gutter, ft (based on Google Maps)	Parking (existing)	Minimum Pavement Width, ft (for one lane each direction; based on class and parking)	Candidate? (based on fatal flaw, vpd, # of ex. lanes, pave. width)
Norfolk	Bay View	Alfred Lane	Sturgis Street	Willow Terrace	n.a.	no	Local	no	10	Both sides	32	no (pave. width)
Norfolk	Bay View	Elk Avenue	Bi-County Road	Buffalo Avenue	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	Campostella	Oakwood Street	Canton Avenue	Indian River Road	cut-thru	no	Local	no	30	One side	25	no (fatal flaw)
Norfolk	Chesterfield Heights	Forbes Street	Kimball Terrace	Westminster Avenue	cut-thru	no	Local	no	26	Both sides	32	no (fatal flaw)
Norfolk	Colonial Place	Delaware Avenue	Newport Avenue	Colonial Avenue	n.a.	no	Collector	no	24	One side	28	no (pave. width)
Norfolk	Colonial Place	LLewellyn Avenue	Granby Street	Connecticut Avenue	Granby ramp	no	Arterial	yes	2 lanes	None	22	no (fatal flaw)
Norfolk	Colonial Place	LLewellyn Avenue	Connecticut Avenue	Delaware Avenue	n.a.	no	Arterial	yes	2 lanes	None	22	yes (2+ ex. lanes)
Norfolk	Diggs Town	Goodman Street	Vernon Drive	Melon Street	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	Diggs Town	Greenleaft Drive	Vine Street	Cypress Street	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	Diggs Town	Thurgood Street	Melon Street	Vernon Drive	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	Downtown	Brooke Avenue	Granby Street	Boush Street	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Norfolk	Downtown	Bute Street	Granby Street	Charlotte Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Downtown	Charlotte Street	Bute Street	Granby Street	n.a.	no	Local	no	40	None	18	yes (pave. width)
Norfolk	Downtown	Charlotte Street	Granby Street	Monticello Avenue	n.a.	no	Local	no	28	None	18	yes (pave. width)
Norfolk	Downtown	College Place	Granby Street	Boush Street	n.a.	no	Local	no	24	One side	25	no (pave. width)
Norfolk	Downtown	Magazine Lane	Olney Road	Brambleton Avenue	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Downtown	Market Street	Monticello Avenue	Granby Street	n.a.	no	Local	no	27	One side	25	yes (pave. width)
Norfolk	Downtown	Randolph Street	City Hall Avenue	Plume Street	n.a.	no	Local	no	25	One side	25	yes (pave. width)
Norfolk	Downtown	Tazewell Street	Boush Street	Monticello Avenue	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Downtown	Voss Street	Olney Road	Brambleton Avenue	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	East Beach	Coventry Lane	27th Bay Street	East Beach Drive	n.a.	no	Local	no	19	One side	25	no (pave. width)
Norfolk	East Beach	East Beach Drive	Coventry Lane	28th Bay Street	n.a.	no	Local	no	19	One side	25	no (pave. width)
Norfolk	East Beach	Hammock Lane	29th Bay Street	24th Bay Street	n.a.	no	Local	no	19	One side	25	no (pave. width)
Norfolk	East Beach	Maiden Lane	25th Bay Street	26th Bay Street	n.a.	no	Local	no	19	One side	25	no (pave. width)
Norfolk	East Ocean View	9th Bay Street	Pretty Lake Avenue	Pleasant Avenue	n.a.	no	Local	no	20	Both sides	32	no (pave. width)
Norfolk	Freemason	Dunmore Street	York Street	College Place	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Freemason	Yarmouth Street	Brambleton Avenue	Grace Street	n.a.	no	Local	no	25	Both sides	32	no (pave. width)
Norfolk	Freemason	York Street	Botetourt Street	Dunmore Street	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	Freemason	York Street	Duke Street	Boush Street	n.a.	no	Local	no	25	One side	25	yes (pave. width)
Norfolk	Freemason	York/Yarmouth Streets	Duke Street	Brambleton Avenue	cut-thru	no	Local	no	19	One side	25	no (fatal flaw)
Norfolk	Ghent	Baldwin Avenue	Hampton Boulevard	Stockley Gardens	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Ghent	Brandon Avenue	Colley Avenue	Hampton Boulevard	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Ghent	Gates Avenue	Hampton Boulevard	Colley Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Ghent	Harrington Avenue	Colley Avenue	Hampton Boulevard	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Ghent	Maury Avenue	Stockley Gardens	Hampton Boulevard	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Ghent	Olney Road	Children's Lane	Fairfax Avenue	hospital drop	no	Local	yes	2 lanes	None	18	no (fatal flaw)
Norfolk	Ghent	Shirley Avenue	De Bree Avenue	Hampton Boulevard	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Ghent	Spotswood Avenue	Hampton Boulevard	De Bree Avenue	n.a.	no	Local	no	22	One side	25	no (pave. width)
Norfolk	Huntersville	A Avenue	Sutton Street	Church Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Huntersville	B Avenue	Church Street	Sutton Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Huntersville	C Avenue	Sutton Street	Church Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Huntersville	Fremont Street	Church Street	Sutton Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Huntersville	Johnson Avenue	Proescher Street	Church Street	n.a.	no	Local	no	22	One side	25	no (pave. width)
Norfolk	Huntersville	Lexington Street	Dungee Street	Church Street	n.a.	no	Local	no	20	One side	25	no (pave. width)

City	Neighborhood	Facility Name	From (directionally)	To (directionally)	"Fatal Flaw"	Traffic Volume >15k vpd?	Func-tional Class	2+ Lanes Existing?	Pavement Width-inclg gutter, ft (based on Google Maps)	Parking (existing)	Minimum Pavement Width, ft (for one lane each direction; based on class and parking)	Candidate? (based on fatal flaw, vpd, # of ex. lanes, pave. width)
Norfolk	Huntersville	Washington Avenue	Church Street	Chapel Street	n.a.	no	Local	no	22	One side	25	no (pave. width)
Norfolk	Ingleside	Peake Road	Etheridge Avenue	Ingleside Road	n.a.	no	Local	no	12	None	18	no (pave. width)
Norfolk	Larchmont	Surrey Crescent	Hampton Boulevard	Jamestown Crescent	cut-thru	no	Local	no	22	One side	25	no (fatal flaw)
Norfolk	Lenox	Bay Avenue	I-64 Ramp	Granby Street	n.a.	no	Collector	no	26	One side	28	no (pave. width)
Norfolk	Lenox	Bay Avenue	Granby Street	Tidewater Drive	n.a.	no	Local	no	26	One side	25	yes (pave. width)
Norfolk	Lenox	Lorengo Avenue	Dudley Avenue	Granby Street	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Lenox	Ocean Avenue	Tidewater Drive	I-64 Ramp	n.a.	no	Local	no	26	One side	25	yes (pave. width)
Norfolk	Lenox	Randall Avenue	Granby Street	Dudley Avenue	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Merrimac Park	Albemarle Drive	Monitor Way	Bay Avenue	n.a.	no	Local	no	19	One side	25	no (pave. width)
Norfolk	Merrimac Park	Nipsic Lane	Albemarle Drive	Albemarle Drive	n.a.	no	Local	no	10	None	18	no (pave. width)
Norfolk	Norfolk State	Mapole Avenue	Princess Anne Road	Dubose Drive	n.a.	no	Local	no	22	One side	25	no (pave. width)
Norfolk	Norfolk State	Mapole Avenue	Corprew Avenue	Virginia Beach Boulevard	n.a.	no	Local	no	22	One side	25	no (pave. width)
Norfolk	Norfolk State	Presidential Parkway	Dick Price Stadium	Corprew Avenue	n.a.	no	Local	no	24	One side	25	no (pave. width)
Norfolk	North Shore	Claud Lane	Shirland Avenue	Hampton Boulevard	n.a.	no	Local	no	11	None	18	no (pave. width)
Norfolk	North Shore	Helena Avenue	Shirland Avenue	Hampton Boulevard	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	North Shore	Pasadena Court	Hampton Boulevard	Shirland Avenue	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	North Shore	Shirland Avenue	Little Creek Road	Trouville Avenue	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	North Shore	Trouville Avenue	Shirland Avenue	Hampton Boulevard	n.a.	no	Local	no	18	One side	25	no (pave. width)
Norfolk	Ocean View	A View Avenue	Mason Creek Road	1st View Street	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Ocean View	Cherry Street	Granby Street	1st View Street	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Norfolk	Ocean View	D View Avenue	1st View Street	Granby Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Ocean View	Duffys Lane	Portview Avenue	A View Avenue	n.a.	no	Local	no	21	Both sides	32	no (pave. width)
Norfolk	Ocean View	Government Street	Granby Street	1st View Street	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Ocean View	Granby Street	A View Avenue	Duffys Lane	n.a.	no	Local	no	30	One side	25	yes (pave. width)
Norfolk	Ocean View	Seaview Avenue	Granby Street	1st View Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	26th Street	Hampton Boulevard	27th Street	n.a.	no	Arterial	yes	2 lanes	One side	32	yes (2+ ex. lanes)
Norfolk	Park Place	27th Street	26th Street	Hampton Boulevard	n.a.	no	Arterial	yes	2 lanes	One side	32	yes (2+ ex. lanes)
Norfolk	Park Place	28th Street	Colley Avenue	Monticello Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	29th Street	Monticello Avenue	Granby Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	29th Street	Omohundro Avenue	31st Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	30th Street	Colonial Avenue	Granby Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	31st Street	Gosnold Avenue	Colley Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	31st Street	Granby Street	Colonial Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	32nd Street	33rd Street	Omohundro Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	33rd Street	Granby Street	32nd Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	34th Street	Colley Avenue	Granby Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	36th Street	Colley Avenue	Colonial Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	37th Street	Colonial Avenue	Colley Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	Fawn Street	27th Street	23rd Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	Gazel Street	27th Street	26th Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Park Place	Gazel Street	Rugby Street	26th Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Park Place	Georgia Avenue	Newport Avenue	38th Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	Michigan Avenue	Gosnold Avenue	Colley Avenue	n.a.	no	Local	no	24	Both sides	32	no (pave. width)
Norfolk	Park Place	Michigan Avenue	Gosnold Avenue	38th Street	n.a.	no	Local	no	24	Both sides	32	no (pave. width)

City	Neighborhood	Facility Name	From (directionally)	To (directionally)	"Fatal Flaw"	Traffic Volume >15k vpd?	Functional Class	2+ Lanes Existing?	Pavement Width- inclg gutter, ft (based on Google Maps)	Parking (existing)	Minimum Pavement Width, ft (for one lane each direction; based on class and parking)	Candidate? (based on fatal flaw, vpd, # of ex. lanes, pave. width)
Norfolk	Tidewater Gardens	Chapel Street	Charlotte Street	Mariner Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Tidewater Gardens	Holt Street	Reilly Street	Chapel Street	n.a.	no	Local	no	10	None	18	no (pave. width)
Norfolk	Tidewater Gardens	Mariner Street	Holt Street (mid-block)	Holt Street (end-block)	n.a.	no	Local	no	22	One side	25	no (pave. width)
Norfolk	Tidewater Gardens	Mariner Street	Holt Street (end-block)	Walke Street	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Tidewater Gardens	Reilly Street	Mariner Street	Virgin Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Tidewater Gardens	Virgin Street	Holt Street	Chapel Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Norfolk	Wards Corner	Kenmore Drive	Virginian Drive	Virginian Drive	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Wards Corner	Wilby Street	Warren Street	Marcy Street	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	West Ghent	Claremont Avenue	Redgate Avenue	Hampton Boulevard	n.a.	no	Collector	no	26	Both sides	36	no (pave. width)
Norfolk	West Ghent	Graydon Place	Weyanoke Street	Old Brandon Avenue	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	West Ghent	Graydon Place	Old Brandon Avenue	Weyanoke Street	n.a.	no	Local	no	26	Both sides	32	no (pave. width)
Norfolk	Willoughby	Hansford Place	Little Bay Avenue	Ocean View Avenue	n.a.	no	Local	no	20	Both sides	32	no (pave. width)
Portsmouth	Olde Towne	Glasgow Street	Middle Street	Crawford Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Portsmouth	Olde Towne	King Street	library cut-thru	Effingham Street	n.a.	no	Local	no	18	One side	25	no (pave. width)
Portsmouth	Olde Towne	King Street	Chestnut Street	Effingham Street	n.a.	no	Local	no	20	None	18	yes (pave. width)
Portsmouth	Olde Towne	King Street	Godwin Street	Peninsula Avenue	n.a.	no	Local	no	22	One side	25	no (pave. width)
Portsmouth	Olde Towne	King Street	Phoebus Street	Elm Avenue	n.a.	no	Local	no	24	One side	25	no (pave. width)
Portsmouth	Olde Towne	Middle Street	North Street	Glasgow Street	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Portsmouth	Olde Towne	Middle Street	London Street	Glasgow Street	n.a.	no	Local	no	30	Both sides	32	no (pave. width)
Portsmouth	Olde Towne	Queen Street	Peninsula Avenue	Effingham Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Portsmouth	Olde Towne	Queen Street	Effingham Street	Crawford Street	n.a.	no	Local	no	20	One side	25	no (pave. width)
Portsmouth	Shea Terrace	North Street	Sandpiper Drive	Constitution Avenue	n.a.	no	Local	no	16	None	18	no (pave. width)
Portsmouth	Shea Terrace	North Street	Chesapeake Avenue	Constitution Avenue	n.a.	no	Local	no	22	One side	25	no (pave. width)
Portsmouth	Shipyard	5th Street	Edwards Street	Madison Street	n.a.	no	Local	no	36	One side	25	yes (pave. width)
Portsmouth	Shipyard	5th Street	Madison Street	Portsmouth Boulevard	n.a.	no	Local	no	36	Both sides	32	yes (pave. width)
Portsmouth	Shipyard	6th Street	Portsmouth Boulevard	Madison Street	n.a.	no	Local	no	36	Both sides	32	yes (pave. width)
Portsmouth	Shipyard	Madison Street	Port Center Parkway	7th Street	n.a.	no	Local	no	36	Both sides	32	yes (pave. width)
Suffolk	Downtown	Clay Street	Finney Avenue	Market Street	n.a.	no	Local	no	18	Both sides	32	no (pave. width)
Suffolk	Downtown	Clay Street	Market Street	Washington Street	n.a.	no	Local	no	19	Both sides	32	no (pave. width)
Suffolk	Downtown	North Street	Market Street	Washington Street	n.a.	no	Local	no	19	One side	25	no (pave. width)
Suffolk	Downtown	Pender Street	Washington Street	Spring Street	n.a.	no	Local	no	16	Both sides	32	no (pave. width)
Suffolk	Downtown	Pine Street	Washington Street	Market Street	n.a.	no	Local	no	18	One side	25	no (pave. width)
Suffolk	Downtown	Pinner Street	Bank Street	Finney Avenue	cut-thru	no	Collector	no	27	One side	28	no (fatal flaw)
Suffolk	Downtown	Saratoga Street	Market Street	Freemason Street	n.a.	no	Local	no	24	One side	25	no (pave. width)
Virginia Beach	Oceanfront	21st Street	Parks Avenue	Atlantic Avenue	from I-264	no	Arterial	yes	2-4 lanes	Both sides	42	no (fatal flaw)
Virginia Beach	Oceanfront	22nd Street	Atlantic Avenue	Parks Avenue	to I-264	no	Arterial	yes	2-4 lanes	Both sides	42	no (fatal flaw)
Williamsburg	Downtown	Boundary Street	Richmond Road	Prince George Street	n.a.	no	Local	no	26	Both sides	32	no (pave. width)

Findings

Execution of the HRTPO staff methodology resulted in approximately 40 of the region's one-way streets—all in Newport News, Norfolk, and Portsmouth—being identified as candidates for two-way operation, representing **almost one-fourth** of the existing one-way segments, as shown below.

TABLE 3 One-way Streets Meeting Criteria for Candidates for Two-way Operation

Source: one-way.xlsx

City	Neighborhood	Facility Name	From (directionally)	To (directionally)
Newport News	NNS/Downtown	29th Street	West Avenue	Warwick Boulevard
Newport News	NNS/Downtown	30th Street	Warwick Boulevard	West Avenue
Newport News	NNS/Downtown	32nd Street	Washington Avenue	Warwick Boulevard
Newport News	NNS/Downtown	33rd Street	Warwick Boulevard	Washington Avenue
Newport News	NNS/Downtown	37th Street	Warwick Boulevard	Washington Avenue
Newport News	NNS/Downtown	38th Street	Washington Avenue	Warwick Boulevard
Newport News	NNS/Downtown	42nd Street	Huntington Avenue	Washington Avenue
Newport News	NNS/Downtown	43rd Street	Washington Avenue	Warwick Boulevard
Newport News	NNS/Downtown	44th Street	Warwick Boulevard	Washington Avenue
Newport News	NNS/Downtown	45th Street	Washington Avenue	Warwick Boulevard
Newport News	NNS/Downtown	46th Street	Huntington Avenue	Washington Avenue
Newport News	NNS/Downtown	47th Street	Huntington Avenue	Warwick Boulevard
Newport News	NNS/Downtown	49th Street	Washington Avenue	Warwick Boulevard
Newport News	NNS/Downtown	50th Street	Huntington Avenue	Washington Avenue
Newport News	NNS/Downtown	51st Street	Huntington Avenue	Warwick Boulevard
Newport News	NNS/Downtown	Washington Avenue	50th Street	49th Street
Norfolk	Colonial Place	LLewellyn Avenue	Connecticut Avenue	Delaware Avenue
Norfolk	Downtown	Charlotte Street	Bute Street	Granby Street
Norfolk	Downtown	Charlotte Street	Granby Street	Monticello Avenue
Norfolk	Downtown	Market Street	Monticello Avenue	Granby Street
Norfolk	Downtown	Randolph Street	City Hall Avenue	Plume Street
Norfolk	Freemason	York Street	Duke Street	Boush Street
Norfolk	Lenox	Bay Avenue	Granby Street	Tidewater Drive
Norfolk	Lenox	Ocean Avenue	Tidewater Drive	I-64 Ramp
Norfolk	Ocean View	Granby Street	A View Avenue	Duffys Lane
Norfolk	Park Place	26th Street	Hampton Boulevard	27th Street
Norfolk	Park Place	27th Street	26th Street	Hampton Boulevard
Portsmouth	Olde Towne	King Street	Chestnut Street	Effingham Street
Portsmouth	Shipyard	5th Street	Edwards Street	Madison Street
Portsmouth	Shipyard	5th Street	Madison Street	Portsmouth Boulevard
Portsmouth	Shipyard	6th Street	Portsmouth Boulevard	Madison Street
Portsmouth	Shipyard	Madison Street	Port Center Parkway	7th Street

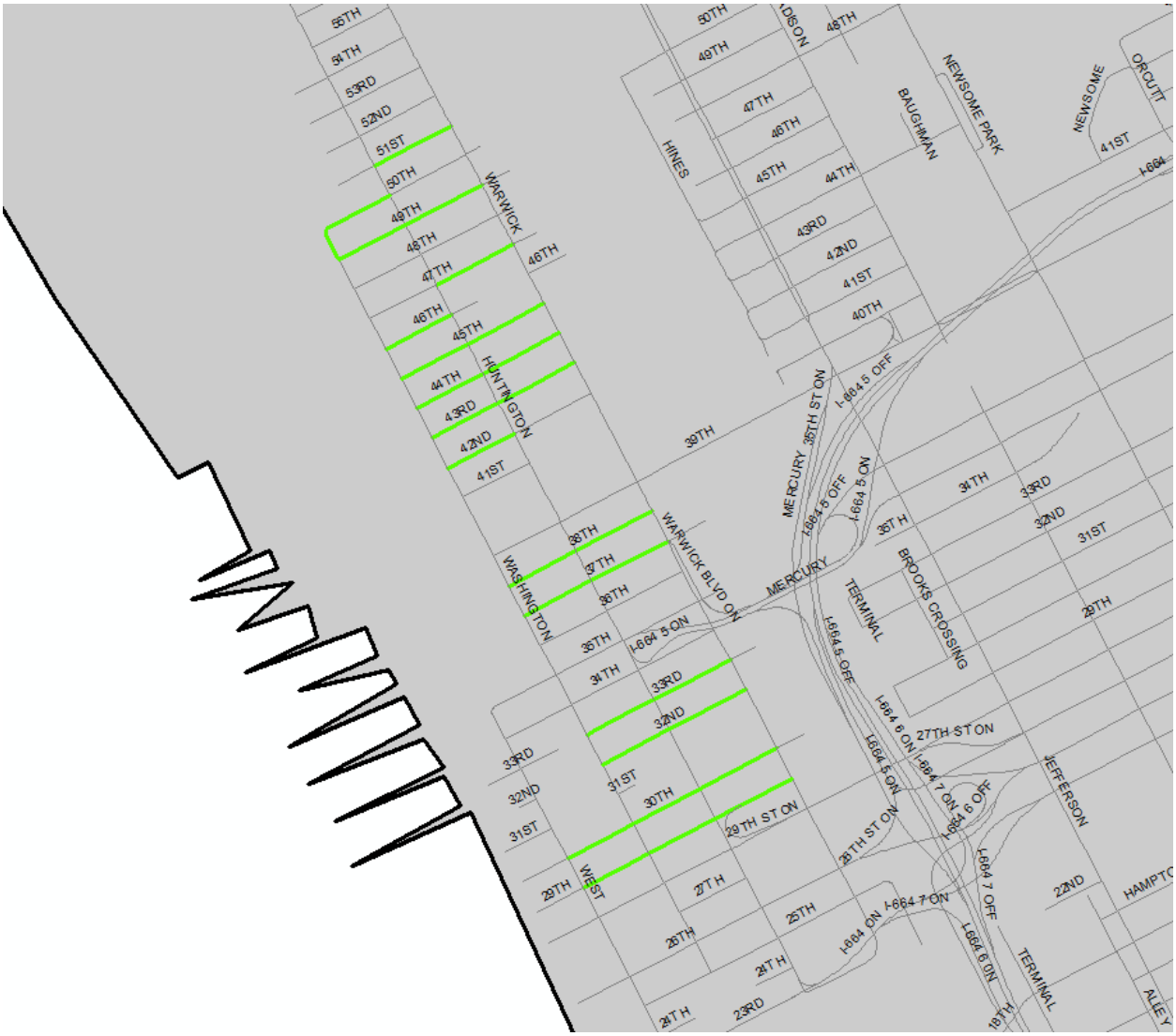

FIGURE 11 **One-Way Street Candidates for Two-Way Operation** **in Newport News**
Source: one-way.mxd

In Newport News, HRTPO staff found several candidates for two-way operation in the NNS/Downtown area.

FIGURE 12 **One-Way Street Candidates for Two-Way Operation in Portsmouth**
Source: one-way.mxd

In Portsmouth, HRTPO staff found several candidates for two-way operation in Effingham Plaza (near Norfolk Naval Shipyard) but only one block downtown (King Street, between Chestnut and Effingham Streets).

FIGURE 13 One-Way Street Candidates for Two-Way Operation in Downtown Norfolk
Source: one-way.mxd

The HRTPO methodology revealed four two-way candidates downtown:

- York Street
- Charlotte Street
- Market Street
- Randolph Street

FIGURE 14 One-Way Street Candidates for Two-Way Operation in Central Norfolk
Source: one-way.mxd

The HRTPO methodology revealed three two-way candidates in central Norfolk:

- Llewellyn Street
- 26th Street
- 27th Street

When considering any change to 26th and 27th Streets, note that these streets have bike lanes.

FIGURE 15 One-Way Street Candidates for Two-Way Operation in Northern Norfolk
Source: one-way.mxd

The HRTPO methodology revealed three two-way candidates in northern Norfolk:

- A short segment of Granby Street at Ocean View
- Ocean Avenue
- Bay Avenue[38]

Caveat

HRTPO staff provides the above identification of candidates for two-way operation as a **starting point** for discussion with traffic engineering and other applicable stakeholders. For example, given the path of light rail in Norfolk, conversion of Charlotte Street (between Bute Street and Monticello Avenue) to two-way operation would require coordination with HRT.

[38] Note: The portion of Bay Avenue from I-64 to Granby Street is considered a Collector and therefore did not pass the width test for two-way operation (see database above).

Focal Areas

Although limited to one research team in the above literature review, Riggs and Gilderbloom found higher home values and lower crime after one-way conversions to two-way operation. Consequently, in case our local government clients wish to focus their conversion efforts in high-crime and/or low-home-value areas, HRTPO staff overlaid the candidate conversion locations with home values and crime statistics.

Crime Statistics

Of the three cities with candidates for two-way operation, Newport News provided crime geography, as shown below.

FIGURE 16 Two-Way Operation Candidates and 2016 Crime in Newport News
Source: one-way.mxd

The area with candidate streets (NNS/downtown) appears to have relatively low crime.

Home Value Statistics

HRTPO staff extracted home values by block group[39] from the 2015 US Census.

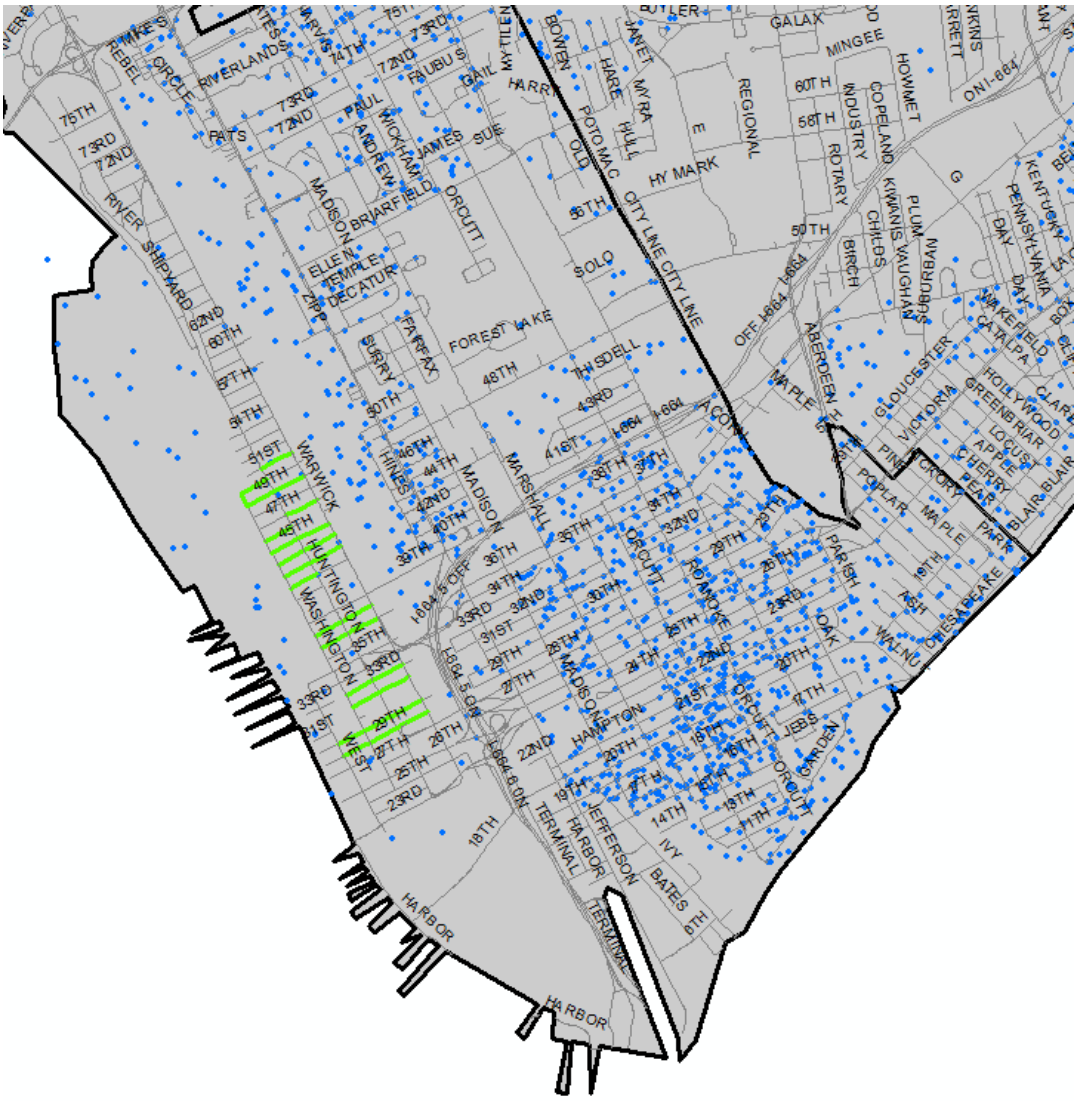

FIGURE 17 Two-Way Operation Candidates and Homes Valued Less than $100,000 (2015) in Newport News
Source: one-way.mxd

The area with candidate streets (NNS/downtown) appears to have relatively few homes valued below $100,000.

[39] Note that the mapping software randomly distributes the applicable dots across the area of the subject block group. Therefore, the home locations shown are approximate.

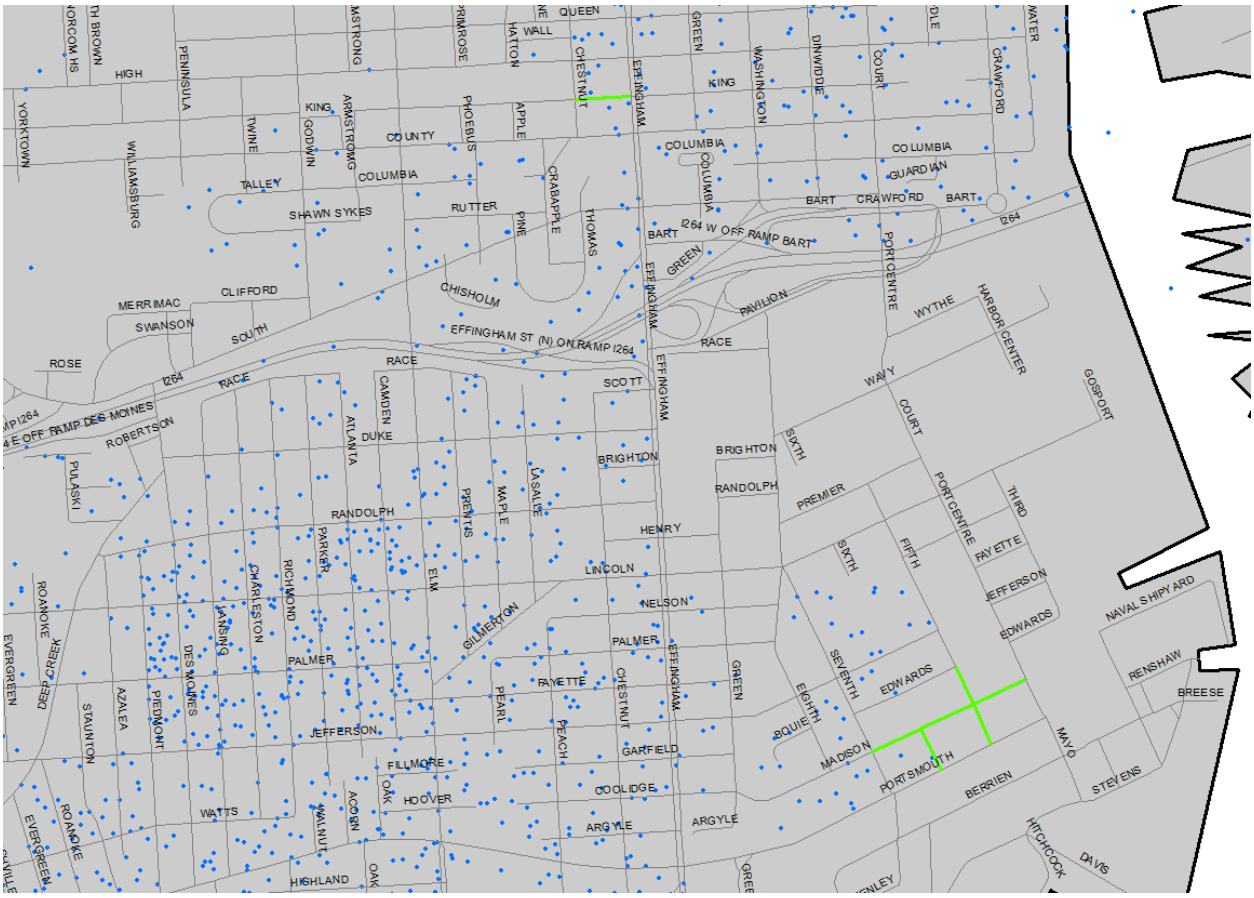

FIGURE 18 Two-Way Operation Candidates and Homes Valued Less than $100,000 (2015) in Portsmouth

Source: one-way.mxd

None of the two-way candidate streets in Portsmouth appear to have many homes valued below $100,000.

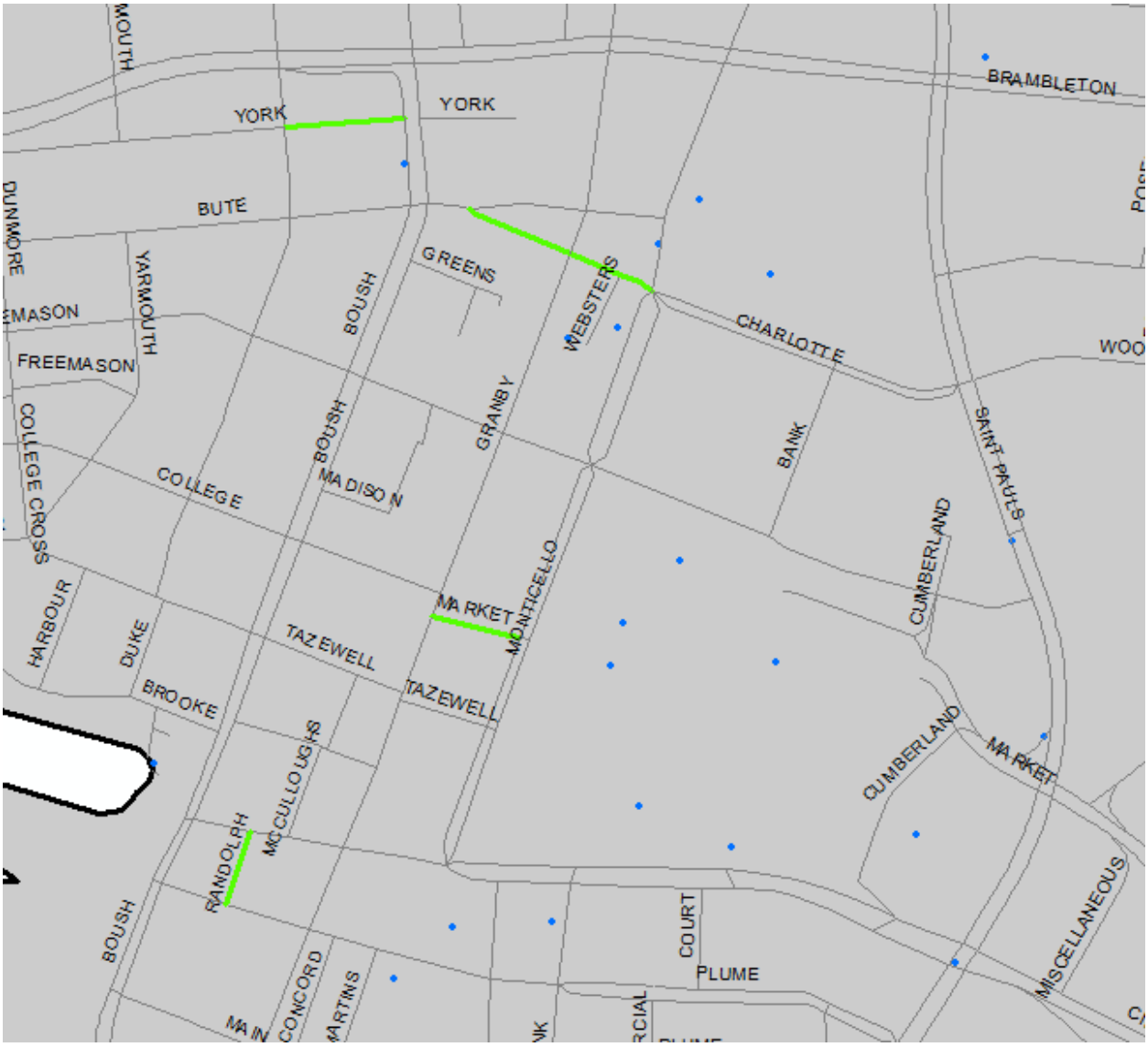

FIGURE 19 Two-Way Operation Candidates and Homes Valued Less than $100,000 (2015) in Downtown Norfolk

Source: one-way.mxd

None of the two-way candidate streets in downtown Norfolk appear to have many homes valued below $100,000.[40]

[40] The housing data being tallied per block group, i.e. exact location unknown, the mapping software randomly spreads the dots across each block group.

FIGURE 20 Two-Way Operation Candidates and Homes Valued Less than $100,000 (2015) in Central Norfolk

Source: one-way.mxd

26th and 27th Streets appear to have a moderate number of homes valued below $100,000.

FIGURE 21 Two-Way Operation Candidates and Homes Valued Less than $100,000 (2015) in Northern Norfolk

Source: one-way.mxd

The density of homes valued below $100,000 on Ocean and Bay Avenues appear to be similar to that of surrounding areas.

CONCLUSION AND NEXT STEPS

Given the literature reviewed above, although one-way streets usually supply lower trip travel times, it **appears reasonable** for the cities of Hampton Roads to pursue **less confusion, more freedom, and lower VMT** by converting one-way streets to **two-way** operation where reasonable traffic volume and adequate pavement width exists. Using a methodology it developed, HRTPO staff identified one-way streets in Hampton Roads that—based largely on pavement width—are candidates for conversion to two-way operation.

The roughly 40 candidate conversion segments are presented by HRTPO staff to the HRTPO **member cities for them to use**, determining which (if any) they wish—after review by applicable departments, agencies, and landowners—to convert to two-way operation.

As they review candidate segments, cities may refer to the **Cost section** (in the literature review above) for aid in estimating the cost of specific conversions.

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COMMENTS AND RESPONSES

HRTPO staff posted this document for public comments from June 7 thru June 21. The following comments were received from Eric Stringfield (VDOT) via 21 June 2017 letter:

Identifying Candidate Streets for Conversion from One-Way to Two-Way (Draft)

- A portion of the one-way streets identified in the study are minor and principal arterials which carry large volumes of traffic and provide a high level of mobility during peak hours. By converting these roadways, capacity could be diminished leading to lower levels of operation and greater traffic impacts to the surrounding roadway network. We recommend that all arterial roadways be removed from consideration.

- Some of the one-way streets provide access to the interstate and other Corridors of Statewide Significance. The "couplet" streets in Newport News, for instance provide access to I-664 and the 21st/22nd Streets in Virginia Beach provide access to I-264. We recommend that all one-way streets that connect to interstates and Corridors of Statewide Significance also be removed from consideration.

- Please consider how bicycle and pedestrian facilities might be impacted by these conversions. Portions of 26th and 27th Streets in Norfolk have bike lanes.

- It may not be necessary to include an analysis of the crime and property value impacts of the proposed conversions. This information is generally unrelated to improving mobility and could serve to stereotype and negatively stigmatize the communities that you've selected. It may be more productive to analyze the environmental and social justice impacts of your recommendations using available demographic information.

Responses

- Concerning "large volumes", based on the literature, HRTPO staff considered only roads with less than 15,000 vpd as candidates for two-way operation in the draft and final documents.

- Based on the above VDOT comment, HRTPO staff removed all one-way streets that join an interstate from consideration as candidates for two-way conversion. This removed 25th – 28th, 34th, and 35th Streets in Newport News from consideration as candidates.

- Based on the above VDOT comment, a note concerning the existing bike lanes on 26th and 27th Streets in Norfolk was added to the document (below the map showing these streets as candidates for conversion to two-way operation).

- We agree that lower crime and higher property values are different impacts from the primary impact on which this study focuses—the freedom of movement of two-way streets. However, given the positive crime and property value impacts reported in the literature review for Louisville, we are providing the crime and home value data as a service to the localities.

    - Note that the removal of 25th through 28th Streets as candidates (per your second comment) has significantly changed the Newport News crime/candidate map.

    - To reflect the concerns expressed in your comment, we have reworded the introduction to the crime and home values section as follows:

        - "Although limited to one research team in the above literature review, Riggs and Gilderbloom found higher home values and lower crime after one-way conversions to two-way operation. Consequently, in case our local government clients wish to focus their conversion efforts in high-crime and/or low-home-value areas, HRTPO staff overlaid the candidate conversion locations with home values and crime statistics."