

1 **DEVELOPMENT AND IMPLEMENTATION OF A 10-YEAR**
2 **PLAN TO MANAGE INTERSTATE PAVEMENTS IN NC**
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ABSTRACT

A 10-Year plan was developed to manage preservation, minor and major rehabilitation of the Interstate Highway System in North Carolina. The guidance given in the development of the plan was a budget of \$100 million per year and applying some treatment to each segment sometime in the 10 year period. The \$100 million per year resulted from analyses using the Pavement Management System (PMS) on the cost to meet and maintain our performance goals for interstate pavements. Without a plan, the funding for interstate maintenance was diverted to other needs, resulting in competition for very limited funding and many deferred needs..

The plan was developed using the Pavement Management System construction history, the performance histories of many treatments, the Pavement Condition Survey results and known pavement needs. Because of the planned approach, the 10-year plan includes preservation treatments as well as light and moderate rehabilitation treatments. Treatments ranged from crack sealing to a five inch asphalt overlay. The draft plan resulted in meeting both targets: \$100 million per year and touching every segment at least once. Following the submission of the draft plan, \$10 million per year was set aside for bridge deck repairs and an additional \$5 million per year was assigned to other interstate needs. The result of these reductions was a plan that extends beyond 10 years in order to treat every segment at least once. Five years of the plan have been converted into projects and the first 2 years have been programmed. The plan demonstrates the importance of dependable and consistent funding in maintaining a high level of service.

Key words: interstate system, maintenance, pavement preservation, long term pavement plan

INTRODUCTION

North Carolina Department of Transportation (NCDOT) owns and maintains one of the largest systems in the US, having 74,617 centerline miles (120059 km) and 163,175 lane-miles (262549 lane-km) of paved roads. State maintained roads vary from unpaved gravel surfaced roads to interstate controlled access freeways. Since 1970 the population of NC has roughly doubled to about 10 million people. During the same period the average vehicle miles travelled has risen from 29.2 billion to 105 billion. Prior to the recession in 2008, the vehicle miles travelled was on a trajectory to reach 120 billion in 2015. Figure 1 graphically displays the relationships between population growth, vehicle registrations and vehicle miles travelled.

The interstate highways consist of 1250 centerline miles (2011 centerline km) and 5986 lane miles (9631 lane km). It was calculated in 2013 to carry 21.2 percent of the total vehicle miles traveled. Less than 3% of the road miles carry more than 20 percent of the total vehicle miles traveled. Figure 2 is a map of the interstate highways in NC with the DOT Divisions shown with a light gray outline. Divisions are regional offices called districts in most state agencies. The figure shows both north/south and east/west interstates as well as urban loops. Thirteen of the fourteen divisions have interstate mileage, although the mileage in Division 1 is so short that it is managed by the adjacent division..

As expected, many travelers on the interstate system are “passing through” North Carolina on their way to other destinations. An example would be vacationers from the northeastern states driving I-95 to Florida. Similarly, commercial trucks carry Florida produce to northeastern cities. In addition to these very traditional uses of the interstate, rush hour congestion on

1 interstates in more urban areas indicate that many local drivers are using the interstate to get to
2 work. Maintaining the interstates in good condition is therefore important to freight, business,
3 vacationers and other travelers, and local users.

4
5 For many years, North Carolina received federal funds labeled as Interstate Maintenance (IM).
6 All too often, the funds were used to treat existing pavement and to develop interchanges and
7 other features as part of Transportation Improvement Program (TIP) construction projects. Any
8 remaining funds were used for Division requested IM projects. There were limitations on the
9 treatment types, and no treatment was allowed to raise the grade by more than 2 inches. The lack
10 of a dependable budget for maintaining and improving the interstate led to areas with poor
11 conditions.

12
13 In the last two years, the state legislature has sought methods of incorporating long term plans,
14 needs based prioritization of work and allocation of funds, and data driven decision making into
15 various government programs. NCDOT has been developing a multi-tier project prioritization
16 process that includes input from Metropolitan and Rural Planning Organizations. Three-year
17 roadway resurfacing programs are being developed using the PMS to identify the “first cut.”
18 The 10-year plan was not developed in response to a legislative mandate, but certainly fits into
19 the data driven, long term planning philosophy.

20
21 In 2012, nine pavement and asset managers from the United States participated in the
22 International Study Tour on Managing Pavements and Monitoring Performance. The team
23 sought input from other agencies on approaches to sustaining performance-based programs. One
24 of the key findings of the scan was that agency culture needs to support a long-term view
25 towards managing pavements (1). This paper demonstrates development of a long term plan for
26 managing the interstate pavements in North Carolina.

27 28 **EXISTING PROCESS FOR INTERSTATE MAINTENANCE PROJECTS**

29
30 In the recent past, the process for developing and funding projects consisted of solicitation of
31 needs from the Divisions, review of those proposed needs and treatments by pavement
32 management and programming them as funds were available. The majority of funds were used
33 to supplement construction activities, but remaining funds were used to meet the division
34 suggested needs.

35
36 Issues associated with this approach included sporadic funding levels, limitations on treatment
37 types, missing segments or treatment gaps, and no preservation activities. As mentioned earlier,
38 the IM budget was used to augment construction projects. It was used to treat existing
39 pavements while construction money was used for widening or bridge replacement. It was also
40 used for interchanges and other needs associated with construction projects. The funding level
41 remaining after the construction project needs were met varied from year to year and was never
42 sufficient to meet the division identified needs. Because of the inadequate and irregular funding,
43 divisions were competing for the limited funds and had to reduce project limits to meet the
44 available funding level. This created gaps in treatment: i.e. segments that did not receive
45 treatment between sections that did. Some divisions overstated their need in an effort to compete

1 successfully. This made Pavement Management act as arbiter. In short, this was a worst first
2 approach.

3
4 Pavement preservation has been successfully used for low and moderate traffic volume roadways
5 in NC for more than 10 years. The existing process for using very limited interstate funding
6 resulted in few if any preservation treatments. In 2010, a special fund with \$10 million per year
7 was established to provide preservation treatments to roads and bridges on the interstate system
8 (2). When divided among the 13 division having interstates, the funds were inadequate to do any
9 but the most basic of treatments. In fact, most of the funds were used to paint bridges. After 3
10 years, the funding was eliminated with the intention that interstate pavement preservation would
11 be included in the 10-year plan.

12 13 **FRAMEWORK FOR THE PLAN**

14
15 NCDOT is required to report to the Legislature every other year on the condition of our
16 infrastructure, including pavements. In the past two reporting cycles, one of the components of
17 the report was a calculation of funding requirements to maintain or improve pavement
18 conditions. These reports indicated that \$90 million per year, plus \$10 million per year already
19 set aside for interstate preservation would be required based on the PMS (3, 4).

20
21 In the most recent budget cycle, the funding set aside for interstate preservation was eliminated,
22 but a total sum of \$100 million per year was established as the plan target. The plan was to
23 include treatments ranging from vacuuming of open graded friction course to heavy
24 rehabilitations. Table 1 includes a list of some of the most common treatments in the plan.

25
26 North Carolina has had a very active pavement preservation program for lower volume roadways
27 since 2002. One of the approaches that we have used in implementing preservation has been a
28 goal of touching 10% of the system every year. This approach was included in the guidance for
29 developing the 10 year interstate plan: every segment should be touched with some level of
30 treatment within the 10 year cycle of the plan.

31
32 Finally, the plan was to be data-driven based on our pavement condition surveys. The surveys of
33 interstates and primary roadways are conducted annually using automated distress data
34 collection. The automated surveys have decreased the variability in the condition ratings and
35 provide consistent interpretation following an initial period of data resolution. The data
36 collection includes not only downward facing 3-D high resolution photos used for distress
37 identification, but also forward wide-view photos. These images are available to all central
38 office and field engineers and were helpful in identifying both distresses and locations.

39 40 **PROCESS FOR DEVELOPING THE PLAN**

41
42 Division spreadsheets were developed containing all the interstate segments within the division.
43 This approach made it less likely that segments would be skipped because all segments,
44 including those just treated, are included. For each pavement management section, the data
45 included beginning and ending mileposts, county number, segment length, number of lanes,
46 pavement surface type, and shoulder type and width. The date of the most recent construction

1 and the construction activity were included. The section distresses included alligator cracking,
2 transverse cracking, rutting, oxidation, patching, etc. IRI data is also available in the PMS and
3 was used in a few cases to select ride quality improvement sections.

4
5 A second spreadsheet was developed that included all of the sections in a vertical column, and
6 then columns for Year 1 treatment, Year 1 cost, Year 2 treatment, Year 2 cost, and so on for the
7 10 year plan period.

8
9 The sections where it was easiest to identify an appropriate treatment and timing were ones that
10 were just treated. An asphalt surface in NC has a life of 11 years, so asphalt surfaced roads just
11 treated would be placed in year 10. Alternatively, crack sealing could be scheduled in say, year
12 5 or 6. Similarly, there were some sections that were already in the TIP for major rehabilitation
13 or reconstruction. These sections were skipped in the 10 year plan because they would be treated
14 in the TIP and would not need retreatment within the 10 year plan. Several additional sections
15 were highlighted to be funded separate from the \$100 million, in part because their expense
16 would use all available funding. These include a section of concrete pavement in Winston-
17 Salem that should have been replaced when the I-40 section was moved out of downtown and
18 widened. Instead this one mile section has new concrete adjacent to 30+ year old concrete that is
19 at the end of its service life. Because of the urban setting, this would be a good section to use
20 precast concrete, but NC has never used this approach and could not estimate its cost.

21
22 Additional “easy” sections for which to select treatment and timing were the remaining
23 uncovered sections of Continuously Reinforced Concrete (CRC). NC has not constructed CRC
24 since 1980, and has had progressive failures in the sections resulting in high maintenance costs.
25 NC has had good performance, with limited maintenance, when CRC is covered with 5.5 inches
26 (14 cm) of asphalt. These remaining sections were scheduled for the thick overlay in years one
27 and two of the plan.

28
29 A treatment and timing were established for every pavement management segment of interstate.
30 For concrete roadways, treatments included joint cleaning and resealing, diamond grinding,
31 minor patching, slab replacements, and overlays with ultra-thin bonded wearing course. For
32 flexible pavement surfaces, treatments included crack sealing, milling and replacement, thin
33 overlays, deeper overlays, and patching. Sections with Open Graded Friction Course (OGFC)
34 were scheduled for vacuuming on a 5 year cycle to improve performance by reducing clogging.
35 The treatment and timing of each PMS section was selected based on condition, construction
36 history, and historical performance in NC, without considering cost.

37
38 The costs for each section treatment were generated from the most recent update of costs within
39 the PMS. Input was sought from several Division Maintenance Engineers regarding the cost of
40 treatments not done historically in NC, like vacuuming OGFC, and these were based on fully-
41 operated rental costs.

42
43 The costs for each year of the first-draft plan were totaled and compared to the \$100 million per
44 year budget. As might be expected, the results were over budget in years 1, 2 and 3 and
45 treatment timing was adjusted into the later years.

46

Another significant activity at this stage was combining pavement sections into meaningful project lengths. Most projects in NC are between 3 and 6 miles (4.8-9.7 km) long and an effort was made to combine sections into this range. Pavements were only combined if they had the same pavement surface type so that similar activities might be proposed. These two steps, adjusting timing and combining sections, were frequently done concurrently. For example, two sections of asphalt surfaced roadway are selected for a single lift overlay. One is scheduled in year 3, the other in year 5. When the sections are combined, they might be scheduled in year 5, with the addition of some incidental patching.

The result of this combining and rescheduling was a 10 year draft plan totaling no more than \$100 million per year for interstate pavements. An excerpt from the draft plan is shown in Table 2. The draft was presented to the Chief Engineer and the Division Engineers for comments and suggestions. Bridge Management and Maintenance and Operations requested and received a “piece of the pie” that amounted to \$10 million and \$5 million per year respectively from the original \$100 million.

This funding change required a second round of timing changes, and in fact resulted in some previously scheduled activities moving outside the 10 year plan period. Five years of the 10-year plan were finalized and the first three years were programmed (i.e. put into the letting list). Table 3 shows the Division Totals for each year of the first 5 years with the reduced pavement budget.

Provision of Bridge Management funding allows bridge deck improvements to be done as part of the work already scheduled for the roadway segments and will reduce road user inconvenience. The Maintenance and Operations piece will be used for incidental needs like markings and markers and lighting that are not part of the originally planned activities and will be independent of the pavement and bridge schedules.

The last phase of moving the plan into action was developing and scheduling projects including project descriptions and letting dates. This portion is handled by the Project Development Unit. The first two years were programmed as firm commitments. At the end of year 1, the next two years will become “firm” and a new year 10 will be developed. Modifications will occur in all years to reflect changing conditions and new treatments if appropriate. In other words, the 10-year planning is not a “once and done” activity, but a living document that will be improved and adjusted annually.

One observation was made in looking at the division by division totals: there are significant differences in funding level. The divisions with the highest funding levels were those including major urban centers: Division 10 includes Charlotte, Division 9 includes Winston-Salem and Division 7 includes Greensboro. While interstate highway in a rural setting will generally consist of a 4-lane divided section, the number of lanes will increase in urban areas to six or eight lane sections with concrete median barriers.

ISSUES AND SOLUTIONS

One difficulty that faces the PMS and that carried into the 10-year plan development is the difference in beginning and ending points for PMS sections in comparison to construction

1 projects. Sections in the PMS are defined by common parameters like pavement type, number of
2 lanes, curb and gutter and many others. Section lengths in PMS in NC are not uniform, but vary
3 by changes in the features. They are typically 0.1 miles to 2.0 miles (.161 to 3.21 km) in length.
4 Construction project beginning and end points are commonly defined by intersections. An
5 example would be from 500 feet (152.4 m) east of SR 1006 to NC 87. As mentioned earlier,
6 project lengths are generally 3 to 6 miles (4.8-9.7 km) long, although longer projects are
7 developed. In developing the 10 year plan, it was necessary to use the PMS sections combined
8 into construction project lengths and then expressed in terms of typical construction beginning
9 and end points. A good geo-lookup table and a skilled technician facilitated this task.

10
11 Another issue that made the plan development difficult is the lack of a straightforward way to
12 identify and consider TIP and ongoing work. Some of the information is available on-line but
13 required a project by project evaluation. Some overlaps between proposed TIP projects and
14 portions of IM Plan projects are being identified. This issue of identifying ongoing work is
15 exacerbated by the increased use of division designed and let contracts that do not come to
16 central office. We have been working to improve coordination with the divisions so we are
17 notified of their projects and the scopes of work, but it is an ongoing issue.

18
19 Somewhat related to this issue is the time lag following completion of a construction project
20 before that project is entered into the PMS. The current process doesn't begin until final
21 acceptance of the project by the Construction Unit. The line-work is then developed by the GIS
22 Unit, and finally the attributes of the roadway segments are added by PMS. The longest delay is
23 from the end of construction to final acceptance. This delay is to allow settlement of all claims
24 and acceptance checklist items, and can result in traffic being on the facility for 1 to 2 years prior
25 to the section existing in the PMS.

26
27 Finally, a successful plan requires input from the divisions in a timeline that fits with the project
28 development and funding schedules. The goal is a program that is developed from PMS data,
29 but that reflects the needs and concerns of the divisions. The current plan is to conduct an initial
30 update based on the pavement condition survey in November of each year. Meetings with
31 divisions to discuss changes in their counties, the new year 1 and year 2, and the new year 10
32 will take place in December and January. An updated plan will be finalized and sent to Program
33 Development in mid-February of each year.

34 35 **CONCLUSIONS**

36
37 The Pavement Management Unit was tasked with development of a 10-year plan to maintain and
38 improve the interstate roadways in the state. Previous analysis using the PMS indicated that
39 \$100 million per year would be required to meet our performance targets for the system. PMU
40 was asked to create a plan that would touch every section of the system at least once in the 10-
41 year period.

42
43 The plan was based on the pavement condition survey findings, pavement management system
44 data, and estimated treatment lives for a variety of treatments. The plan includes a wide range of
45 treatments including crack sealing, vacuuming of open graded friction course, overlays, mill and
46 replace treatments, diamond grinding, concrete patching and overlays of concrete pavements.

1 The treatments fall into broad categories that include maintenance, preservation, light
2 rehabilitation, and major rehabilitation. A sub-set of projects that require very substantial
3 funding were removed from the plan and were brought to the attention of those developing the
4 Transportation Improvement Program.

5
6 The original plan was reduced from the original \$100 million per year for pavements to include
7 \$10 million per year for bridge deck work within pavement project limits and \$5 million for
8 other roadway needs. These changes in funding resulted in some sections not being treated
9 within the 10 year period. Five years of the plan have been finalized and the first three years
10 have been programmed.

11
12 Some issues became apparent in the process of developing the plan. The plan was developed
13 using PMS pavement sections rather than construction beginning and ending points. Sections
14 were grouped together to create projects and a geo-lookup table was used to convert to typical
15 construction endpoints. While NCDOT has increased the amount of information available
16 online, identifying ongoing and previously scheduled projects was a tedious project by project
17 process that could be improved. The delay in entering new roadway construction (including
18 widening of existing roadways) into the PMS is due to separate sequential processes for project
19 final acceptance, GIS line-work creation, and finally PMS attribute assignment. This can result
20 in traffic being on the roadway for 1-2 years before the roadway is in the PMS. Timely input
21 from the divisions is necessary to have a plan that addresses their needs. A process to update the
22 plan on an annual basis, including discussions with the division engineers will result in a final
23 plan for project development in February of each year.
24

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Figure 2	Map of NC interstates and Divisions

Treatment Category	Asphalt Surfaced	Concrete Surfaced
Preservation	Mill patching	Diamond grinding
	Crack Sealing	Clean and Reseal Joints
	Vacuum Open Graded Friction Course	
Light Rehabilitation	Mill and Replace Driving Lanes	1% patching, diamond grinding
	Single lift Overlay	
	Spot Mill and Replace for Rutting	
Moderate Rehabilitation	Mill, Replace and Overlay	2% patching, Overlay with Ultra Thin Bonded Wearing Course
	Multiple lift Overlay	
Heavy Treatment	Mill 3", Replace, Overlay with 2 Lifts of Surface.	Overlay CRC with 5" Asphalt Overlay

Table 1: Sample Treatment Types from 10-Year Plan

1

County	Route	Begin	End	Surface	Treatment	Cost (Both Directions)
Henderson	I-26	0.000	4.927	concrete	Concrete patching 3%/ Diamond Grinding/ reseal joints	\$4,955,808.00
Pender	I-40	13.290	25.690	asphalt	Interstate - 1.5" Overlay (C Level) +OGFC	\$5,487,896.00
Nash	I-95	11.021	12.756	concrete	Interstate - Minor Concrete Rehab / Diamond Grinding	\$1,586,136.00
Wilson	I-95	11.605	15.493	asphalt	Interstate - Mill 1.5" & Replace (D Level)	\$2,199,096.00
Randolph	I-73	21.045	28.743	asphalt	Interstate - Mill 3.0" & Replace (D Level)	\$6,334,902.00
Randolph	I-85	1.979	4.000	asphalt	mill patching	\$768,000.00
Davie	I-40	7.219	12.719	CRC	Overlay with 5" HMA	\$10,442,980.00
Forsyth	I-40	11.204	12.997	concrete	Interstate - Major Concrete Rehab / Overlay	\$14,918,808.00
Forsyth	I-74	0.727	9.199	asphalt	Interstate - Mill 1.5" & Replace (D Level)	\$4,562,534.00
Mecklenburg	I-77	0.000	4.786	asphalt	Interstate -first 4 miles, mill 3" and replace with D level mix; Last 0.786 miles, mill 1.5" and replace with D level mix	\$7,341,786.00
Mecklenburg	I-77	9.476	10.476	concrete	Moderate Concrete Patching; Diamond Grind	\$1,673,184.00
Mecklenburg	I-85	0.724	5.730	concrete	Interstate - Minor Concrete Rehab / Diamond Grinding	\$5,980,984.00
Mecklenburg	I-485	27.922	36.238	asphalt	Interstate - 1.5" Overlay (D Level)	\$7,760,606.00
Iredell	I-40	14.314	18.874	CRC	Overlay 5" HMA	\$9,278,410.00
Iredell	I-77	14.473	19.953	asphalt	Overlay 1.5"	\$1,818,000.00
Haywood	I-40	23.225	28.238	asphalt	mill patching	\$600,000.00

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3

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Table 2: Excerpt from Year 2 of the 5-Year Plan

5

1

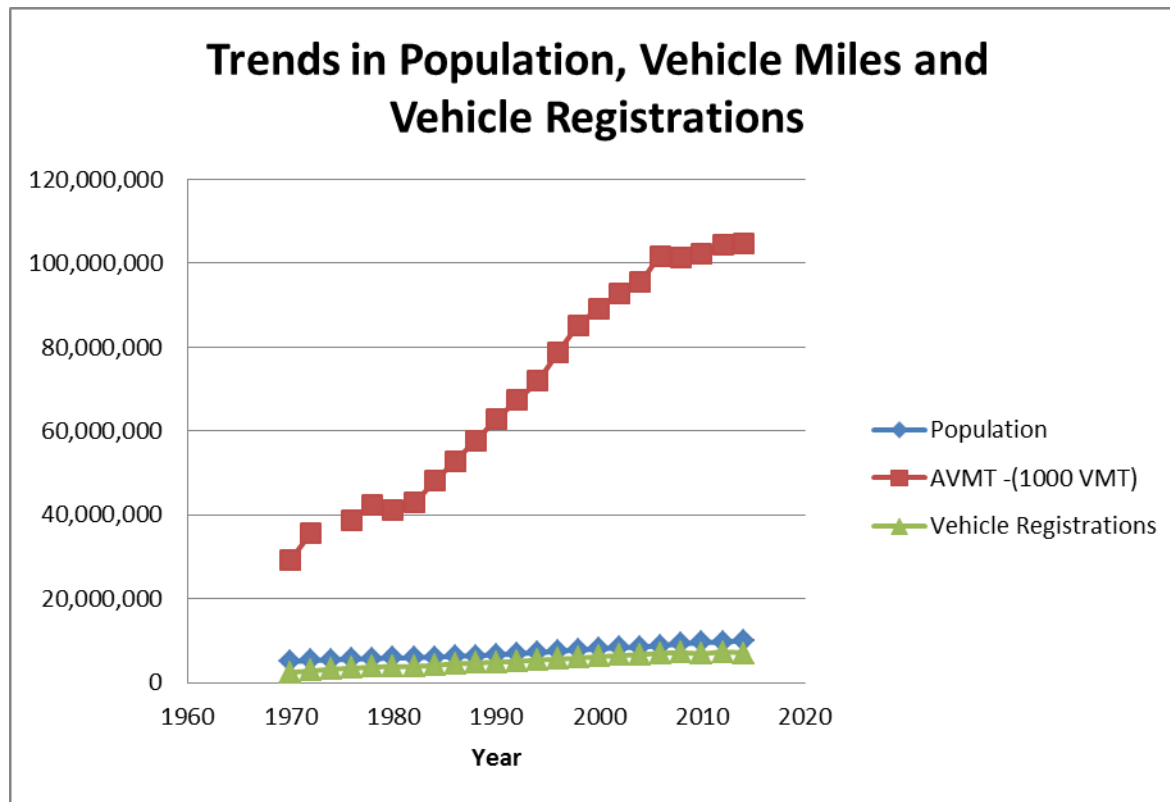
Division	Year 1	Year 2	Year 3	Year 4	Year 5
1					\$ 1,948,576
3	\$ 12,059,408	\$ 5,487,896	\$ 468,312	\$ 4,291,410	\$ 72,694
4	\$ 16,856,220	\$ 3,785,232	\$ 11,207,346	\$ 6,421,256	\$ 3,250,136
5	\$ 4,601,260		\$ 836,592	\$ 5,210,404	\$ 8,216,988
6	\$ 2,078,824		\$ 1,914,560	\$ 1,572,816	\$ 11,456,736
7	\$ 9,651,300		\$ 13,527,560	\$ 8,476,900	\$ 17,041,081
8	\$ 7,150,000	\$ 7,102,902	\$ 552,960		
9	\$ 3,127,392	\$ 29,924,322	\$ 9,690,554	\$ 19,158,448	\$ 12,103,822
10	\$ 16,070,000	\$ 22,756,560	\$ 20,284,041	\$ 18,197,114	\$ 13,813,406
11	\$ 1,600,000		\$ 3,142,169	\$ 5,534,928	\$ 9,860,446
12		\$ 11,096,410	\$ 8,292,704	\$ 1,936,632	
13	\$ 8,168,500		\$ 14,018,045	\$ 10,678,479	\$ 5,400,636
14	\$ 800,000	\$ 5,555,808	\$ 2,328,800	\$ 4,637,400	\$ 3,171,280
Totals:	\$ 82,162,904	\$ 85,709,130	\$ 86,263,643	\$ 86,115,787	\$ 86,335,802

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Table 3: 5-Year Plan Division Totals

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FIGURE 1 Vehicle miles travelled, vehicles registered and population from 1970 until 2014.

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