

Virginia Transportation Research Council

research report

Determining the
Maintenance Superintendent
and Facility Needs for Residencies
in the Virginia Department of Transportation

http://www.virginiadot.org/vtrc/main/online_reports/pdf/10-r9.pdf

G. MICHAEL FITCH
Associate Principal Research Scientist

DANIEL S. ROOSEVELT, P.E.
Research Scientist

AUDREY K. MORUZA
Associate Research Scientist



Standard Title Page - Report on Federally Funded Project

1. Report No.: FHWA/VTRC 10-R9	2. Government Accession No.:	3. Recipient's Catalog No.:	
4. Title and Subtitle: Determining the Maintenance Superintendent and Facility Needs for Residencies in the Virginia Department of Transportation		5. Report Date: June 2010	
		6. Performing Organization Code:	
7. Author(s): G. Michael Fitch, Daniel S. Roosevelt, and Audrey K. Moruza		8. Performing Organization Report No.: VTRC 10-R9	
9. Performing Organization and Address: Virginia Transportation Research Council 530 Edgemont Road Charlottesville, VA 22903		10. Work Unit No. (TRAIS):	
		11. Contract or Grant No.: 82145	
12. Sponsoring Agencies' Name and Address: Virginia Department of Transportation Federal Highway Administration 1401 E. Broad Street 400 North 8th Street, Room 750 Richmond, VA 23219 Richmond, VA 23219-4825		13. Type of Report and Period Covered: Final	
		14. Sponsoring Agency Code:	
15. Supplementary Notes:			
16. Abstract:			
<p>In the spring of 2007, the Virginia Department of Transportation (VDOT) began the process of reducing the number of superintendents and facilities dedicated to ordinary maintenance tasks. The need to downsize was the direct result of the requirement in House Bill 667 passed by the Virginia General Assembly in the 2006 session to outsource all normal interstate maintenance. The purpose of this study was to develop a procedure to assist VDOT in determining the number of superintendents needed to oversee and manage maintenance in each residency and the number of facilities needed to support their maintenance operations.</p> <p>Current superintendent (Transportation Operations Manager II) workloads were quantified and calculated for each VDOT residency based on a limited number of workload parameters and a workload boundary representing the maximum observed workload for any combination of the parameters. Reductions in the number of superintendent positions were then made without exceeding the maximum current workloads for residencies.</p> <p>Deicing chemical storage capacity and maximum travel time to residency limits were determined to be the factors related to the number of necessary facilities. The minimum number of facilities to be retained by each residency was determined using residency-specific data related to these two factors.</p> <p>The procedure for determining the appropriate number of area headquarters superintendents and maintenance facilities was presented to and accepted by Virginia's Commonwealth Transportation Board in the fall of 2006. Reductions in the numbers of superintendent positions and facilities began taking place in the spring of 2007.</p> <p>Beginning with 213 superintendents at 207 maintenance area headquarters (AHQ) in 2006, the study presented in this report recommended a reduction of 35 superintendents, whereas the final plan issued by VDOT in 2007 called for a reduction of 32 superintendents. Similarly, the study presented here recommended a reduction of 35 AHQ facilities, whereas the final plan issued by VDOT called for a reduction of 31 AHQ facilities. The decisions leading to the differences between the recommended and effected reductions in superintendents and AHQ facilities, resulted from both public comment and internal VDOT comment and are beyond the scope of this study.</p>			
17 Key Words: maintenance area headquarters, superintendent workloads, maintenance operations, maintenance facilities		18. Distribution Statement: No restrictions. This document is available to the public through NTIS, Springfield, VA 22161.	
19. Security Classif. (of this report): Unclassified	20. Security Classif. (of this page): Unclassified	21. No. of Pages: 31	22. Price:

FINAL REPORT

**DETERMINING THE MAINTENANCE SUPERINTENDENT AND FACILITY NEEDS
FOR RESIDENCIES IN THE VIRGINIA DEPARTMENT OF TRANSPORTATION**

G. Michael Fitch
Associate Principal Research Scientist

Daniel S. Roosevelt, P.E.
Research Scientist

Audrey K. Moruza
Associate Research Scientist

In Cooperation with the U.S. Department of Transportation
Federal Highway Administration

Virginia Transportation Research Council
(A partnership of the Virginia Department of Transportation
and the University of Virginia since 1948)

Charlottesville, Virginia

June 2010
VTRC 10-R9

DISCLAIMER

The contents of this report reflect the views of the authors, who are 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 Virginia Department of Transportation, the Commonwealth Transportation Board, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. Any inclusion of manufacturer names, trade names, or trademarks is for identification purposes only and is not to be considered an endorsement.

Copyright 2010 by the Commonwealth of Virginia.
All rights reserved.

ABSTRACT

In the spring of 2007, the Virginia Department of Transportation (VDOT) began the process of reducing the number of superintendents and facilities dedicated to ordinary maintenance tasks. The need to downsize was the direct result of the requirement in House Bill 667 passed by the Virginia General Assembly in the 2006 session to outsource all normal interstate maintenance. The purpose of this study was to develop a procedure to assist VDOT in determining the number of superintendents needed to oversee and manage maintenance in each residency and the number of facilities needed to support their maintenance operations.

Current superintendent (Transportation Operations Manager II) workloads were quantified and calculated for each VDOT residency based on a limited number of workload parameters and a workload boundary representing the maximum observed workload for any combination of the parameters. Reductions in the number of superintendent positions were then made without exceeding the maximum current workloads for residencies.

Deicing chemical storage capacity and maximum travel time to residency limits were determined to be the factors related to the number of necessary facilities. The minimum number of facilities to be retained by each residency was determined using residency-specific data related to these two factors.

The procedure for determining the appropriate number of area headquarters superintendents and maintenance facilities was presented to and accepted by Virginia's Commonwealth Transportation Board in the fall of 2006. Reductions in the numbers of superintendent positions and facilities began taking place in the spring of 2007.

Beginning with 213 superintendents at 207 maintenance area headquarters (AHQ) in 2006, the study presented in this report recommended a reduction of 35 superintendents, whereas the final plan issued by VDOT in 2007 called for a reduction of 32 superintendents. Similarly, the study presented here recommended a reduction of 35 AHQ facilities, whereas the final plan issued by VDOT called for a reduction of 31 AHQ facilities. The decisions leading to the differences between the recommended and effected reductions in superintendents and AHQ facilities, resulted from both public comment and internal VDOT comment and are beyond the scope of this study.

FINAL REPORT

DETERMINING THE MAINTENANCE SUPERINTENDENT AND FACILITY NEEDS FOR RESIDENCIES IN THE VIRGINIA DEPARTMENT OF TRANSPORTATION

G. Michael Fitch
Associate Principal Research Scientist

Daniel S. Roosevelt, P.E.
Research Scientist

Audrey K. Moruza
Associate Research Scientist

INTRODUCTION

Background

During the 2006 session of the Virginia General Assembly, House Bill No. 667 unanimously passed the House and Senate. The bill stated: “All maintenance on components of the Interstate Highway System in Virginia, excluding frontage roads, shall be carried out under contracts awarded by the Commonwealth Transportation Commissioner.” The provisions of this bill, now Section 33.1-49.1 of the *Code of Virginia*, were to be executed no later than June 30, 2009.

The interstate maintenance privatization required of the Virginia Department of Transportation (VDOT) was to be accomplished by way of eight turnkey asset management services (TAMS) contracts. VDOT estimated this would allow for a reduction in maintenance staff by 159 positions. In addition, VDOT’s draft business plan for FY 2007 indicated VDOT would consider outsourcing 55 percent of its primary maintenance and 50 percent of its secondary maintenance operations. This work would be outsourced through task contracts to be administered at the maintenance area headquarters (AHQ) level.

VDOT is composed of nine districts that are broken down into 44 residencies. Each residency has from three to seven AHQ (see Figure 1). In 2006, VDOT had 213 maintenance crews (defined as an AHQ crew by the research team), each with a superintendent (TOM II), working out of facilities at 207 locations (defined as AHQ facility). VDOT also had maintenance crews that reported to a superintendent at another location (defined as sub-AHQ crew). This occurred at 17 facilities (defined as sub-AHQ facility). The initiative to go to TAMS contracts for the interstate system would result in a reduced workload for the

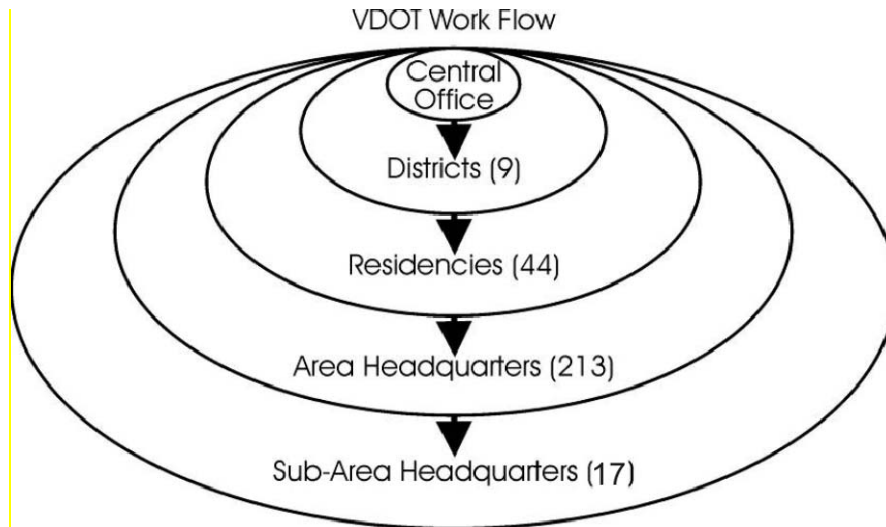


Figure 1. VDOT Management Structure and Workflow

administrators of AHQ crews. The TAMS and task contracts would reduce the need for operators. The net result was predicted to be not only a need for fewer maintenance positions but also the consolidation of maintenance positions at fewer locations. This presented an opportunity to reduce the number of AHQ managers and equalize the workloads among those retained.

Previous Studies of Maintenance AHQ Reductions

Since 1983, VDOT has conducted several studies to determine the optimum number of AHQ facilities it should operate.¹⁻⁵ In general, the studies used two approaches for determining the number and location of needed facilities: (1) maximum travel time from the AHQ location to work sites, and (2) workload of the maintenance superintendents. Most of these studies differentiated little between the needed number of maintenance *facilities* and the needed number of maintenance *organizations*. Although specific recommendations varied from study to study, significant reductions in facilities or superintendents were suggested in each.

Despite these previous studies indicating that VDOT could reduce the number of maintenance facilities and the number of superintendents working out of these facilities, few reductions occurred. This, coupled with the fact that as of June 2009 under House Bill 667 VDOT was required to have outsourced all ordinary maintenance associated with the interstate system and VDOT had planned to increase outsourcing of primary and secondary maintenance tasks, implied that facility and superintendent reductions would be possible without reducing the level of service below that previously deemed acceptable.

PURPOSE AND SCOPE

The purpose of this study was to assist VDOT management in addressing two major questions:

1. How many superintendents were needed to oversee and manage maintenance in each residency?
2. How many facilities were needed to support maintenance operations in each residency?

Only the numbers of needed superintendents and maintenance facilities were addressed in this study. The analysis did not extend below the level of area superintendents; therefore, no conclusions about operator, foreperson, or other administrative staff numbers or workloads should be derived from this research. Specialty crew superintendents, staff, and facilities were also excluded from the analysis.

Further constraints were imposed. First, the existing residency boundaries were not to be changed. Therefore, instead of determining the number of superintendents and maintenance facilities needed on a statewide basis, the analysis was done on a residency-by-residency basis. Second, to ensure adequate VDOT representation throughout the state, each county was required to have at least one superintendent and AHQ maintenance facility (county rule). Third, the workload associated with all interstate maintenance activities was to be outsourced and was therefore factored out of the superintendent workload. The first two constraints were established by VDOT management and were consistent with the approach taken in previous studies. The third constraint was a direct result of Section 33.1-49.1 of the *Code of Virginia* as previously described.

METHODS

The study objectives were achieved through a four-step process:

1. A steering committee was formed.
2. Preliminary activities with key VDOT personnel were conducted; these included meetings and the administration of a survey to capture residency-level input on factors impacting superintendent workload and number of facilities needed.
3. The number of maintenance superintendents needed to manage VDOT residency maintenance workloads was determined.
4. The minimum number of facilities needed to support maintenance in each VDOT residency was determined.

Formation of Steering Committee

In an effort to ensure that the method used to develop the procedure was transparent and that pertinent information and ideas were properly considered throughout the study, formal input was requested from a variety of sources within VDOT. A steering committee composed of the

administrator and assistant administrator of VDOT's Asset Management Division (now the Maintenance Division), a district administrator, and two resident administrators was formed. This small committee was formed to provide the researchers with early input and feedback on the variables and criteria considered in the analysis process, and the researchers met with this committee regularly. By design, this committee represented several levels of management responsible for maintenance within VDOT.

Preliminary Activities with Key VDOT Personnel

The research team had two rounds of regional meetings with all VDOT residency administrators, district maintenance engineers, and district administrators to brief them on research progress and obtain their input on the direction of the research. The residency administrators were also asked to participate in an on-line survey (see Appendix B). Three residencies, chosen by the research team and the steering committee for their varying levels of impact from the new legislation requiring the outsourcing of interstate highway maintenance, were designated to participate in a pilot application of the preliminary method. Finally, the research team briefed the district administrators, asset management and human resources division administrators, and VDOT chiefs on the pilot findings.

Determination of Number of Maintenance Superintendents Needed

Prior to determining the number of superintendents needed to manage VDOT residency maintenance workloads after the outsourcing of the maintenance of all interstate miles by 2009, the research team identified metrics that would serve to quantify average workloads for superintendents in each residency in 2005.

The metrics chosen for analysis were similar to the workload metrics used in the previous VTRC maintenance AHQ study in 1995.⁴ Unlike the previous study cited, in the present study all VDOT-maintained lane-miles were unweighted in the superintendent phase based on the reasoning that the workload for the AHQ superintendent was not demonstrably greater for one system than for another. A firm distinction between the workloads of the superintendent and the work crews underlay the decision not to weight lane-miles in the present study.

Quantification and Calculation of Existing Maintenance Superintendent Workloads for All Residencies

Based in part on the results of previous research⁴ and input from the residency administrators by way of the electronic survey (results shown in Appendix C) and regional meetings cited above, the research team analyzed superintendent workloads and determined that two general categories of activities accounted for most of the superintendents' time: (1) inspection of and planning for asset maintenance, which are influenced by the number of assets maintained and the rate of asset deterioration, and (2) meeting with citizens concerning maintenance needs.

The two categories were seen to be a function of three parameters:

1. lane-miles maintained (this was a proxy for assets maintained)
2. daily vehicle miles traveled (DVMT) per lane-mile (because asset deterioration is most influenced by traffic action)
3. population served per lane-mile (this was a surrogate for time allotted to citizen relations).

Superintendent workloads were then measured with respect to these three parameters at the residency level by combining 2005 residency-wide levels of traffic volumes, VDOT-maintained lane-miles, and residency populations.⁶ Then, the population and DVMT per lane-mile for each residency were compared. A 0.92 correlation between the two allowed DVMT to be used as a surrogate for both deterioration rate and citizen contact load.

Since these two workload parameters, DVMT per lane-mile and lane-miles maintained, compete for a superintendent's time, residency averages were determined for each of the two parameters. Residency lane-miles were divided by the number of superintendents currently in the specific residency, thereby providing residency-specific averages per superintendent. Similarly, the average DVMT per residency lane-mile was calculated.

To compare workloads across residencies, a scatter plot of residency-average data points was created. A line connecting the outermost residency data points represented the maximum average superintendent workloads in 2005 and produced a generally convex boundary (see Figure 2). It must be emphasized that each residency data point was actually an average for the residency and the AHQs comprising the residency in reality fell around that point rather than directly on it. As a consequence, superintendents may be presumed to have had actual workloads in excess of and below the residency average. The research team and its steering committee therefore considered the boundary as representative of a *feasible* workload for any residency since some of the superintendents represented were likely to be operating above the boundary workload in 2005. In effect, the boundary represented the average workload of the

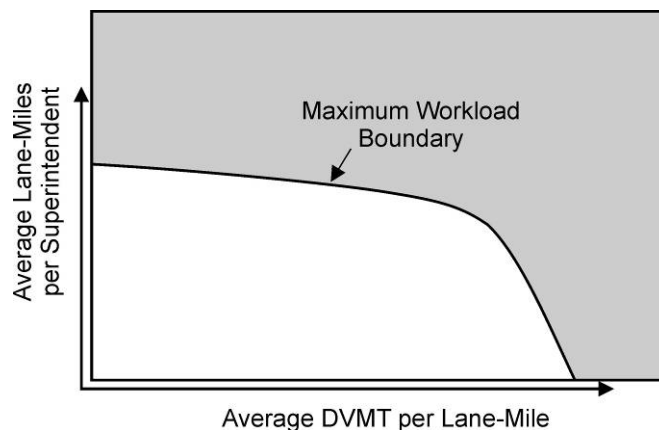


Figure 2. Boundary Formed by Maximum Residency Average Workloads

busiest superintendents in 2005 as measured by the chosen descriptors, yet the boundary was considered feasible because the workload of some superintendents in residencies at the boundary exceeded the average for their residency.

Determination of Superintendent Reductions to Make Residency Workloads Comparable

Residencies for which the data points fell within the boundary had average combined superintendent workloads below the observable maximum superintendent workloads, and thus these workloads could potentially be increased (i.e., moved upward and/or to the right toward the maximum boundary) by reducing the number of superintendents in those residencies. In addition, because it was assumed that the outsourcing of maintenance on all interstate lane-miles by 2009 would further reduce the workload of some superintendents, to estimate acceptable superintendent reductions, two adjustments were made to residency data. First, all interstate lane-miles were removed by residency in anticipation of the outsourcing of interstate maintenance by 2009. Second, each residency's data point was recalculated with one less superintendent. The new residency data points were then replotted. At the steering committee's direction, the original line demarcating the 2005 maximum workload boundary was preserved to ensure that no revised superintendent workload resulting from the study exceeded the maximum observable workload in 2005.

All residencies whose combined average workload after these changes exceeded the 2005 baseline boundary were deemed ineligible for a superintendent reduction. In addition, residencies with one maintenance AHQ per county were ineligible for an initial superintendent reduction (county rule) or further reductions after the county rule applied. All residencies for which the average residency workload after one superintendent reduction was still within the 2005 boundary were subjected to a second superintendent reduction. If the elimination of a second superintendent resulted in an average workload outside the 2005 workload boundary for the remaining superintendents, the residency was deemed ineligible for the second reduction. These calculations were the final arbiter of which residencies would be recommended for zero, one, or two superintendent reductions. The final stage of the model resulted in a list of residencies that would be recommended for no superintendent reductions and those that would be recommended for one or two.

Determination of Number of Maintenance Facilities Needed

The second component of the procedure developed by the research team was carried out to help determine the minimum number of facilities needed to support maintenance in each residency. The primary steps for this component were as follows:

1. Preserve the one-to-one superintendent-to-AHQ facility relationship based on the revised number of superintendents.
2. Identify factors contributing to the need for additional facilities.

3. Determine travel times and necessary chemical storage capacities for all residencies.
4. Determine the minimum number of additional facilities needed in each residency to comply with the requirements for travel time and chemical storage capacity.

Determination of Baseline Number of Facilities

Because more than 95 percent of currently occupied area maintenance facilities employ personnel under the administration and supervision of a single individual (superintendent), the research team and steering committee determined that where this condition currently existed, the best option would be to maintain this one-to-one superintendent-to-AHQ facility relationship as consolidation of facilities was considered. Additional justifications for this choice included the potential overcrowding if more than one superintendent was assigned to a facility and the better accountability afforded by a single manager. This decision set the baseline number of facilities in most residencies as the number of superintendents established by the superintendent determination component discussed previously.

Determination of Factors Contributing to Need for Additional Facilities

With the help of the steering committee and input from residency and district administrators, a number of factors were examined to foster an understanding of their importance in determining the number of facilities needed in each residency. It was agreed that the ability to respond properly to planned emergencies (e.g., snow removal) was the most important factor for VDOT to consider when determining how many maintenance facilities were needed in each residency. Further, because deicing chemicals other than those owned by VDOT are not locally available, and because environmental considerations necessitate special handling and storage of these chemicals, it was assumed it would be impractical for contractors to store their own deicing chemicals. Therefore, regardless of the degree of outsourcing of winter maintenance for the primary and secondary routes in the future, VDOT will need to ensure that it has adequate facilities to store sufficient volumes of salt to treat all non-interstate road miles that are to receive deicing chemicals.

The number and location of facilities for maintenance operations determine travel time from facilities to work sites. The research team and steering committee considered both normal workday travel time and response time to a planned emergency (e.g., snow removal) to be important but initially placed an emphasis on response to planned emergencies. The steering committee chose 90 minutes as the target maximum travel time from a chemical facility to the furthest point along primary snow removal chemical routes within a residency's boundary (key intersections). This choice of 90 minutes was based on the time interval between applications of deicing chemicals recommended in NCHRP 6-13.⁷

Determination of Travel Times and Chemical Storage Capacities

Given the two factors (planned emergency response and chemical storage) identified in the previous step, two data sets were developed: (1) the time it takes to travel from each residency facility to the residency boundary along primary routes and secondary routes that

require chemical treatment for snow removal, and (2) the quantity of deicing chemicals that could be stored at each facility within the residency. Values related to these two variables were calculated for each of VDOT's 44 residencies, as described here.

Estimation of Travel Time

Normal travel times from each facility to each key intersection were derived using a computer-based travel time algorithm that supports Yahoo and Map Quest travel services. These travel times were then doubled to account for the slower speeds that would be expected for trucks with spreaders traversing these routes in adverse weather conditions.

Calculation of Chemical Storage Capacity Need

Because of the concerns expressed by residency and district administrators regarding potential reductions in total salt storage capacity, the minimum capacity recommended for each residency was calculated by way of a two-step process that used both nationally recognized recommended chemical application rates⁷ and residency-specific historical chemical application data from VDOT's Administrative Services Division's stock inventory records for fiscal years 2001 through 2005. The two steps were as follows:

1. *Determine recommended chemical application rates.* With input from the steering committee, a hypothetical 5-day storm at temperatures around 20°F was chosen to determine the proposed minimum residency chemical need. This storm was considered to be a major event that would rarely occur in central Virginia. To compensate for the different duration, intensity, and frequency of storms in various parts of the state, Virginia was sectorized into five regions of which the central Virginia region served as a baseline. Based on 50 years of weather data⁸ and the assumption of the hypothetical storm scenario, the minimum recommended storage capacity of a given residency in a particular region was adjusted to accommodate more or less chemical storage capacity relative to the chemical storage needs of the central Virginia region. The minimum storage capacity for each residency was calculated by multiplying the number of chemically treated lane-miles in the residency by the recommended application rate and by the regionally adjusted number of applications (see Equation 1). This number (tons of salt) became the proposed storage need for the residency.

$$PS = CR \times AR \times NA \quad \text{[Eq. 1]}$$

where

PS = proposed storage capacity (tons)

CR = chemical route (lane-miles)

AR = application rate (tons/lane-mile)

NA = number of applications (no units).

2. *Compare proposed storage capacity to current storage capacity and historical usage.* This step compared proposed and current storage per chemically treated lane-mile. Tons per chemically treated lane-mile was used because the number of chemically treated lane-miles in many residencies changed when interstate lane-miles were removed from VDOT's winter maintenance responsibility. The minimum ratio of proposed to current storage capacity was set at 0.9 because 90 percent of current storage was considered close enough to potential storage needs while preventing excess capacity resulting from the addition of facilities merely for chemical storage. In other words, in some cases, adding facilities to residencies for which the ratio was just above 0.9 resulted in storage capacities well in excess of their current capacity. If the ratio of proposed to current storage capacity in tons per chemically treated lane-mile was less than 0.9, the proposed storage value was increased until the ratio was greater than or equal to 0.9. However, to ensure that no residency with a ratio of less than 1.0 was burdened with more than one restocking per year, facilities were added back for those residencies whose usage and storage capacity suggested more than one restocking per year. The estimated proposed restocking rate (defined as the number of times chemical storage facilities must be refilled during a winter season) was calculated for each residency based on its highest chemical usage in tons per chemically treated lane-mile during the winters of 2000 through 2005 (see Equation 2).

$$RR = \frac{CU_{Max}}{\left(\frac{PS}{CR}\right)} \quad [Eq. 2]$$

where

RR = restocking rate (times/year)

CU_{Max} = highest chemical usage (tons/lane-mile/year).

Determination of Minimum Number of Facilities Needed in Each Residency

A facility selection tool (dubbed *the calculator*) was developed for each residency using Microsoft Excel. Each residency's data were summarized in a single worksheet containing the following information:

1. *Facility location information:* latitude and longitude of specific location
2. *Facility type:* designation based on the infrastructure existing at the location and personnel located there; types included the following:
 - *AHQ:* infrastructure and space to house crew and equipment; superintendent and crew present on site
 - *Sub-AHQ:* infrastructure and space to house crew and equipment; superintendent not present; crew may or may not be present

- *Chemical storage*: infrastructure present to store deicing chemicals; no superintendent or crew present
 - *Lot*: no infrastructure present for the storage of deicing chemicals or use by crew or superintendent
3. *Key intersections*: latitude and longitude of intersection of each primary route and a limited number of secondary routes with the residency boundary
 4. *Facility chemical storage capacity*: total tons of covered salt storage available
 5. *Travel times*: estimated time of travel from each facility to each key intersection at the boundary of the residency.

By linking this information for each facility with the facility name in a matrix format, each facility could be “selected” to remain active. The maximum travel times to specific locations and the total chemical storage capacity for the residency were automatically recalculated based only on the facilities selected to remain active. For any scenario selected, the travel times were compared to the 90-minute standard and the selected chemical storage capacity was compared to the estimated chemical storage needed. The calculator, therefore, allowed a variety of facility retention scenarios to be examined quickly with the goal of retaining the minimum number of facilities while complying with the requirements for travel time and chemical storage capacity for the residency.

RESULTS AND DISCUSSION

Number of Superintendents Needed

Existing Superintendent Workloads for All Residencies

The average superintendent workloads based on the average number of lane-miles per superintendent and DVMT per lane-mile for each residency are shown in Figure 3. The line drawn through the Chesterfield, Fairfax, Williamsburg, and Sandston residencies (all in highly urbanized counties) establishes the maximum workload experienced by VDOT superintendents in 2005. It should be noted that in each of these four residencies, the AHQ superintendents have multiple Transportation Operations Manager I (TOM I) positions and/or additional support for some administrative tasks from the residency office, which does not exist at most residencies. For these reasons, the steering committee and research team agreed that in the process of increasing the workloads of superintendents, no average workload should exceed this current maximum.

The particular slope of the line connecting the four residencies implied that increases in DVMT per lane-mile up to that of the Fairfax Residency required only small offsets in lane-miles per superintendent. Beyond the DVMT per lane-mile of the Fairfax Residency, however, the slope of the line showed that further increases in DVMT were accompanied by steeper

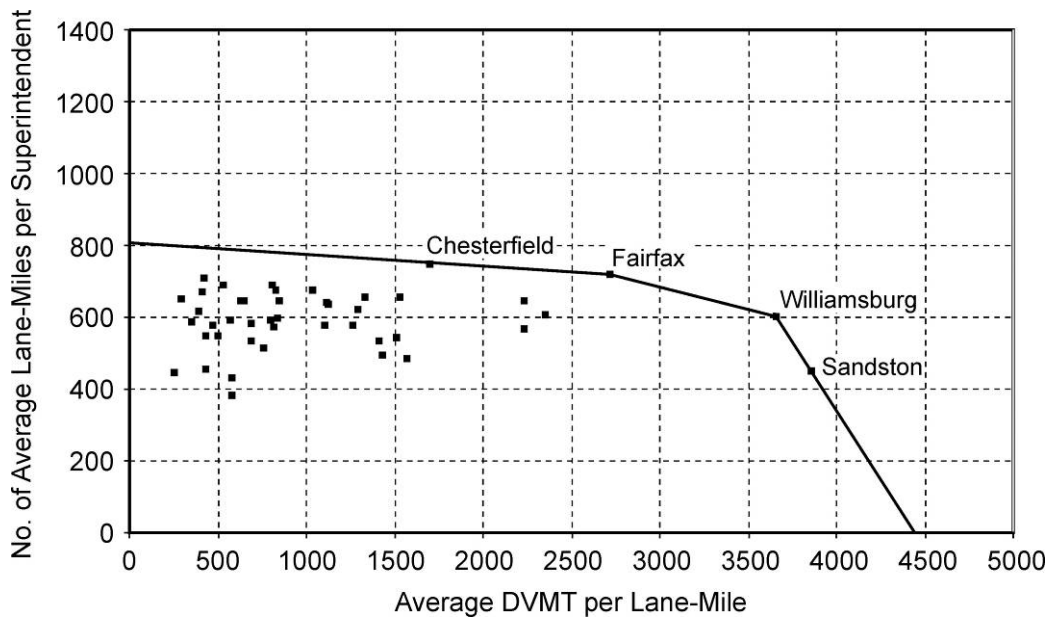


Figure 3. Average Superintendent Workloads in All Residencies in 2005. The line drawn through the Chesterfield, Fairfax, Williamsburg, and Sandston residencies (all in highly urbanized counties) establishes the maximum workload experienced by VDOT superintendents in 2005.

offsets in lane-miles per superintendent. The final model employed a convex frontier with linear segments more closely following the contour of the data. This is consistent with the expectation that network maintenance requires more superintendent effort when DVMT per lane-mile is relatively high than when it is low.

Superintendent Reductions to Make Residency Workloads Comparable

Figure 4 shows the results of the workload revisions when all interstate lane-miles were removed from each superintendent’s responsibility and the appropriate number of superintendent positions was removed from each residency. The plot clearly shows that the average for most residencies moved up and to the right, indicating a per superintendent increase in the number of lane-miles and DVMT. In certain cases, however, the point indicating the average may have moved down or to the left. This occurred in those instances where interstate lane-miles were removed but no reduction in the number of superintendents was allowed because it would have resulted in the workload crossing the maximum threshold or the rule of maintaining at least one superintendent per county being violated.

In many cases, the loss of one superintendent was sufficient to move the residency beyond the 2005 baseline; to attempt to ensure that administrative tasks did not overwhelm the superintendent, these residencies were exempted from any reductions in the number of superintendents. In some cases, these exempted residencies will have even lower average superintendent workloads in 2009 than in 2005 after interstate maintenance is outsourced.

In total, 35 of the initial 213 AHQ superintendent positions were recommended for elimination. Statewide, this represented a 16 percent reduction in the number of superintendent positions in 2006. Table 1 shows the number of residencies for which the elimination of 0, 1, or

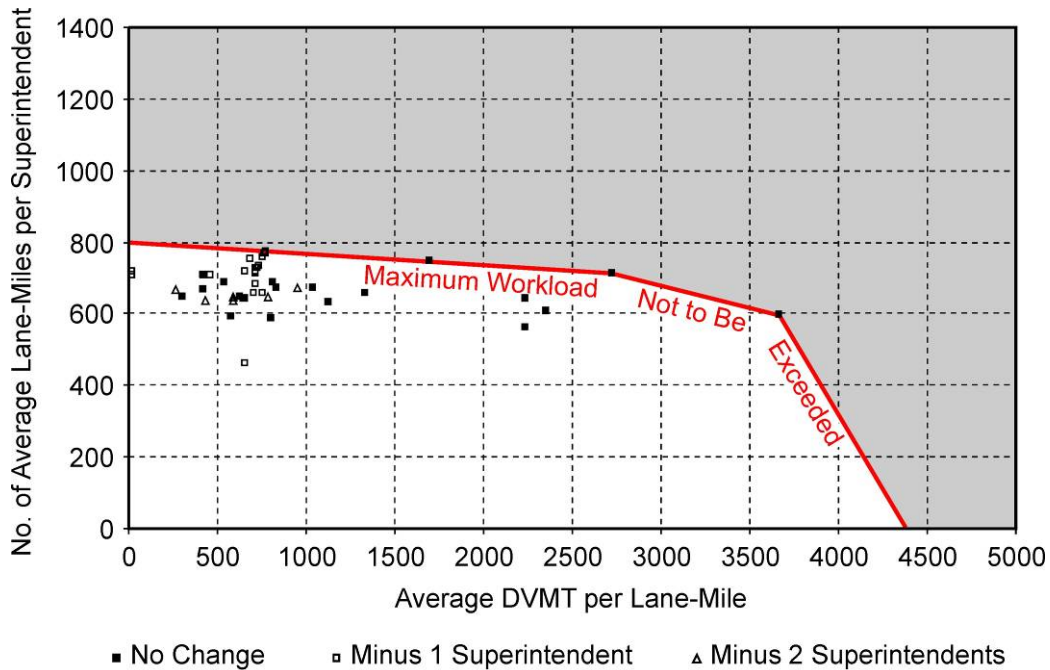


Figure 4. Revised Residency Average Superintendent Workloads After Lane-Mile Reductions (Because of Outsourcing Interstate Maintenance) and Reduction in Number of Superintendents in Some Residencies

Table 1. Superintendent Reductions by Residency, Resulting in Total Reduction of 35 Positions

	Reduction of 0 Superintendent Positions	Reduction of 1 Superintendent Position	Reduction of 2 Superintendent Positions	Other ^a
No. of Residencies	21	17	6	2

^aTwo residencies, responsible exclusively for interstate maintenance, lost a total of 6 superintendent positions.

2 of these positions was recommended. With these reductions, no residency would have an average AHQ superintendent workload above that of the four residencies currently representing the maximum (i.e., Chesterfield, Fairfax, Williamsburg, and Sandston). It should also be noted that even with the forecast growth in DVMT and population, the projected 2009 workloads do not exceed the maximum (except for those four residencies currently falling on the maximum workload line) after interstate maintenance is outsourced.

Number of Facilities Needed

Baseline Number of Facilities

As described in the “Methods” section, the starting point for the number of facilities needed in each residency was set to equal the revised number of AHQ superintendents for the residency. Statewide, this totaled approximately 176 facilities (four locations actually had more than one superintendent working out of a single facility).

Factors Contributing to Need for Additional Facilities

Facilities were added to a residency's starting number of facilities to comply with the requirements for a maximum normal travel time of 45 minutes to all primary and selected secondary locations and the need for additional chemical storage. Based on feedback from VDOT management during the two rounds of regional meetings, numerous additional variables were considered. A subset of these variables included the following:

- number of chemical-lane-miles
- proximity to towns (higher expectations)
- non-planned emergency response time requirements; accessibility during emergencies
- growth trends (population, lane-miles, DVMT, housing starts, rezonings, etc.)
- availability of contractors
- affordability of contractors
- impact of devolution
- special facilities (drawbridges, rest areas, etc.)
- increased citizen expectations of VDOT in specific areas
- age of facilities and infrastructure
- county-level analysis
- exceptional maintenance needs.

Each was determined to be either impossible to quantify or sufficiently accounted for by the maximum travel time and/or minimum chemical storage capacity requirements.

Minimum Number of Facilities Needed in Each Residency

Using the facility selection calculators (see example in Figure 5), approximately 28 facilities above and beyond those allocated in the baseline step of one per superintendent were added statewide. Although several residencies did not require additional locations, most needed 1 to 5 additional facilities to comply with the requirements for travel time and chemical storage capacity. VDOT used this methodology as the first step in reducing the number of maintenance AHQs and consolidating AHQ locations.

SUMMARY OF RESULTS OF ANALYSIS PROCESS

In July 2006, the analysis process was applied to each of the 44 VDOT residencies. Tables 2 and 3 provide the numbers of AHQs and facilities in existence before the study and the numbers resulting from the application of the analysis process previously described.

The "study model" data shown in Tables 2 and 3 are the result of the analysis process previously described. The TOM II positions are based on the results of the traffic volume per lane-mile data and the lane-miles maintained analysis. The number of facilities is based on the assumption of a base number of AHQ facilities per residency equal to the number of TOM II positions warranted with additional facilities added to meet the minimum deicing chemical

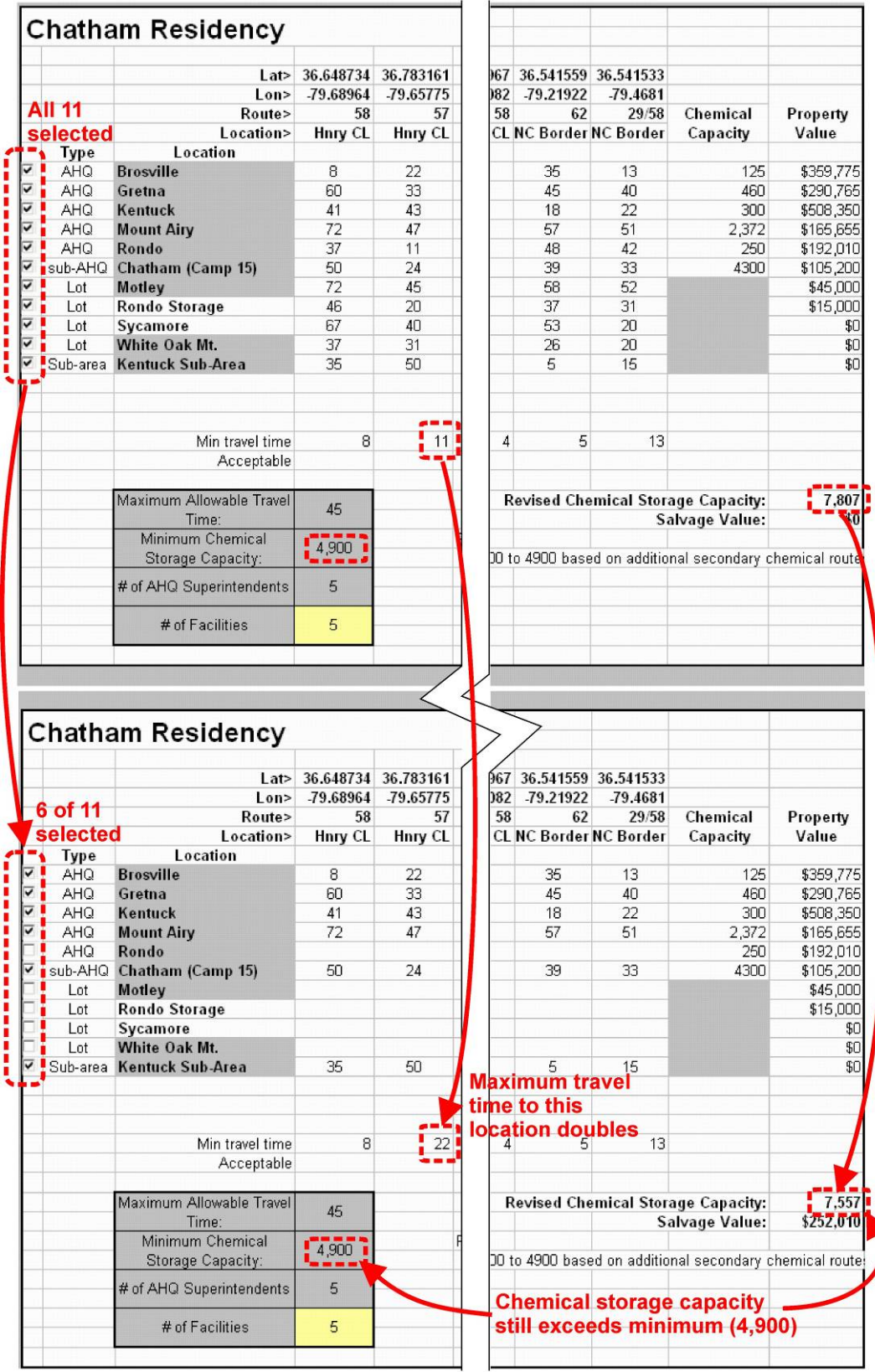


Figure 5. Example of Calculator Showing Effects on Chemical Storage Capacity and Travel Time When Facilities Are Eliminated

Table 2. Number of Area Headquarters Managers by Type Before Study and After Analysis (Study Model)

Area Maintenance Facility Type	Before Study	Study Model (July 2006)
TOM II (at AHQ)	213	178
TOM I (at sub-AHQ)	17	1
Total managers	230	179

Table 3. Number of Approved Maintenance Facilities by Type Before Study and After Analysis (Study Model)

Area Maintenance Facility Type	Before Study	Study Model (July 2006)
AHQ	207	172
Sub-AHQ	17	1
Chemical storage site	63	27
Lot	48	0
Total	335	200

storage capacity. An exception was made to the base number for four locations where two or more maintenance AHQs work out of the same facility. The study model lists the minimum number of TOM II positions and AHQ facilities generated for each residency.

CONCLUSIONS

- The workload of a VDOT AHQ superintendent can be modeled as a function of the number of lane-miles overseen and the volume of traffic (DVMT) on those lane-miles.
- The minimum number of maintenance facilities needed in a residency is controlled by the need to respond in a timely manner to planned emergencies.
- Since they comprise a planned emergency operation implemented under a statewide policy, snow removal operations needs can be used to determine the minimum number of maintenance facilities needed. The snow removal operation needs that influence the number of locations needed are the round-trip travel time for chemical routes and the deicing chemical storage capacity.

REFERENCES

1. Wyant, D.C. *Methodology for the Placement of Maintenance Area Headquarters*. VHTRC 85-R15. Virginia Highway & Transportation Research Council, Charlottesville, 1985.
2. Wyant, D.C. *Refinement of a Methodology for the Placement of Maintenance Area Headquarters*. VHTRC 86-R33. Virginia Highway & Transportation Research Council, Charlottesville, 1986.

3. Virginia Department of Transportation. *A Preliminary Report to the Secretary of Transportation on the Organization and Administration of the Virginia Department of Transportation*. Richmond, 1991.
4. Roosevelt, D.S. *Determining Maximum Superintendent Workload As a Function of Traffic Load*. VTRC 96-TAR1. Virginia Transportation Research Council, Charlottesville, 1995.
5. Virginia Department of Transportation. *Maintenance Area Headquarters Study: Equipment Shop Consolidation Study, VDOT's Response to the 1995 Amendments to the Appropriation Act, Chapter 853, Item 606*. Richmond, 1995.
6. Weldon Cooper Center for Public Service, University of Virginia. Demographics and Workforce. <http://www.coopercenter.org/demographics>. Accessed June 18, 2010.
7. Blackburn, R.R., Bauer, K.M., Amsler, D.E., Boselly, S.E., and McElroy, A.D. *Snow and Ice Control: Guidelines for Materials and Methods*. National Cooperative Highway Research Program Report 526. Transportation Research Board of the National Academies, Washington, D.C., 2004.
8. Southeast Regional Climate Center. *Historical Climate Summaries and Normals for the Southeast*. Columbia, SC, 2006.

APPENDIX A

EPILOGUE

The number of recommended maintenance AHQs and facilities for each residency described previously in the study model was provided to the appropriate district administrator (DA). The DAs were instructed to choose specific maintenance AHQs and additional facilities in each residency to remain active in accordance with the recommended number arrived at through the analysis process described previously. Any changes to these recommended numbers required that the DA make a request to the Commonwealth Transportation Commissioner for an exception.

On November 3, 2006, after the commissioner had reviewed the DAs' submissions and requests for exceptions, a draft AHQ and facilities reduction plan was distributed for public review and comment. A series of meetings around the state was held to obtain public comment.

On December 14, 2006, a final AHQ and facilities reduction plan approved by the commissioner was issued to the public. The plan constituted a modification of the draft AHQ and facilities reduction plan and reflected a number of changes suggested during the public input period. Implementation of the final plan was to begin after the close of the 2006-2007 winter season (approximately April 2007) and was to be coordinated with the implementation of the interstate TAMS contracts then in process.

In the time since its issuance, the final AHQ and facilities reduction plan has been modified. Tables A1 and A2 indicate the numbers of AHQs and facilities, respectively, extant at each of the steps in the implementation process.

Table A1. Number of Area Headquarters Managers by Type at Various Dates

Area Maintenance Facility Type	Before Study	Study Model (July 2006)	Draft Reduction Plan (November 2006)	Final Reduction Plan (December 2006)	Current (June 2010)
TOM II (at AHQ)	213	178	181	181	183
TOM I (at sub-AHQ)	17	1	1	16	14
Total managers	230	179	182	197	197

Table A2. Number of Approved Maintenance Facilities by Type at Various Dates

Area Maintenance Facility Type	Before Study	Study Model (July 2006)	Draft Reduction Plan (November 2006)	Final Reduction Plan (December 2006)	Current (June 2010)
AHQ	207	172	176	176	178
Sub-AHQ	17	1	1	16	14
Chemical storage site	63	27	51	23	NA
Lot	48	0	10	12	NA
NA	0	0	6	21	NA
Total	335	200	244	248	192

Draft AHQ and Facilities Reduction Plan

The study model discussed previously made no accommodation for other attributes of the AHQ facilities, such as age of the facility, capacity to absorb additional personnel and equipment, and existing plans for facility additions or replacement. With each residency having from 3 to 14 facilities available to choose from to meet the minimum requirements, many residencies had more than one option for the revised facilities alignment. This made it **infeasible** for the study model to consider the normal maintenance travel time encountered under a new facilities alignment. Consideration of these attributes and options was the purpose of the DAs' field review and exception process. In addition, under the study model, facilities that were not functioning maintenance AHQs, sub-AHQs, or chemical storage facilities were considered surplus. Future disposition of these properties was considered during the review and exception process.

The review and exception process resulted in the draft AHQ and facilities reduction plan that added a net 44 facilities and 3 TOM II positions to the numbers recommended by the study model. These facility changes were as follows:

- *Twenty-three facility additions were lots or developed facilities that were determined to be infeasible to surplus. Reasons for the infeasibility were that some lots were adjacent to other maintenance facilities, locations where specialty crews were housed, or had been purchased to replace existing facilities but were not yet developed.*
- *Concerns raised about reductions in chemical storage resulted in a supplemental review of chemical storage capacity in some residencies. This review is described in the study report as Step 2 under "Calculating Chemical Storage Capacity." The supplemental review resulted in the addition of 11 chemical storage facilities.*
- *Four locations in mountainous areas were added as chemical storage locations.*
- *Two submissions resulted in maintenance areas that had more than 50 percent of the secondary road mileage in the maintenance area located more than 45 minutes from the remaining residency AHQ facilities (although travel time to chemical route locations complied with study guidelines). The two locations were retained as operating facilities.*
- *The closure and disposal of the Short Pump AHQ facility was under review during this time. Options under consideration involved three other facilities in the Sandston and Ashland residencies. All three facilities were retained until the Short Pump issue could be resolved.*
- *One facility convenient to the Route 17 Bridge over the James River was retained for storage of barriers used to control traffic during maintenance operations and emergencies.*

- *A realignment of maintenance responsibility for roads in the Waverly and Franklin residencies reduced by 1 the total number of AHQ facilities needed.*

The reasons for the TOM II additions were as follows:

- *The potential closing of the Short Pump AHQ reduced the options available for managing maintenance in Ashland and Sandston residencies. The reduced options available increased by 2 the number of TOM II supported by the study methodology.*
- *Conditions in the Bedford Residency supported 3 TOM IIs, a reduction from the pre-existing 4, but the resulting TOM II workload was among the highest in the study. Because of limited capacity, 4 facilities are needed to house all the area maintenance operators. Rather than reduce 1 AHQ to sub-AHQ status, permission was given by the Commonwealth Transportation Commissioner to retain the status quo.*

An issue not fully resolved at the time the draft AHQ and facilities reduction plan was released for public input was the number of sub-AHQs that would be needed to house the maintenance operators to be distributed among the reduced number of TOM IIs. The commissioner and DAs were comfortable that the additional chemical storage facilities designated in the draft AHQ and facilities reduction plan were sufficient to house all area maintenance personnel. To present a “worst case scenario” and give VDOT management the most options for a final AHQ and facilities reduction plan, all these facilities were listed as chemical storage only.

Final AHQ and Facilities Reduction Plan

After public input on the draft AHQ and facilities reduction plan, a final plan was adopted that increased the number of facilities by 4 and designated 16 facilities as sub-AHQs. In addition, some of the unoccupied facilities were designated as “staging areas” that could be used as temporary work stations for maintenance operations. Of the 4 additional facilities, 1 was designated a staging area, 2 were designated as sub-AHQs, and 1 was designated an AHQ. The additional AHQ (Free Union) was offset by downgrading another AHQ (Yancey Mills) in that residency (Charlottesville) to sub-AHQ status.

The total number of TOM IIs did not change, but minor adjustments were made to a few AHQ locations (e.g., within a residency an AHQ was downgraded to a sub-AHQ or chemical storage facility with a corresponding upgrade of a lower-rated facility to AHQ status). Two changes not involving a tradeoff of facility status were made:

1. *The Surry chemical storage facility was upgraded to an AHQ, increasing by 1 the number of maintenance AHQs. Surry’s chemical storage facility designation in the draft AHQ and facilities reduction plan was a violation of the condition that all counties in the state have at least 1 AHQ facility within its boundaries. Public sentiment that Surry County receive treatment equal to that of all other counties prevailed.*

2. *The “Short Pump” issue was resolved.* The facility was closed and sold, and the maintenance AHQ was moved to Basie Road in the Sandston Residency. This change allowed the Oilville AHQ to be downgraded to a sub-AHQ, reducing by 1 the number of AHQs in the Ashland Residency.

Current: June 2010

Since the adoption of the final AHQ and facilities reduction plan, eight of VDOT’s nine districts outsourced all interstate maintenance. Bids for the outsourcing contracts exceeded estimates, and one option used to reduce prices was to provide surplus facilities to contractors in lieu of paying them to provide their own facilities. In addition, the economic downturn reduced VDOT’s revenue, resulting in a reduction in services, and VDOT undertook a major downsizing of its staff. Both actions place a premium on finding options to reduce travel time for day-to-day operations. VDOT’s surplus facilities can be a key factor in these options. For these reasons, in 2008, VDOT placed a hold on the disposal of any additional properties until at least the outsourcing projects and the downsizing were fully in place. Therefore, the number of unoccupied VDOT properties is no longer influenced by the study model.

In January 2010, after a review of requests from respective DAs, the Commonwealth Transportation Commissioner upgraded two sub-AHQs (Yancey Mills and Oilville) to full AHQ status. His review concluded that the sub-AHQs’ “staffing level and service area were congruent with these factors at other area headquarters locations statewide.” With this exception, the total number of maintenance AHQs managed by a TOM II is the same as that in the adopted final AHQ and facilities reduction plan. Some locations within residencies have changed, but the number of locations and TOM IIs in each residency is the same as approved in the final plan.

There are now 14 sub-AHQs, 2 less than approved in the final AHQ and facilities reduction plan (these are the sub-AHQs upgraded to full AHQ status). In the intervening time, however, 3 residencies have upgraded an unoccupied facility to sub-AHQ status and 3 residencies have eliminated sub-AHQs.

A measure of the efficacy of the study approach is that as VDOT downsizes its staff from 9,500 to 7,500 positions, the numbers of maintenance AHQs and TOM II positions have not been subject to further reductions.

APPENDIX B

ELECTRONIC SURVEY PROVIDED TO RESIDENCY ADMINISTRATORS

I. Rank 5 factors from the following list in order of their impact (1=highest impact) on AHQ superintendent workload in your residency:

- Increased travel time due to terrain (mountains, rivers):
- Increased travel time due to dead-end roads:
- Increased travel time due to population dispersion:
- Increased travel time due to communications limitations (cell phone, radio blackout zones):
- Increased travel time due to congestion:
- Growth trends (population, lane-miles, DVMT, housing starts, rezonings, etc):
- Percentage of trucks:
- Building permits:
- Number of customer requests/complaints:
- Number of private entrance permits:
- Commercial vs. residential development:
- Environmental requirements (jurisdictional waters, etc):
- FMS II/Purchasing impacts:
- Finding contractors (snow removal, etc):
- Percent and type of functions outsourced:
- Density of assets:
- Type of assets:
- Exceptional maintenance needs:
- Response to emergency situations (weather, incidents, etc):
- Number of logging permits:
- Another major factor impacting superintendent workload:
- Purchasing, Inventory and Equipment utilization regs.

II. Rank 5 factors from the following list in order of their impact (1=highest impact) on the number of AHQ facilities needed in your residency:

- Travel time due to shape of geographic area:
- Travel time due to population/business dispersion:
- Storage capacity for materials:
- Storage capacity for equipment:
- Storage capacity for chemicals:
- Shared facilities with residencies and shops:
- Number of chemically-treated lane-miles:
- Higher expectations (proximity to towns, etc):
- Emergency response time requirements:
- Growth trends (population, DVMT, housing starts, rezonings, etc):
- Availability of contractors:
- Affordability of contractors:
- Special facilities (drawbridges, rest areas, etc):
- Age and adequacy of infrastructure:
- Exceptional maintenance needs in residency:
- Another major factor impacting the number of facilities needed:
- Lack of adequate facilities to consolidate manpower & equipment

APPENDIX C

**RESULTS OF ELECTRONIC SURVEY PROVIDED TO RESIDENCY
ADMINISTRATORS**

Superintendent Workload

Score	Number of Responses	Additional Factors to Consider
40	10	Number of customer requests/complaints
32	10	Growth trends (population, lane-miles, DVMT, housing starts, rezonings, etc)
26	9	Response to emergency situations (weather, incidents, etc)
25	6	Environmental requirements (jurisdictional waters, etc)
24	7	Increased travel time due to terrain (mountains, rivers)
14	4	Density of assets
11	3	Increased travel time due to congestion
8	3	Increased travel time due to population dispersion
8	3	Increased travel time due to communications limitations (cell phone, radio blackout zones)
8	3	Type of assets
7	5	Exceptional maintenance needs
6	2	Percentage of trucks
6	2	FMS II/Purchasing impacts
6	2	Finding contractors (snow removal, etc)
4	2	Percent and type of functions outsourced
3	1	Number of private entrance permits
3	3	Commercial vs. residential development
0	0	Increased travel time due to dead-end roads
0	0	Building permits
0	0	Number of logging permits

Another major factor impacting superintendent workload

- Purchasing, Inventory and Equipment utilization regs.
- Additional Administrative Duties - eg Inventory, AMS reporting
- The need to evaluate equipment and material needs for specific projects that may require working with adjacent MAHQs that are in another Residency
- Definition -#5 Exceptional Maintenance Needs: Unpaved roads, aging - substandard roads, freeze-thaw cycles creating winter break-up, slides, rockfalls, etc., environmentally sensitive areas, travel time to purchase supplies
- Congestion
- age and condition of assets along with public expectations of asset management

Number of Facilities

Score	Number of Responses	Additional Factors to Consider
49	12	Emergency response time requirements
42	11	Travel time due to shape of geographic area
30	8	Growth trends (population, DVMT, housing starts, rezonings, etc)
19	6	Higher expectations (proximity to towns, etc)
18	7	Age and adequacy of infrastructure
16	6	Exceptional maintenance needs in residency
14	5	Number of chemically-treated lane-miles
14	6	Availability of contractors
13	4	Travel time due to population/business dispersion
7	4	Affordability of contractors
3	3	Storage capacity for chemicals
3	1	Special facilities (drawbridges, rest areas, etc)
2	1	Shared facilities with residencies and shops
0	0	Storage capacity for materials
0	0	Storage capacity for equipment

Another major factor impacting the number of facilities needed

- Lack of adequate facilities to consolidate manpower & equipment
- Workload per crewman in terms of travel restrictions/locations
- Survey is not adequate to evaluate the proposed reduction in MAHQs with inadequate time to review with Residency staff.
- Definition -#3 Exceptional Maintenance Needs: Unpaved roads, aging - substandard roads, freeze-thaw cycles creating winter break-up, slides, rockfalls, etc., environmentally sensitive areas, travel time to purchase supplies
- Age and adequacy of infrastructure
- Growth trends and assets by county instead of residency average for multiple counties