II. DIVISION OF STREETS AND ROADS

The Division of Streets and Roads provides a wide variety of services, including paving, patching, milling, street sweeping, alley cleaning, ditch cleaning and maintenance, mowing, concrete repair and maintenance, tree trimming and removal, vacant lot cleanup, traffic signal maintenance, sign fabrication, maintenance and installation, warehouse oversight, as well as other services and activities. This chapter of the report analyzes and provides recommendations in the operation and organization of the Division:

1. THE TRAFFIC CONTROL UNIT OF THE DIVISION OF STREETS AND ROADS IS INSUFFICIENTLY STAFFED TO ACCOMPLISH PREVENTIVE MAINTENANCE AND REPAIR OF METRO'S TRAFFIC SIGNALS.

The Traffic Control Unit of the Streets & Roads Division is responsible for repairing and maintaining approximately 800 traffic signals in Metro while it uses a private contractor primarily for new installations. Well planned and executed signal maintenance is important to Metro for several reasons. The first is that a properly operating system is essential for proper traffic flow, particularly in areas of high congestion. Improperly operating signals, or non-operational signals result in diminished traffic handling, often requires uniformed police officers to direct traffic in areas of congestion and results in repair call-outs on overtime. Additionally, signal failures create a potential liability to Metro if they are causal in traffic accidents and personal injuries.

Signal maintenance is accomplished through staff located in the Signal Maintenance and Signal Construction units of the section. Specifically, these staff positions are listed in the table below:

Staff Assigned to Signal Maintenance and Repair

Signal Construction Unit	Signal Maintenance Unit
Signal Technician III (3)	M&R Leader III
Signal Technician II (3)	M&R Leader II
	M&R Worker III
Signal Technician I (2)	M&R Worker II (2)
Total = 8	**Total = 5**

As can be seen in the table above, there are a total of 13 field traffic technician positions responsible for the maintenance and repair of Metro's signalized intersections. With approximately 800 signals, this equates to a signal to technician ratio of 61.5 to 1. Industry standards indicate that this ratio should be within the range of one technician per 30 to 35 signals, indicating that the Units require approximately 22 to 26 technicians, or between 9 and 13 additional staff.

This apparent staffing deficit is validated in part through an analysis of Traffic Control Section records for its re-lamping program. The Signal Maintenance Unit maintains manual records of signals, their intersection locations, the numbers of 60W, 90W and 120W bulbs at these locations, and the dates of re-lamping at these intersections. The project team reviewed these records and found that none of the approximately 800 intersections received "proactive" bulb replacement during the 12 months ended 12/31/01, although interviews indicate that the section "targets" an annual replacement of each bulb to ensure maximum reliability and operability of the system. Any replacements performed were accomplished as bulbs failed.

In addition to the re-lamping program, the Traffic Control Section performs preventive maintenance (PM) on control cabinets, which includes checks of timing information, general condition checks of the remote cabinets, cleaning of cabinet housing, checking of controllers, conflict monitors, and other activities. The Traffic Construction Unit targets a preventive

maintenance cycle of once per two years for each cabinet. Data obtained from the Unit indicate that 242 preventive maintenance events occurred in 2001, indicating that, if this number is indicative of previous years, each cabinet is on a PM cycle of once per 3.3 years.

The relatively low number of preventive maintenance occurrences is an indication of the low staffing level of the Traffic Control Unit. In the experience of the project team, not only is the current actual PM level of once per 3.3 years too infrequent based on industry standards of performance, but the targeted service level of once per 2 years is less frequent than recommended. This targeted service level should be at least once per year, with some cities targeting a level of twice per year to ensure optimum system reliability. The risk to Metro in terms of the increased liability for accidents caused by signal inoperability indicates that this problem should be addressed immediately. Although data are not available to assess whether accidents have been attributable to this lack of preventive maintenance in the past, this lengthy cycle of preventive maintenance indicates that the potential exists to be problematic in the future.

An additional indicator that the two units are insufficiently staffed is in the lack of record-keeping regarding the system reliability. Specifically, the Traffic Control Unit should be able to report the percentage of time each signal is operable, and the reasons for system failures, with a determination as to whether the failure was preventable or non-preventable. This is not possible in Metro's Traffic Control Unit as the Division's work reporting system does not track this data.

Recommendation 2-1. The project team recommends that the Traffic Control Section significantly increase staff in order to initiate, and continue to provide on an on-going basis, a preventive maintenance program which will allow the Section to proactively maintain Metro's 800 signalized intersections, as well as to maintain records regarding system reliability. An estimate of the cost to minimally staff the Signal Maintenance and Construction Units is approximately $405,500 in operating costs. Of this amount, an

estimated $76,500 would be increases in supplies and materials, and $329,000 would be in personnel costs, as is shown in the table below. We anticipate that the new personnel will require up to three bucket trucks, for a capital cost of $300,000 based on Metro's most recent bids. It is expected that the potential benefits will include a reduction in repair callouts, improved traffic flow, and reduction in liability exposure.

Given that only approximately 0.5 FTE's are performing proactive cabinet PM's, a significant percentage of the additional staffing may need to be allocated to this function. It is assumed in the table that, of the recommended 9 new employees, 5 are Signal Technician I's, and 4 are M&R Worker II's.

Calculation of Costs Associated with Additional Traffic Technicians

Position	Additional Number Needed	Salary at Midpoint	Extended Salaries at Midpoint	Benefits (at 30%)	Total Direct Cost
Signal Tech. I	5	$31,470.40	$157,352.00	$47,205.60	$204,557.00
M&R Worker II	4	$23,857.60	$95,430.40	$28,629.12	$124,059.52
Total	**9**	$55,328.00	**$252,782.40**	**$75,834.72**	**$328,617.12**

Therefore, as the table shows, the project team recommends that the Section add staff with an annual estimated cost of approximately $329,000 plus $300,000 for additional bucket trucks.

The estimate for an increase in supplies and materials is based on the current budget for repair and maintenance supplies in the Signal, Signs, and Markings Unit, less expenditures for signs divided by the number of current signal crew personnel. This equates to an average of $8,500 per staff person. At the same ratio, the addition of nine personnel would increase material costs by $76,500, for a total increase in costs of $405,500. This will also require additional equipment; we estimate the need for three bucket trucks at $100,000 each, based on the City's most recent purchases.

Recommendation 2-2. The capability to track signal operations and reasons for system failure should be incorporated into Metro's proposed Intelligent Transportation System data collection and reporting. There should be no additional cost associated with this recommendation through incorporation into the grant-funded ITS. This information should also link to a work order management system, discussed later in this chapter. The benefit of this information is that it will permit Department management to monitor signal activity on a regular basis, track outages, and prepare work plans to address systematic problems.

2. THE TRAFFIC CONTROL SECTION SHOULD BEGIN THE PROCESS OF BIDDING ON SIGNAL INSTALLATIONS TO ENSURE A MORE COMPETITIVE ENVIRONMENT, AND TO ENSURE A MORE COST-EFFECTIVE PROCUREMENT OF THESE SERVICES.

Interviews and analyses of contractual documents indicate that traffic signal installations have been historically provided by a single private entity. This situation has resulted in non-competitive procurement of services, and has reportedly resulted in relatively lengthy installation periods, especially within the recent past. Although the project team did not have access to data indicating the exact amount expended for labor services in providing the installations (figures available through the Department's Staff Services unit reflected total prices, inclusive of materials and labor) the total amount expended in signal installations was over $1.7 million since mid-1998.

The Traffic Control Section does not currently possess the personnel resources to install traffic signals; further, there are indications that it is unlikely that there will be sufficient numbers of competitors in this field to ensure the existence of a competitive environment in the foreseeable future in Metro. Therefore, for reasons of flexibility as well as potential cost-effectiveness, the project team recommends that, at the time of the next bid cycle for signal installation services, the Traffic Control Section submit a "bid" to provide these services internally, much in the same manner that any other private concern would submit its own. This

competitive model, first developed in Phoenix, enables a City department to offer its services in a competitive environment. There are several advantages to this approach:

- It creates a competitive environment where historically there has been only a single service provider; it puts the provider on notice that its pricing needs to competitive and its service needs to be responsive.

- The model enables Metro to evaluate whether it can provide the service more efficiently and effectively than the private provider without having to make a commitment to staffing and equipment acquisition prior to undertaking the service.

Recommendation 2-3. Allow the Traffic Control Section to submit a "bid" for the installation of traffic signals as a measure to create a more competitive environment for this service. Typically, this approach to competition has the result of reducing costs for the same level of service by approximately ten to fifteen percent. Based only on existing, open purchase orders with the current service provider, we estimate that this approach would yield savings of about $54,000 per year.

Normally, the MAXIMUS project team would develop a staffing and work model for a recommended organization. However, to do so here would place the Department at a competitive disadvantage, since potential competitors would then know the pricing it must beat. Therefore, for the purposes of implementing this recommendation, the Department should not assemble any "bid based" information until Metro is ready to seek new bids for the service contract and should then prepare its proposal as if it were a private service provider.

The next issue analyzes the staffing levels of the Signs and Markings Unit.

3. SIMILARLY, THE SIGNS AND MARKINGS UNIT IS INSUFFICIENTLY STAFFED TO PROVIDE PROACTIVE MAINTENANCE OF METRO'S STREET SIGNS.

The Signs and Markings Unit of the Traffic Control Section maintains and repairs approximately 86,000 street signs in Metro with one Signs and Markings Supervisor (who expends approximately 50% of time in road striping oversight) and three M&R Worker III's.

This equates to an approximate ratio of 24,570 signs per field worker, assuming 3.5 equivalent field workers.

As with signalization, the proper maintenance of street signs is important for proper traffic flow and traffic safety. Missing or improperly reflectorized signs can result in drivers getting lost and making improper traffic movements and can create potential liability situations for Metro if those movements result in traffic accidents and/or personal injury.

The project team noted two concerns regarding the staffing and operations of the Signs and Markings Unit. These can be summarized as follows:

- **Each crew member is responsible for maintaining a relatively large number of signs.** – As noted above, each of the crew members in the Signs and Markings Unit is responsible for approximately 24,570 signs. In the project team's experience, this is an unusually large number, as the "norm" is generally in the 8,000 to 12,000 range. This large number of signs for which each crew member is responsible is forcing the Unit into a reactive mode of operation. As an illustration, the Unit responded to a total of 5,488 requests for new sign installations, modifications and repairs in 2001. If each of these requests requires travel time and actual on-site work equating to one hour, this would have required 5,488 person hours of the 3.5 employees. If each of the employees works an average of 1,650 productive hours each year, this results in a capacity of 5,775 productive crew hours, leaving approximately 287 hours (or about 82 per year, per employee) for proactive efforts relating to the checking of sign reflectivity, administrative reporting, and other activities. Assuming that each crew member is responsible for 12,000 signs, this would equate to the need for a minimum total of 7 crew members. Given that one of these crew members is 0.5 FTE, this would require 4 additional employees. The project team raises the issue of the feasibility of increasing the numbers of employees allocated to sign maintenance and repair.

- **There is no automated inventory of signs in Metro.** – Although the Unit maintains a manual history of sign repairs performed, this is not automated. Therefore, it becomes a manual process of retrieving information related to maintenance histories, locations, sign types at specific locations, and dates of required maintenance.

As the preceding discussion indicates, the project team has noted significant concerns in the Signs and Markings Unit operations. At issue is the high workload per employee which is

resulting in the "reactive" mode of operations in the Unit. As noted above, each of the crew members in the Signs and Markings Section is responsible for maintaining over 24,000 signs. In itself, this is not a particularly meaningful figure until compared to other jurisdictions with which the project team has experience. This experience indicates that crew members should be responsible for approximately 8,000 to 12,000 signs, or about one-third to one-half of the number of Metro's crews. As further evidence, Signs and Markings crews replaced 3,903 signs in 2001, or about 4.5% of the total. This implies that each sign is replaced once per 22 years, which is well beyond the typical sign's reflectivity life cycle, and is an indication that the Unit is simply replacing signs as they are damaged or destroyed. The continued replacement of signs over such a protracted period exposes the Division, Department and Metro to the possibility of faded or damaged signs being illegible, leading to potential accidents or, at a minimum, inconvenience to motorists. Signs which have been vandalized or, worse, removed, without the prompt attention of Traffic Control staff could result in accidents which may have been preventable had sufficient staff been deployed in a more proactive manner.

Recommendation 2-4. The project team recommends an increase of four M&R Workers in this Unit to accomplish routine sign maintenance and repair, inventory collection and maintenance, and proactive determinations of those signs in need of repair. The following table provides a calculation of salary and benefits related to "full staffing" of the Signs and Markings Unit, assuming that each sign crew is staffed with a M&R Worker II or III. The estimated cost of this recommendation is approximately $204,059 in operating costs for personnel and materials; of this amount, $124,059 would be for additional personnel, and $80,000 for supplies and materials. In addition to the operating costs, there would be an estimated capital cost of $125,000 for additional vehicles. The commensurate benefit is improved traffic movement and safety and reduced public liability.

Preliminary Cost Calculation for "Full Staffing" of Signs & Markings Unit

Position	Additional Number Needed	Salary at Midpoint	Extended Salaries at Midpoint	Benefits (at 30%)	Total Direct Cost
M&R Worker II	4	$23,857.60	$95,430.40	$28,629.12	$124,059.52

As shown in the table above, the estimate to fully staff the Signs and Markings Unit of the Traffic Control Section of Streets and Roads is approximately $124,060.

Based on a review of accounts payable, the Department paid $111,863 for signs and materials in the past fiscal year. This is an average of $15,980 per sign staff. The addition of four more staff would increase the materials spending by $63,920. Anticipating greater work productivity, we recommend estimating a total of $80,000 for additional materials.

Depending upon the availability of vehicles in a restructured Fleet Maintenance Division, the Signs and Markings Unit may additionally require the purchase of new vehicles to accommodate the transportation needs of the new employees. These expenses could be as much as $125,000 for four vehicles, which should be equipped to carry signs, posts, and equipment related to the installation and repair of the signs.

Recommendation 2-5. The project team recommends that the Department develop an automated inventory of signs maintenance. At a minimum, this could be an internally developed Access database; however, more ideally, this should be part of a master work order and control system, discussed later in this chapter. As a local data base, this recommendation has no cost implications. The overall costs of a work order system are discussed later in this chapter. The benefits of this recommendation are improved management of work and inventory, resulting in a more efficient use of personnel and a more effective sign maintenance program.

The next issue discusses the internal organizational structure of the Traffic Control Section.

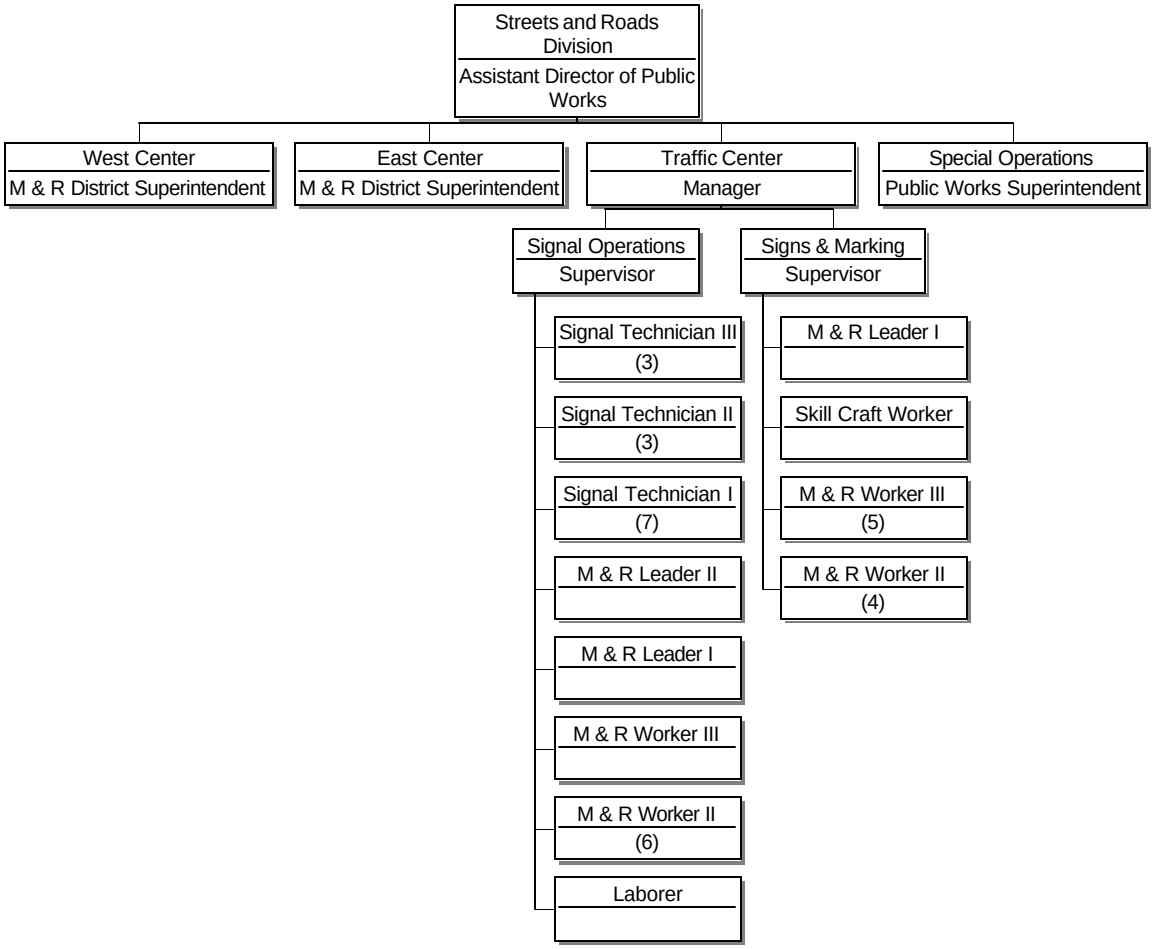
4. THE TRAFFIC CONTROL UNIT SHOULD CONSOLIDATE THE CURRENTLY-SEPARATE SECTIONS OF SIGNAL CONSTRUCTION AND SIGNAL MAINTENANCE.

Currently, the positions of Signal Maintenance Supervisor and Signal Construction Supervisor oversee separate sections which perform activities related to the maintenance and repair of traffic signals. Although these two sections require employees possessing separate skills, the management of these units requires a coordination of effort to ensure that preventive maintenance is performed in accordance with a pre-established plan. Further, many calls for service currently handled by Signal Technicians in the repair and maintenance of controllers, wires, etc., could be combined with functions now performed by the Signal Maintenance Unit, such as bulb replacement, control box change-outs, and potentially other activities.

The issue here is not one of the elimination of functions, but rather of consolidation of managerial efforts. In the experience of the project team, it is common to combine the management of these two disciplines under a single management structure while recognizing the need for a separation of duties performed by field staff.

Recommendation 2-6. The project team recommends combining the two currently separate disciplines of signal construction and signal maintenance. The consolidation of these two functions will allow the reduction of one of the Supervisor positions with an estimated cost saving of approximately $57,800 annually in salary and benefits. The proposed, revised organizational structure is presented in the chart on the following page. Note that the new organization chart contains the recommended positions discussed in the two previous sub-sections, above.

RECOMMENDED ORGANIZATION
STREETS AND ROADS DIVISION
TRAFFIC CONTROL UNIT



The next issue provides an analysis of costs associated with the in-house milling function provided by Special Operations.

5. THE IN-HOUSE MILLING OPERATION APPEARS TO BE COST-EFFECTIVE, BUT DATA PROBLEMS PRECLUDE ABSOLUTE DETERMINATION.

The project team analyzed the cost-effectiveness of the in-house milling operation, and has questions regarding its cost-effectiveness in comparison to private sector costs. The cost of milling was analyzed by sampling three months of data (July through September, 2001) during which varying amounts of milling were performed. The direct labor costs and associated benefits shown in the table below are reflective of the three months in the sample. However, as equipment-related costs tend to vary significantly from month to month, a two-year sample was obtained for repair and maintenance parts and labor charges. These costs were divided by 24 (to reflect an average month of costs), and added to the labor-related charges, then divided by the square yards of milling accomplished in the sample month. The results are shown in the following table:

Calculation of In-House Milling Cost
Based on Sample of July, August and September, 2001 Work Activity

Element	July, 2001	August, 2001	September, 2001
Labor hours expended in milling	1,466	3,325	301
Labor Costs (as reflected in time sheets)	$18,852.68	$41,316.29	$3,870.84
Benefits Cost (at 30% of salaries)	$5,655.80	$12,394.88	$1,161.25
Maintenance and Repair Costs	$3,892.15	$3,892.15	$3,892.15
Parts Costs	$6,347.47	$6,347.47	$6,347.47
Contracted Repair Costs	$367.80	$367.80	$367.80
Depreciation Costs	$8,789.34	$8,789.34	$8,789.34
Total Costs	**$49,561.04**	**$78,763.73**	**$30,084.65**
Square Yards Milled	87,780.1	102,220.0	38,758.8
Cost per Square Yard	**$0.56**	**$0.77**	**$0.78**
Typical milling costs from private contractors (for 2" mill depth, inclusive of debris hauling charge of approx. $0.25/sq. yd. – Range is dependent on length of segment, numbers of valve boxes in stretch, etc.).	$0.75 to $1.00 per square yard		

As the table shows, the calculations of milling costs for in-house crews vary from July, when a relatively high number of square yards were milled, to September, when a relatively few were milled. To some degree, this difference may be explained by allocating fixed monthly maintenance and depreciation costs to the workloads. In other words, the same amount of depreciation, maintenance and parts charges were allocated to September's activity as were allocated to July's. However, there is also a large variation in productivity of crews, given that there were approximately 60 square yards milled per person hour in July, but only 31 in August. The relatively low figure in August may be explained by the fact that the paving crew assisted heavily in milling operations that month in cleaning up debris and production materials left by the milling crew. This is a routine occurrence during months in which the paving machine is out of operation, or that there is little paving to be completed.

The variations in productivity, combined with the fixed allocations of maintenance and depreciation charges, make comparisons to the private sector difficult in the case of the milling operation. As can be seen from the table, private contractors' costs vary (as do those of Metro crews) with the characteristics of the road segment being milled. However, the three months of data collected by the project team indicate that, for longer stretches of road milling, Metro crews appear to be somewhat less costly than private contractor operations.

It should be noted that the actual reported work data for September was incorrect in that it reported square yardage rather than square footage. The analytical figure in this report of 38,758 square yards milled in September was assumed, based on conversion from reported yards. This value is within a reasonable range for the 301 hours expended in the effort. Although this adjusted figure is assumed to be correct, it should be noted that the error has been allowed to stand since September, 2001.

It should also be noted that, as was the case for the paving crew in August, the milling crew is not utilized strictly in the milling of road segments, but rather is deployed in various activities when not performing milling work. Although there were several functions performed by individuals within the "milling crew" when not milling, these functions tended to be related to the concrete sidewalk pulling and construction. Given that the average crew size for the milling crew is approximately 11 members, the typical milling crew member expended approximately 118 hours per month in milling in the months of July, August and September, 2001. Viewed another way, approximately 8.1 full time equivalent (FTE) personnel were engaged in milling in these three months.

To some degree, the wide variations in productivity and utilization of crews may be a function of the lack of planning of effort. As the milling crew's efforts correspond somewhat directly to the paving function, this is less likely to be the case than in some other functions of the Division, as the paving effort is one of the few which appear to be planned to some degree. The milling function, like the paving effort, is subject to weather conditions, and, as is frequently the case in the Streets and Roads Division, is also a function of the reliability of the milling machine.

Recommendation 2-7. Given the variance in the cost figures for milling, the project team does not, at this time, make a recommendation regarding the retention or outsourcing of the function. Rather, it is recommended that the Division begin capturing and analyzing data over the next 12 months to establish a basis for comparison to private providers, and to determine if there are certain characteristics of the in-house operation which make it either more cost-effective than private providers, or if there are characteristics of certain jobs which make obtaining bids from private contractors difficult or impossible. If data analysis indicates that this function is not cost-effective, the Division would be recommended to re-deploy approximately 8.1 FTE's in other areas. Given that the employees currently in the milling crew perform other functions throughout the year, this would allow the Division to enhance services in other areas, such as in concrete replacement and inspection. If the cost analysis holds after the collection of valid data, it would appear that the milling operation is effective, when compared to private contractors.

It should be further noted here that the project team recommends that the Department greatly expand its slurry seal program as a preventive maintenance measure. This is discussed in greater detail in Chapter 4 of this report. This recommendation will result in a proportional reduction in the requirement to overlay streets, as is currently done. Given that the full implementation of the slurry seal program will take between 12 and 24 months, the project team recommends the retention of the milling function for that duration of time. At that time, it is recommended that the Streets and Roads Division re-evaluate the cost-effectiveness and productivity of the milling crew. If the volume of work and cost-effectiveness do not warrant the retention of the milling crew after the full implementation of the slurry seal program, the project team recommends its elimination, with the transfer of the approximately 8.1 FTE's to other functions in the Department.

The next issue discusses the cost-effectiveness of the in-house paving operation.

6. THE IN-HOUSE PAVING OPERATION IS SIMILAR TO THE MILLING OPERATION IN THAT THERE IS WIDE VARIABILITY IN ITS COST-EFFECTIVENESS BETWEEN PERIODS.

Interviews indicate that the paving crew in the Special Operations Unit of the Streets and Roads Division attempts to provide paving of streets which are of little interest to private contractors due to the presence of short paving segments or obstructions in the roadways which do not allow for continuous, uninterrupted work activities which promote maximum productivity. This assertion is only partially validated by analyzing the tons of asphalt poured per day in the months of May and July, 2001.

Specifically, in the project team's experience, highly productive paving crews pour an average of between 500 and 700 tons of asphalt per day when examining an extended time period of activity. This range takes into account an equal number of road segments containing impediments as those which allow for uninterrupted activity. In analyzing the productivity of Metro's paving crew, the overall two-month average for May and July, 2001 was approximately 431 tons per day for the 15 days on which paving was performed. Again, however, there was a very large variance in productivity, and resulting cost-effectiveness. The table below calculates only the labor and equipment cost per ton of asphalt laid (it does not include materials cost):

Calculation of Paving Productivity
May and July, 2001
(Does not include cost of asphalt)

Element	May, 2001	July, 2001	Total
Salaries and benefits	$7,249	$17,028	$24,277
Equipment depreciation	$15,494	$15,494	$30,988
Subtotal	**$22,743**	**$32,522**	**$55,265**
Tons of asphalt laid	4,332.49	2,138.18	6,470.67
Salaries and Equipment Cost per ton	**$5.25**	**$15.21**	**$8.54**
Contractor Cost	**$10.00 to $11.00 per ton**		

The figures in the table reflect a significant variance in the variable costs associated with pouring each ton of asphalt, suggesting that the characteristics of the street segments paved were vastly different between the two months. In support of this observation, although the overall number of tons poured per day was 431, as noted above, the figure for May was 866 tons per day, and was 214 tons per day in July.

In contrast to the analysis of the milling operation, above, the analysis of cost and productivity in the paving function points to more definitive conclusions. These include the following:

- Although the cost and productivity per ton of asphalt poured in May are within the normal ranges for paving operations, the figures suggest that, contrary to the Division's assertions, in-house paving crews are at least at times utilized to pave street segments with characteristics similar to those which were reported to be reserved for the private sector.

- Although the cost and productivity figures for July are reflective of characteristics of roadways which the Division has indicated are reserved for in-house crews (i.e., short, interrupted segments), there was an almost negligible number of tons poured, calling into question the value of retaining the in-house crew.

To summarize, the in-house paving crew provides services at cost and productivity levels similar to, but no greater than, those available in the private sector when performing work on similar street segments. On the other hand, the in-house crew displays very low productivity levels on street segments which do not allow great economies of scale.

Recommendation 2-8. On a strict cost-effectiveness basis, the project team does not recommend the elimination of the paving function at this time. However, as was noted above in the analysis of the milling function, the project team recommends that the Department greatly expand its slurry seal program as a preventive maintenance measure. This is discussed in greater detail in Chapter 4 of this report. This recommendation will result in a proportional reduction in the requirement to overlay streets, as is currently done. Given that the full implementation of the slurry seal program will take between 12 and 24 months, the project team recommends the retention of the paving function for that duration of time. At that time, it is recommended that the Streets and Roads Division re-

evaluate the cost-effectiveness and productivity of the paving crew. If the volume of work and cost-effectiveness do not warrant the retention of the paving crew after the full implementation of the slurry seal program, the project team recommends its elimination, with the transfer of the employees in the paving crew to other functions in the Department.

As discussed in the section on a slurry seal program in the Engineering Chapter, it is expected that the Department will hire a professional consulting firm to assist in the development of the program. The evaluation of any retention of paving functions within the Department would be an appropriate consideration in the development of the subsequent final program.

7. WORKLOADS ARE UNEVENLY DISTRIBUTED BETWEEN THE EAST AND WEST SATELLITE CENTERS.

In addition to the central location at South 5th Street, from which the Special Operations Section operates, the Streets and Roads Division of Public Works has two satellite centers from which field crews are dispatched to work sites. These are the East and West Centers, located at 941 Dr. Richard Adams Drive, and 3800 Charlotte Pike, respectively.

The work activities, as well as the staffing levels, at the two satellite locations are generally the same, with the exception that cemetery burials are performed at the East Center. The crew descriptions and staffing levels are presented in the table below:

Staffing and Functions at the Satellite Centers

Crew	East Center Staff	West Center Staff
Shoulder Maintenance & Construction	9	8
Tree Removal	9	9
Construction	6	8
Patching	6	6
Masonry	4	4
Storm Sewer	6	8
Mowing	6	3
Median	3	4
Street Cleaning	3	3
Vacant Lot Cleaning	8	8
Total Staff	**60**	**61**

Interviews indicate that, at the time the responsibility areas were allocated between East and West Centers, an attempt was made to evenly distribute the workloads based on similar numbers of street mileages. The project team obtained the lengths of street segments within each of the Councilmanic Districts, and utilized this allocation for validation purposes. This appeared to be a reasonable proxy for responsibility area allocation, as workloads are reported daily based on this designation. Although three Council Districts (12, 19 and 20) appear to be split between the East and West Centers, there is generally a clear definition of which Council District is allocated to each of the two Satellite Centers, as the table below shows.

Allocation of Council Districts and Linear Feet of Roadways between East and West Centers

East Center		West Center	
Council District	**Linear Feet of Road**	**Council District**	**Linear Feet of Road**
1	790,868	12 (50%)	176,712
2	300,949	13	258,287
3	339,515	16	294,414
4	281,405	17	213,851
5	226,268	18	145,521
6	218,927	19 (50%)	153,604
7	260,652	20 (50%)	143,431
8	256,491	21	286,788
9	308,795	22	225,107
10	380,486	23	417,998
11	340,665	24	330,587
12 (50%)	176,713	25	285,425
14	243,162	26	223,927
15	499,034	27	247,943
19 (50%)	153,604	28	264,192
20 (50%)	143,431	29	391,614
		30	190,874
		31	363,770
		32	298,226
		33	239,585
		34	223,279
		35	361,799
Total	**4,920,965**	**Total**	**5,736,934**

As can be seen from the table, if Council Districts 12, 19 and 20 are split evenly between the two Centers, the East Center has responsibility for 14.5 Council Districts and the West

Center has responsibility for 20.5. Further, the West Center has responsibility for approximately 53.8% of all paved roadway maintenance, versus approximately 46.8% in the East Center.

The project team noted during the preliminary data analysis that many of the metrics reported in the monthly reports indicated that the West Center accomplished a greater level of output than did the East Center. In following up on this preliminary indicator, the project team requested and received from the Metro Information Technology Department a summary of the Automated Inquiry Management ("AIM's") system work orders by Council District for 2001 to determine the degree to which these work requests validated the disparity in workloads. The results showed that, in many cases, the variances in work requests between Centers are significant, as the table below shows.

AIM's Work Orders by Center
For Selected Category Codes

Category	East Center Work Orders	West Center Work Orders	Total Work Orders
Ditch Maintenance (#101)	681	852	1,533
Patching (#103)	207	281	488
Tree Removal (#106)	484	837	1,321
Emergency Calls (#134)	446	509	955
Debris Clean-up (#137)	798	909	1,707
Dumpsite Clean-up (#138)	774	235	1,009
Total All AIM's Work Orders	**7,831**	**9,412**	**17,243**
Note: The Ditch Maintenance function has been transferred to the Water Department.			
Note: During the period for which these data were collected, Metro was experiencing severe storm conditions on the west side of the City; response to these storm conditions explains, in part, the higher volume of West Center work related to tree removal, emergency calls, and debris removal.			

Note that, since not all AIM's work categories are reflected in the table, the totals for the six categories that are shown in the table do not sum to the overall total of 17,243 work requests received during the year. These six categories do, however, represent approximately 60% of all work requests for which the two Centers could have been expected to respond. (After HazMat, milling, paving, and sign repair work requests, for example, have been omitted from the totals.

These are functions under the responsibility of other sections in the Division). Therefore, these six categories are representative of the allocation of work between the two centers.

Highlights from an analysis of the table indicate the following:

- The West Center received approximately 55% of all ditch maintenance requests, or 25% more than the East Center.
- The West Center received 58% of all Patching requests, or 36% more than the East Center.
- The West Center received 63% of all tree removal requests, or 73% more than the East Center.
- The West Center received 53% of all Emergency Calls, or 14% more than the East Center.
- The West Center received 53% of all calls for Debris Clean-Up, or 14% more than the East Center.
- The East Center, however, received 77% of all calls for Dumpsite Clean-Up, or 229% more than the West Center.
- Overall, the calls for work activities in the West Center accounted for approximately 54.6% of the total, although, as noted above, the two Centers did not have responsibility for the responses to a significant percentage of the total.

Aside from the wide variance in the numbers of dumpsite clean-up calls, the West Center appears to be responding to a significantly greater number of AIM's work requests than is the East Center. Given that the staffing levels at the two Centers are similar, it would follow that the East Center, with a lower number of AIM's work requests which, by nature require a *reactive* approach to maintenance, should be generating greater volumes of *proactive* work output. In analyzing the degree to which this is actually occurring, the project team reviewed the monthly reports, which report output levels for certain work types, and noted those categories which could be classified as proactive. Although this is not a clear definition, and certainly not one

used by the Department, the project team evaluated each of the reported metrics and determined that the "proactive" work elements (i.e., those which are generally not performed in response to a complaint, but rather performed as a part of a routine service) include the following, along with the annual totals of work output by Center.

"Proactive" Work Output Metrics by Center

Reported Metric	East Center Volume	West Center Volume
No. of Inlets Cleaned	2,790	2,718
Headwalls Built	102	118
Shoulders Constructed	631,836 ft.	487,164 ft.
Rights of Way Trimmed	303.4 miles	374.4 miles
Rights of Way Mowed	2,854.7 miles	4,343.8 miles

The figures in the table do not indicate that the East Center is accomplishing a volume of "proactive" work sufficient to compensate for the significantly lower "reactive" call volume received through AIM's work requests. On the contrary, taking the mowing activities as an indicator, the West Center is mowing its area of responsibility approximately 4 times per year. In contrast, the East Center mows its area of responsibility approximately 3 times per year.

Finally, to verify whether there is, in fact, an inequitable workload distribution, or whether the East Center is simply transferring personnel into West Center areas of responsibility on a daily basis to compensate for the apparent disparity in area assignments, the project team analyzed the locations of work performed by personnel during the month of June, 2001. To accomplish this, the project team identified those crew members who were assigned to the East and West Centers, and summarized their numbers of hours expended during the month of June, 2001 within each Council District. Then, the hours were summarized according to whether specific Districts were within or outside the crew members' assigned Center area of responsibility. The results of this analysis are presented in the table below:

Summary of East and West Center Staff Hours by Area of Responsibility
June, 2001

Personnel Assigned to:	Hours of Work Performed in Council Districts within Assigned Center's Area of Responsibility	Hours of Work Performed in Council Districts Outside Assigned Center's Area of Responsibility	Total Hours
East Center	2,340	72	2,412
West Center	2,138	32	2,170
Total	**4,478**	**104**	**4,582**

Therefore, the table shows that, even when considering the number of hours expended by East Center personnel which were outside of the Center's area of responsibility, the large majority (over 97%) of hours expended by East Center personnel during the month of June were expended within Council Districts which are assigned to the East Center. Similarly, over 98% of hours expended by West Center personnel were for activities performed in Council Districts which were within the West Center's area of responsibility. The table also indicates that the East Center transferred out 40 more hours into West Center areas of responsibility than was the case for West Center personnel into the East Center's area of responsibility. If the month of June, 2001 can be assumed to be indicative of the other 11 months of the year, then there may have been about 480 more hours transferred into the West Center area of responsibility than was transferred into the East Center areas. This equates to approximately 30% of one FTE, which is far less than adequate to account for the imbalance in workloads assigned between the two Centers.

An additional indicator of work load distribution is the use of overtime. The Internal Audit staff of the Finance Department reviewed overtime records for personnel for the calendar year 2001. That review showed that total overtime paid to East Center personnel was $63,710,

and overtime paid to West Center personnel was $74,134. This difference in overtime is commensurate with the imbalance in workloads assigned between the Centers.

The analysis above indicates that, by any measure or standard applied, there is an imbalance in work assignment between the East and West Centers. Viewed differently, it may be argued that there is an imbalance in the staffing resources assigned to the two satellite centers. This phenomenon would be a relatively simple one to correct if this were the extent of the problem; however, as we will discuss throughout this chapter, there are also related problems in terms of work order management and structural supervisory issues. In fact, by transferring responsibility for District 13, and that portion of District 12 which is currently split, to the East Center area of responsibility, the overall distribution of workload would be approximately the same, as the table below shows:

Effect on Workload Distribution by Transferring Council District 13 and All of District 12 to East Center

Scenario	East Center		West Center	
	Road Miles	**AIM Work Orders**	**Road Miles**	**AIM Work Orders**
Current	932	7,831	1,087	9,412
Proposed	1,014	8,516	1,004	8,727

Recommendation 2-9. As the table shows, through a simple reallocation of areas of responsibility, the Division can attain rough parity in the workload distribution between East and West Centers. This reallocation is a geographically logical one, as Districts 12 and 13 are located in the far eastern area of Davidson County. The project team does, in fact, recommend that the Division make this change, as there should be a reduction in overtime associated with the West Center labor, a reduction in travel time for these personnel, and an increase in productivity of the East Center staff. We estimate that the cost savings for the change would be, at a minimum, $10,500 in reduced overtime in the West center staff. There is, however, a clear difference in productivity between the two Centers as well, suggesting fundamental differences in the manner in which the two Centers are managed.

The management of the activities performed within the two Centers, and those of the Division generally, are analyzed in the following sub-sections.

8. DATA ANALYSIS INDICATES PRODUCTIVITY CONCERNS IN THE DIVISION'S DITCH MAINTENANCE FUNCTION.

As ditch maintenance is among the most frequently performed tasks by crews at the two satellite centers, the project team analyzed the methods of accomplishing this task in terms of crew sizes, route planning and degree of proactive scheduling of effort. The findings in these regards are illustrative of the general "reactive" nature of work performance at the Centers. The following discussion and analysis are provided as substantiation of these initial observations.

AIM's work orders indicate that there were a total of 1,562 requests for ditch maintenance in 2001. This ranks it as the fourth most-requested category of maintenance, and represented over 9% of all work requests for that year. Further, it represented the second greatest expenditure of effort at each of the two satellite centers in June, 2001. (Interestingly, however, the top-ranking work volumes varied significantly between the East and West Centers in June, 2001 – one of the project team's two sample months - with Mowing representing the greatest level of effort in the East, and Tree Removal the highest-volume activity in the West).

In analyzing the method of work accomplishment for ditch maintenance, the project team analyzed the month of June, 2001 at the East Center, and listed the numbers of days ditch maintenance was performed, the crew sizes, the numbers of hours expended by crew size, the numbers of sites at which work was performed, and finally, the number of Council Districts within which the daily work was performed. This latter piece of data was not utilized to determine the volume of work performed within a particular Council District, but rather to provide an indirect indication as to the degree to which ditch maintenance work is effectively

routed. For example, a specific crew may perform work at three work sites during a particular day. However, it is an indirect indication of good route scheduling if all three sites are within the same Council District. Conversely, it is indirectly indicative of either poor scheduling or a reactive mode of work accomplishment if the work was performed in three separate Council Districts. The following table summarizes the results of the analysis of the month of June, 2001 at the East Center.

Summary of Ditch Maintenance Work Accomplished at East Center
June, 2001

Crew Size	No. of Days	Total Hours Expended	Avg. Hours per Crew Member (per day)	Number of Sites	Number of Council Districts
2	4	33	4.1	3 days, 1 site 1 day, 4 sites	1 District 3 Districts
3	12	69	1.9	7 days, 1 site 1 day, 2 sites 1 day, 3 sites 2 days, 4 sites 1 day, 4 sites	1 District 1 District 2 Districts 3 Districts 4 Districts
4	2	60	7.5	1 day, 1 site 1 day, 2 sites	1 District 2 Districts
5	13	482.5	7.4	3 days, 1 site 1 day, 2 sites 1 day, 2 sites 1 day, 3 sites 4 days, 3 sites 2 days, 4 sites 1 day, 5 sites	1 District 1 District 2 Districts 1 District 3 Districts 3 Districts 3 Districts
6	2	78	6.5	2 days, 1 site	1 District
7	3	147	7.0	1 day, 1 site 2 days, 2 sites	1 District 2 Districts
8	2	104	6.5	2 days, 2 sites	2 Districts
9	1	27	3.0	1 day, 2 sites	2 Districts

Highlights from the table above include the following points:

- The East Center performed ditch maintenance on 17 days in June, 2001. (Note that the total number of days in the table sum to more than 17, as multiple crew sizes were used on several of the same days in the month).

- There were 9 crew-days on which ditch maintenance was performed at 2 sites. On 7 of these crew-days, the work was performed in two separate Council Districts.

- There were 6 crew-days on which work was performed at 3 sites. On 4 of these crew-days, the work was accomplished in multiple Districts.

- There were 6 crew-days on which work was performed at 4 different work sites. On each of these 6 crew-days, the work was accomplished in multiple Districts, the minimum being 3 separate Districts.

- There was a single crew-day on which work was accomplished at 5 separate work sites. On this day, the work was performed within 3 separate Council Districts.

- There were 17 crew-days on which work was performed at a single site. On these occasions, it is possible to work in only one District.

- In summary, of the 22 crew-days on which work was performed at multiple sites, there were 18 crew-days on which the work was performed within multiple Council Districts.

The above points make it clear that work is being performed in a "scatter-shot" approach, which is symptomatic of simply "putting out fires" as they occur. (It should be noted that since the project team did not have access to the exact locations of the ditches which were cleaned in each of the Council Districts, the possibility exists that work was accomplished within confined geographical boundaries, even as the work effort spanned up to three Council Districts by a single crew. The project team believes this is extremely unlikely given the degree to which crew activities covered multiple Districts. In other words, the likelihood is believed to be very low that on 18 of the 22 crew-days on which work spanned multiple Districts, the work happened to be at the very narrow intersections on the boundaries of these Districts. Further, on 11 of the 18 days in which work was performed in multiple Districts, there was at least one District which was not contiguous with the others within which work was accomplished. In one case, work was performed by a single crew in Districts 1 and 12, which are on opposite sides of the County).

However, beyond the simple reactive nature of the response, there is an equally clear failure to analyze and define the optimum crew size for the accomplishment of this task. As evidence of this observation, note that the table indicates that for the month of June alone, the East Center utilized eight different crew sizes to accomplish its ditch maintenance workload. It is not possible for the project team to determine the optimum crew size for this type of work in Metro, as the numbers of linear feet of ditch cleaned each month are not reported for specific crew sizes.

Recently, another jurisdiction conducted an analysis of the impact of crew size on ditch cleaning productivity. Although that jurisdiction's crew sizes did not vary as greatly as those in Metro, the analysis pointed out some useful results that are directly relevant to Nashville. These can be summarized in the table below.

Summary of Recent Ditch Cleaning Effectiveness by Size of Crew

Crew Size	Feet Cleaned	Hours Expended by Total Crew	Hours Expended per Worker	Feet Cleaned per Person-Hour Expended
3	4,265	124.5	41.5	102.78
4	12,121	497.0	124.3	97.55
5	24,615	878.5	175.7	140.10
6	19,416	744.5	124.1	156.45
7	**16,320**	**663.5**	**94.8**	**172.15**
8	830	66.0	8.25	100.61

Note that the bolded line, corresponding to the crew size of 7, reflects the maximum number of linear feet of ditch cleaned, by crew worker, for each of six different crew sizes. Industry practice indicates that ditch cleaning, like many other functions performed in public works operations, displays varying levels of productivity per worker based on the crew sizes utilized. In the case shown above, there is strong evidence to suggest that, for this particular community, seven crew members is optimal for its ditch cleaning function. This will vary according to the length, width, accessibility and relative cleanliness in Metro; however, the methodology used in determining this optimum crew size should be used for this, and other functions.

The project team attempted to determine the optimum crew size for the Streets and Roads Division's ditch cleaning crews, however the data on feet cleaned were so clearly incorrect that this exercise did not prove valuable. The primary point of this discussion is not to focus strictly upon the ditch maintenance effort, but rather on the importance of establishing work standards,

and to measure results and hold crews accountable for their accomplishment. The project team again stresses the importance of measuring work performed and developing work standards and expected levels of productivity in this, and other, functions and activities performed within the Division. For ditch maintenance, the project team suggests that the Division establish a targeted service level of 140 linear feet of ditch cleaned per person-hour.

Recommendation 2-10. The Division should begin the process of determining optimum crew sizes for each of the functions performed at the Centers, as well as at the satellite locations, based on a standard of 140 linear feet of ditch cleaned per person hour (commensurate with a crew size of five). The implementation of this recommendation will require the Division to allocate time and effort to more than a surface level of analysis. Specifically, although an automated work management system will generate cost data and productivity of labor for certain tasks, it will require a higher level of analysis to perform comparative analyses for various crew sizes to determine the optimum sizes for each tasks. It should be noted that the ditch maintenance functions has recently been slated to transfer out of Public Works. The project team provides a methodology for the analysis suggested in the report for ditch maintenance crews, which would continue to be valid regardless of which department is responsible for the function. This methodology should be extended to other functions in the Division as well. There is no cost associated with this recommendation; we would expect that the benefit of this recommendation would be a greatly enhanced level of productivity both in ditch cleaning and other crew based work such as street maintenance and repair, signs and signals, tree crews, and the like, resulting in greater cost efficiency.

9. THE STREETS AND ROADS DIVISION SHOULD ESTABLISH AN ANNUAL WORK PLAN TO GUIDE THE ACCOMPLISHMENT OF WORK, AND TO ENSURE ACCOUNTABILITY FOR ITS USE OF RESOURCES.

It is common in Public Works operations to assume that the unpredictability of work and work locations makes annual planning infeasible or, at best, a widely varying target. While the basic "unpredictability" assumption is true, it does not negate the value of planning efforts related to historically probable events. The project team has noted the fact that activities are being accomplished in the field, and are being accomplished, in most verifiable cases, cost-

effectively. However, there are at least two issues regarding the accomplished work that the project team raises. These include the following:

- With the exception of contracted work, as well as milling and paving by in-house crews, the activities performed by Special Operations, East and West Centers, appear to be performed almost solely in reaction to requests for services.

- Managers have not actively sought information which would enable them to anticipate workloads, location and timing of services, and staffing needs for the various crews under their supervision.

Although both of the above issues present separate problems, they are related insofar as the lack of historical workload measurement data prevents the establishment of meaningful targeted service levels for the Division. In on-site interviews and data collection efforts, the project team was able to collect certain information from monthly reports which provides limited data regarding such activities as tons of asphalt patch mix used, feet of ditch cleaned, cubic yards of base repaired, square yards of street surface milled, as well as other measures. A reproduced monthly report for the Special Operations Section for January, 2001, is provided in the exhibit on the following page.

Although the information contained in the monthly report is useful to some degree, it fails as a meaningful management tool on several measures. These include the following:

- **The monthly report does not provide information regarding the resources utilized to accomplish the work.** – Note that in the sample reproduction of the monthly form for January, included as an attachment to this report, 1390 square feet of concrete was replaced. In isolation from any other historical data, this piece of information does not reveal sufficient facts about the concrete replacement effort in Metro. For example, it does not reflect the numbers of person-hours expended in replacing the concrete. Nor does it tell managers the locations of concrete replaced, the types of employees used, the crew sizes, the equipment used, or whether it was initiated as part of a targeted effort to ensure all concrete is replaced on a specified time frequency, or whether it was replaced in response to complaints.

- **Information appears to be captured inconsistently between Centers.** – The full extent of this problem is unclear, however the project team noted, in summarizing annual totals of work accomplished, that at least one reported metric is captured differently between the East and West Centers. This metric is the asphalt patching "Square Yards Repaired". It is apparent that one of the two satellite centers reports this data incorrectly, or they both report it accurately using different units of measurement. For example, the West Center repaired a total of 2,270 square yards in 2001, using 2,437 tons of asphalt patch. The East Center reported that it repaired 32,190 square yards, using 1,579 tons. The likelihood is that the East Center is reporting area in square feet (although the form indicates otherwise), however, the error has been allowed to persist.

- **The monthly reports do not relate the metrics to expected levels of productivity.** – This issue relates primarily to the lack of establishment of targeted service levels for each of the major functions performed. However, the lack of service level definition (for example, how often should rights of way be mowed?; how many curb miles should be swept by in-house crews in the Central Business District per day?, etc.) is a symptom of the lack of collection of data regarding daily, monthly and annual production by in-house crews, as well as a lack of comparison to industry standards for such activities as square yards of pavement repaired per day per crew, linear feet of ditch cleaned per day per crew, etc. Therefore, much of the data reported in the monthly reports is of limited value, given that the data are not placed within the context of what was expected, or *planned.*

Roads Division Monthly Report

Center- Special Operations **Month - January** **Year - 2001**

	A.I.M.	Long	Total
Prior month balance	361	70	431
Work Orders completed	316	1	317
New work orders received	155	1	156
Balance	200	70	270
Work orders over 30 days	139	48	187

Patching

	Tons Mix Used
	Sq. Yards Repaired
	Feet Berm

Drainage

	Feet Ditch Cleaned
70	# Inlets Cleaned
	Feet Pipe Cleaned
40	Feet Pipe Installed
	Headwalls Installed
	Headwalls Built

Litter Cleanup

2418	# Receptacles Serviced
60861	Feet Alleys Cleaned
223.2	Tons Debris Dumped
296.66	Feet Alleys Cleaned by Contractor

Base Failures

	Cubic Yards Excavated
	Square Yards Repaired

Emergency Calls

	Tree Calls
	Debris in road
8	HazMat
23	Signs
149	Signals
	Snow Removal
13.5	Tons salt used
88.1	Miles salted
28	Miles plowed
	# Calls

Sidewalks

460	Sq. Feet Repaired
1390	Sq. Feet Replaced
	Sq. Feet New
1	# D/W Ramps
2	# Pedestrian Ramps

Concrete Curb

	Feet Repaired
235	Feet Replaced
	Feet New

Fence

	Feet Repaired
	Feet New

Guardrail

	Feet New
	Feet Repaired

Signs

248	# Manufactured
268	# Replaced
63	# New

Street Lights

11	# Requested
50	# Installed
82	# Removed
	# Relamped

Street Sweeping

838	Miles swept Metro
37	Miles swept contract

	Other		Miles flushed
Milling		**Chipper Service**	
	# Work Orders Completed	1190	# Crew hours (Contractors)
	Square Yards	585.86	Tons
Paving		**Vacant Lots**	
1	# Work Orders Completed	15	Previous balance
	Square Yards	33	New W.O.
16	Tons of Asphalt	20	# Completed
		12	Balance
Markings			
4	# Legends	**Graffiti Removal**	
155860.32	Feet Thermoplastic	3	# Request
19641.6	Feet Paint	3	# Completed within 48 hours
991	Crosswalks		Sq. feet removed
1497	Stop Bars		
		Base Stone	
Shoulders			Tons
	Feet Constructed		
		R/W Trimmed	
Median			Miles
Mowing/Trimmed			
	Sq. Yards	**R/W Mowing**	
			Miles

Related to the last point above, the project team was able to obtain from the Information Services Department of Metro a summary of Automated Inquiry Management (AIM) work orders. Prior to the project team's request, the information contained in the database had not been summarized or analyzed by managers in the Department, but rather the information regarding complaints by Council District, by type of complaint, was input into the AIM system, but not retrieved, other than to report the number of open work orders at the end of the month. It is important to note that a potentially valuable piece of data is available to management in forecasting workloads, yet its value has not yet been fully recognized. The data contained in the AIM summary will be utilized at a later point in the report. The intent of this section, however, is to point out the need for a greater level of focus upon the types of information available and required to create an annual plan of work to be accomplished by the Division.

The exhibit on the following pages provides a guideline for establishing the Division's annual work plan. Note that there are a series of steps in the development of this plan which will require an intensive analysis of activity levels which have been provided on a historical basis. This analysis has not been performed before, and will require Streets and Roads Division personnel to pull activity reports from prior years to establish a "baseline" of effort by task, as opposed to the current method of work accumulation, which relies upon the use of CostSum. Although CostSum may in the future provide certain useful data, it has limitations (as will be discussed below), and the Division should take a more proactive stance in utilizing its available historical data.

Recommendation 2-11. The project team recommends the development of an annual work plan which will not only guide the Division in prioritizing and performing specific tasks, but will provide Department and Metro management with a document with

which to hold the Division accountable for results. This plan should be prepared in coordination with the Engineering Division and signed off by the Engineering Division. This will ensure a comprehensive approach to the management of streets and roads and coordination of maintenance and improvement projects. The Division will benefit from a greater level of accuracy in reporting for cost comparison purposes, which will enable cost savings through procurement of services which are more efficiently provided by contractors. Further, there will be a greater level of accountability for activities, both projected and achieved, which will allow Department management to assess the effectiveness and productivity of staff. The costs associated with the implementation of this recommendation will require a greater level of effort from managerial staff in the planning of effort, and the development of feasible targeted service levels associated with the available physical resources, as shown in the exhibits on the following pages.

It is important to note that the establishment of an annual plan involves a great deal more than simply documenting productivity and calculating what is possible based on the available resources. This annual plan should be seen as a process whereby the concerns of managers of the Division, Department and Metro are incorporated. This will require a series of planned meetings and consultations with various stakeholders and interest groups to best match the Division's resources to those required by the community.

It is important to note that the responsibilities outlined in the exhibit will fundamentally change the focus of Center Supervisors (or, as is recommended later in this report, the Special Operations Section Superintendent, after a reorganization of the Division) from their current roles of field oversight and allocation of tasks to crews, to that of management of personnel, equipment and financial resources through analysis of reports, communication with field supervisors and Division management, as well as cost and workload analysis, in order to ensure conformance with individual plans.

EXHIBIT:

MANAGEMENT REQUIREMENTS FOR THE STEPS IN THE DEVELOPMENT OF AN ANNUAL WORK PLAN

Component in the Development of the Annual Plan	Requirement	Responsibility
1. Identification of Information Sources and Needs	• The Division should analyze the sources of information available in its determination of feasible service level targets. These include, currently, CostSum and AIM, although the daily activity sheets generated by each crew contain valuable data which are not currently summarized. • Work orders should be re-examined and re-designed to ensure the consistent, and comprehensive, capture of activity data between the component Units within the Division.	• Although this step should be initiated by the Asst. Director, it should involve, initially, the Supervisors of the three Centers, and the Traffic Control Manager. The Department Director should be consulted in the process as well, to ensure that information is coordinated among each of the Divisions. • Information Technology Department should be involved in the process, as new software systems may need to be evaluated, as recommended in this chapter.

Component in the Development of the Annual Plan	Requirement	Responsibility
2. Analysis of Historical Trends in Services Provided	• The Division should determine the levels of service which have been provided in previous years in order to proceed to the next step in the process, which is the determination of appropriate "targeted" service levels commensurate with the resources available. As a starting point in this effort, the Division should utilize benchmark targets for those services for which these exist. These can include the work standards presented in this report and the best practices analysis included as an Attachment. • This analysis should result in a historical listing of inputs as well as outputs for each service or activity. Examples include numbers of person-hours expended in, dates and locations of, milling, ditch cleaning, tree removal, vacant lot clean-up, as well as others. • This analysis will require a thorough review of previous months' activity reports in order to extract person-hour data by activity. These data are not currently captured in CostSum. Further, as the report notes, the Division should contact the Information Technology Department to summarize previous years' AIM work order data to establish a basis for making projections of probable work by type, by location.	• Although the mechanical analysis may be delegated to Divisional staff, the effort should be initiated by the Asst. Director in consultation with the Center Supervisors. As previously noted, the Information Technology Department may provide a critical piece of the data for this effort.

Component in the Development of the Annual Plan	Requirement	Responsibility
3.Service Level Needs Analysis	• After the development and presentation of the "raw data" regarding historical trends, these trend data should be matched against available resources to determine the feasible targeted service levels for each activity. Input factors such as optimal crew sizes, required work , probable numbers and locations of citizen requests based on population growth, equipment availability, and others will be utilized in this determination. • The result of this step will be a definition of feasible targeted service levels for each activity type, as well as a priority listing of activities which are most critical for the Division to accomplish. This definition represents the foundation for future analyses which will focus upon the acceptability of the defined service levels, and the resulting refinement of resources needed, or alternatively, the need to reallocate existing resources to higher-priority activities.	• Center Supervisors, Traffic Control Manager. • Asst. Director should provide input into the process to ensure that priorities for work accomplishment are in accordance with Departmental expectations.
4. Identification of Personnel and Equipment Resources Needed to Accomplish Targeted Service Levels	• This step will be the natural result of the preceding step. The Division may, after analyzing historical trends and available staff and equipment resources, find that there is a "mismatch" between feasible and desired service levels. Refinements will be made, and will lead to the next step, which is the development of budgetary needs commensurate with the targeted service levels.	• Center Supervisors, Traffic Control Manager.

Component in the Development of the Annual Plan	Requirement	Responsibility
5. Development of Program Budgets	• This step represents the relatively mechanical process of developing programmatic budgets for each of the activities provided by the Division. It is important to note that this step should entail a routine examination of the feasibility of outsourcing specific functions, either due to the relative cost of in-house performance, or to the inability to accomplish certain tasks, defined in the work plan, with existing resources. • The development of the Divisional budget, therefore, is the result of an analysis of the individual components of the Division's defined tasks and service levels, as opposed to the projected escalation of expenses for the Division as a whole, based on the previous years' expenditures.	• Center Supervisors and the Traffic Control Manager will be responsible for the determination of budgetary requirements for each of their assigned areas of responsibility. • The Asst. Director should be responsible for guiding the process, and for assembling and presenting the final budget package to the Department Director. The Asst. Director will also be responsible for making decisions regarding budgetary reductions, additions or reallocations between service centers prior to the development of the final package.

Component in the Development of the Annual Plan	Requirement	Responsibility
6. Activity Monitoring and Reporting	• The objective is to monitor and evaluate work performance against two standards. First, work should be evaluated against past performance to assure continued progress. Second, work should be evaluated against a final goal, which is achievement of, or exceeding, the industry standards from steps two and three. • Once targeted service levels have been defined, relying upon industry benchmarks as appropriate, with budgets established for each activity, each Center Supervisor should receive weekly and monthly reports regarding work accomplished, work planned, and any resulting variations from the plan. • Variances from the plan must be documented, with a narrative explaining the impact on the Center's ability to accomplish the overall performance targets. • Corrective actions must be defined. These may take the form of budget transfers, deferral of planned work, or outsourcing of planned activities.	• Center Supervisors should be responsible for monitoring of budgets and work accomplishment according to plan, for each of their assigned areas. • Monthly meetings with the Asst. Director should be planned. These meetings should focus on variances from plans, and the corrective actions necessary.
7. Management of Resources	• The reporting of time, activities and expenditures should not be a strictly reactive function. Refinements must be made to the allocation of resources as it becomes clear that problems have surfaced. Examples of problems which may legitimately cause deviations from original plans may include weather related problems, unforeseen employee absences or turnover, or cost/labor issues with contractors.	• Center Supervisors should monitor these issues daily and make refinements.

As the exhibit indicates, the Division of Streets and Roads should establish targeted service levels for each of the activities and services it provides. Further, it should, once these targeted service levels are established, with personnel and equipment resources defined and

procured, report on the planned and accomplished work on a monthly and annual basis. To assist in guiding the process of developing standards and work practices, the project team provides sample documents in the exhibits following this page. Immediately following these two exhibits, the project team provides sample reporting documents which list, for sample activities, a reporting format which outlines planned work and work accomplished on an annual basis.

The project team believes that the lack of the establishment of reasonable targeted service levels, as well as the planning and reporting of work in accordance with these service levels, is a primary recommendation for the Department in its transition to the provision of exemplary services. In the absence of the implementation of this business-oriented approach, the project team believes that only marginal gains are possible.

EXHIBIT:
SAMPLE PERFORMANCE STANDARD FOR THE SPECIAL OPERATIONS UNIT DRAINAGE SECTION

<table>
<tr><td>Activity No.:

D-001</td><td>Activity Name:

Cleaning Culverts and Pipes</td></tr>
<tr><td colspan="2">Description and Purpose:

Periodic inspection, cleaning and removal of debris as required from culverts and pipes, as well as adjacent ditches to ensure proper drainage. This includes, but is not limited to, driveways and entrance culverts.</td></tr>
<tr><td colspan="2">Schedule

All culverts and pipes should be inspected and cleaned (if required) once annually. Typically, this will occur over the spring and fall, however, emergencies may occur throughout the year and should be corrected as emergency dictates, or as other routine, scheduled work allows.</td></tr>
<tr><td>Authorized by:

Section Supervisor</td><td>Level of Service:

Ensure the free flow of water through pipes and culverts through the routine inspection and cleaning at least once annually.</td></tr>
<tr><td>Crew Sizes:

1 Equipment Operator II
1 M&R Worker II

Equipment:

1 Dump truck
1 Backhoe</td><td>Work Method:

1. Place safety signs and devices at work site in accordance with MUTCD standards.
2. Remove debris and any other foreign substance which impeded the flow of water from inlet and outlet channels, restoring original grade.
3. Clean out silted materials from pipe.
4. Check for damage to structure.
5. Report damage and/or need for other scheduled maintenance and repair to Superintendent.</td></tr>
<tr><td>Material:

Sod
Ready mix concrete
Sections of concrete pipe
Other, as required</td><td>Average Daily Production

2 – 6 per day</td></tr>
</table>

EXHIBIT:
SAMPLE PERFORMANCE REPORT

Work Progress Report for Special Operations – Drainage Section
Period: July 1, 2002 – June 30, 2003

Work Activity	Labor Days		Amount of Work		Total Cost		Productivity	
	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
Pipe and Culvert Cleaning	220	221	2,200 linear feet	2,323 linear feet	$43,000	$48,512	14 to 18 per day	18.6 per day
Ditch cleaning	65	67	32,500 linear feet	30,444 linear feet	$39,000	$40,657	500 linear feet per day	454 linear feet per day
Installation of driveway pipe	150	150	21,600 linear feet of pipe	21,830 linear feet of pipe	$108,000	$101,788	One 18' segment per 45 minutes (excludes travel)	One 18' segment per 44 minutes

EXHIBIT:
SAMPLE PERFORMANCE STANDARD FOR THE SPECIAL OPERATIONS UNIT PATCHING SECTION

<table>
<tr><td>Activity No.:

P-001</td><td>Activity Name:

Pothole Patching</td></tr>
<tr><td colspan="2">Description and Purpose:

Patching intermittent areas of roadway surface with hot or cold premix bituminous material and hand tools to correct depressions, edge failures or other potential surface hazards.</td></tr>
<tr><td colspan="2">Schedule

Potholes should be repaired upon discovery throughout the course of the year. Unless the pothole presents an immediate hazard tot he motorist, potholes should be patched only after allowing the surface to dry.</td></tr>
<tr><td>Authorized by:

Special Operations Asst. Superintendent</td><td>Level of Service:

Fill depressions as noted, and in accordance with regular, routine spot checks of all roadway surfaces, both through the pavement condition analysis and through site observations by crews, other Metro employees, and citizen call-ins.</td></tr>
<tr><td>Crew Sizes:

1 Equipment Operator II (Patcher)
1 Equipment Operator II (Roller)
2 M&R Worker I (Hand tools)
2 M&R Worker I (Flagging)

Equipment:

Patch Truck
Roller
Pickup truck</td><td>Work Method:

1. Place safety signs and devices at work site in accordance with MUTCD standards.
2. Ensure that roadway surface is dry and potholes do not contain water or other moisture.
3. Clean out pothole using hand tools.
4. Apply tack coat of asphalt material.
5. Shovel material into potholes, not to exceed 3 inch depth. Tamp each layer prior to placing next layer.
6. Ensure that final layer is flush with pavement after compaction with hand tools or roller.</td></tr>
<tr><td>Material:

Premix bituminous material
Liquid asphalt</td><td>Average Daily Production

12 – 14 patches per day (varies by distance covered) per crew.
8 – 12 tons of asphalt per day, per crew.</td></tr>
</table>

EXHIBIT:
SAMPLE PERFORMANCE REPORT

Work Progress Report for Special Operations - Paving Function
Period: July 1, 2002 – June 30, 2003

Work Activity	Labor Days		Amount of Work		Total Cost		Productivity	
	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
Resurfacing	135	131	67,500 tons	66,484 tons	$2.06 M	$2.04 M	500 tons per day	507.5 tons per day
Pothole Patching	185	177	2,220 patches	1,770 patches	$96,000	$94,585	9 tons per day	8.3 tons per day

10. THE COSTSUM INFORMATION SYSTEM IS FAILING TO PROVIDE USEFUL INFORMATION TO DEPARTMENT MANAGERS.

The Streets and Roads Division of Public Works utilizes the "CostSum" information system to report costs related to each work order. This system has numerous deficiencies in its ability to provide meaningful information to managers in their allocation of resources and planning of work. These include the following.

- **The system reports cost information rather than labor hours.** – After daily time sheets are turned in, Office Managers at each of the three locations convert the hours worked by each of the crew members into a direct cost, based upon the hourly rates pertinent to the position category within which the employee worked that day. Instead of using any internal capacity which CostSum may have, the calculations are being performed manually. These hourly rates are added and multiplied by the numbers of total hours worked on a specific job to derive the direct labor cost attributable to the job. In addition to the time consuming step of manually calculating the direct costs attributable to the jobs, the information which the calculation yields is of questionable value. This is because the direct cost of service provision can be reasonably expected to increase over time as labor rates increase. Therefore, any analysis of the resources needed for specific work types which is based on a historical review will show escalating values rather than labor hours, which should remain stable over time. In other words, increases over time in labor hours for a particular work type may be indicative of decreasing productivity. Increases in direct costs may be attributable simply to increases in hourly rates, and could mask underlying problems.

- **The system reports equipment costs which do not appear to be based on actual costs.** – In addition to the labor costs discussed above, Office Managers determine the equipment costs for machinery and equipment used on jobs. Each piece of equipment has an associated "rental rate" and this rate is multiplied manually by the number of hours the equipment was used on the particular job. These rental rates do not appear to be based on any analysis of actual costs related to repair and maintenance or depreciation rates, but rather have been in existence for many years without an update. Although the recently-completed Fleet Management study addressed this issue, the inclusion of equipment cost, even if accurate, on a per-job basis does not, in the opinion of the project team, provide managers with meaningful information. Rather, equipment costs should be allocated to specific *functions* (e.g., milling, paving, concrete repair, brush removal, etc.) to analyze their cost-effectiveness, as has been done in the analysis of milling operations in the next sub-section.

- **Managers Do Not Appear to Be Utilizing Information Contained in CostSum.** – Discussions with managers in the Streets and Roads Division indicate that the information contained in CostSum is of limited value to them. Further, a request by the project team to retrieve cost information by project code was not fulfilled due to the reported inability of the system to report information in this manner.

In summary, the CostSum system does not appear to be providing useful information to Streets and Roads managers. Further, the input of time sheet data into the CostSum system is time consuming for clerical and administrative personnel at the Centers, and duplicates, to a large degree, the payroll input process for these employees.

Recommendation 2-12. The project team recommends that the Division discontinue input into the CostSum program, as the output is of little value to managers. The Division should, however, begin the search for a suitable job work order system which will facilitate the accumulation of pertinent data, as well as summarize this data for use in the annual planning process outlined above. The costs for such systems vary greatly depending upon desired elements. If the Department is able to expand an existing license agreement with another Metro Department with a suitable information system, the cost could be as little as $25,000 to $50,000. However, if the existing systems in other departments are unsuitable for use in Public Works, the cost could be as great as $350,000 to $500,000 for a new system.

The new job work order system should incorporate the following elements:

- Intake of Calls for Service
- Generation of a Work Order
- Categories and Sub-categories of Work
- Location, Zone or District Notation
- Cost of Materials, Supplies and Other Consumables, including parts inventory
- Cost of Contracted Services
- Staff Hours in Productive Work and Travel Time
- Code for Planned or Emergency Work

- Work Scheduling System Capability

- Inventory of principal work components, including but not necessarily limited to, signs, signals, ditches, street segments, with linkage of work items to each work area. This should either be accomplished internally in the application itself or be linked to stand-alone databases of that information with a query capacity.

- Reporting of individual and crew productivity

- Interface with Geographical Information System

- Preventive Maintenance Alerts

In considering a work order system, Metro should consider several key points. These include:

- The Department of Public Works is not the only Metro department which requires a work order system. Given the investment required in obtaining and implementing a system, Metro should consider this as an application development project for all of Nashville government. As such, the needs of all potential users should be incorporated into a system selection evaluation.

- Metro currently has several initiatives that will impact a work order system. These include the FASTNET implementation, the acquisition of an activity based costing system, and a labor costing system. All of these applications will either generate information that would be needed for a robust work order system or would receive information from such a system. Thus, integration of the applications is essential.

- Metro is acquiring and installation a customer service system for a central customer call center. This system also has a basis work order system. Metro should evaluate whether this system is sufficient to meet the needs of Public Works and other departments.

- While there are numerous vendors of work order and tracking systems, for ease of acquisition and implementation, the obvious starting point should be the J.D. Edwards ERM packages that provide the core of FASTNET. J.D. Edwards has both a straight-forward public sector project management tool; it also has a Manufacturing module that has solid inventory and job order and management systems.

The next sub-section analyzes the adequacy of inventory controls at the Warehouse.

11. CONTROL PROCEDURES AT THE WAREHOUSE SHOULD BE ENHANCED TO ENSURE PROPER ACCOUNTABILITY FOR INVENTORY.

The project team conducted a physical inventory count of 162 randomly-selected items in the warehouse. Conducted on January 7, 2002, this physical count was performed to ensure that adequate controls existed over the items contained in the warehouse. The 162 items selected represented a value of $56,075.37, or 7.7% of the total value of $728,089.42 in inventory on the date of the sample. It should be noted, further, that the total value of items purchased for placement in the Warehouse inventory for the 12 months ending in January, 2002, was $143,054.

The Warehouse includes all non-rolling-stock items for which Public Works crews have operational needs. Examples of these items include wrenches, hacksaws, gloves, caulk, degreasers, electrical cords and many other items. The procedure for checking out items from the Warehouse entails creating a paper ticket denoting the name of the requestor, the item description, item count and date of disbursal. As items are checked out, the counts in inventory are "debited" in the inventory program (an internally-developed system utilizing Qbasic, a DOS-based program), and reconciled against physical counts which are performed annually for the entire stock. In addition to the annual count, the three employees at the Warehouse perform cycle counts once every two weeks on a percentage of the inventory. The results of these routine inventory exercises are presented to the Public Works Department's Business Manager.

A summary of the results of the physical inventory sample performed by the project team is presented in the table below:

Summary of Physical Inventory Sample

Performed January 7, 2002

Range of Discrepancy between Physical Count and Warehouse Record Count	Number
No Discrepancy	104
Count Short by 1 to 2 Items	25
Count Short by 3 to 5 Items	10
Count Short by 6 or More Items	5
Count Over by 1 to 2 Items	13
Count Over by 3 to 5 Items	3
Count Over by 6 or More Items	2
Total Number of Items Sampled	**162**

As is shown in the table, the project team found no discrepancy between the physical counts and the item counts in the warehouse records for 104 of the 162 items sampled, or 64%. However, there were 38 categories for which the project team's physical count indicated a discrepancy of at least 2 items. This could be due in part to the fact that the inventory was being issued throughout the day while the count was being taken. This equates to 23% of the categories. The remaining 13% of item categories displayed discrepancies of greater than 2 items. This degree of inaccuracy in accountability for inventory represents a potential problem for the Division, with the 36% discrepancy rate representing a far greater level than is acceptable. Typically, in well-managed warehouses, this rate will be less than 3%, which allows for an accounting for inventory which has recently been issued but not yet entered into the inventory tracking system.

The results of the inventory sample indicate that certain procedures need to be examined. Although in most cases the discrepancies are relatively small, the numbers of categories for which discrepancies appeared are symptomatic of a potential procedural deficiency regarding the accountability for "returnable" items issued to crew members. It should be noted that, in conducting this inventory, MAXIMUS project staff received an inventory list in the morning and

conducted the actual counts during the afternoon; this would, expectedly, result in some differences in the inventory count.

In analyzing this function, interviews indicated that Warehouse personnel do not routinely check for items issued to crews on longer-term loans. This may account for part of the discrepancy in physical counts and warehouse counts. Further discussion with the Warehouse Manager indicates that the Warehouse had experienced personnel problems over the past 6 months relating to failure to follow procedures in counting inventory items. Reportedly, however, these employees have been terminated, and the Warehouse Manager is optimistic that the problems have been corrected. However, given that the Warehouse is now reportedly performing routine cycle counts of inventory items once per two week period, discrepancies on the magnitude of those documented during the project team's sample count should have been discovered and corrected to a much larger degree than has apparently been the case.

Recommendation 2-13. Based on the above analysis, the project team makes the following recommendations to improve inventory management:

- **Warehouse personnel should make weekly "spot checks" of inventory items which have been issued to Department personnel on longer-term bases. These may include such items as wrenches, shovels, gloves, etc. If items are found to be missing, these occurrences should be documented and the Division Assistant Director should be notified. Additionally, procedures should be established to penalize employees to whom the items were issued.**

- **The results of the bi-weekly cycle counts should be issued to the Department's Business Manager, as well as to the Assistant Director of the Division of Streets and Roads. Explanations for any discrepancy should accompany the bi-weekly report.**

- **Procedures should be established in the Warehouse which will decrease the rate of discrepancy from current unacceptably high levels to no more than 3% at a single point in time.**

- **The Department should also modernize its inventory software system, which is currently an older, limited capacity system. Since inventory items track primarily to the Department's streets and roads operations, it would be appropriate to incorporate the inventory management into the recommended job work order system previously discussed. The costs for this would be included in the cost of the work order system.**

While there is no cost implication to these recommendations, the project team believes that the implementation of the above recommendations will establish a degree of accountability for the inventory that is not currently present at the Warehouse.

The next issue analyzes the effectiveness of communicating utility cut information to the Technical Services Unit of the Streets and Roads Division

12. THE DIVISION SHOULD REVISE ITS POLICIES AND PROCEDURES FOR ENSURING THAT ROADWAY DAMAGES ARE REPAIRED, WITH THE TECHNICAL SERVICES UNIT OF THE DIVISION ADVISED AFTER EACH DAMAGE OCCURRENCE AND REPAIR.

The project team noted in interviews that the permitting process may result in inadequate attention to ensuring that utility cuts are performed in accordance with Metro standards. In obtaining permits for road cuts, contractors and utilities obtain permits through the Engineering Division, and are assessed a "Damage Assessment Fee", which is based on the age of the surface of the roadway segment. After this point, the contractor is responsible for ensuring that the road segment is repaired after the cut. There are at least two concerns regarding this process. These are as follows:

- The project team has discerned no formal procedure to ensure that the road cuts are performed. Further, if they are completed, there is no oversight of the process to ensure that these repairs are performed in accordance with Metro standards. Interviews do not indicate that this latter concern is an issue at the current time, however, the lack of a formal procedure is of some concern to the project team.

- After road cuts are performed and repaired, there does not appear to be a formal notification process to the Technical Services Section of the Streets and Roads Division. This lack of notification could, in theory, result in road segments which have a far lower pavement rating than are in the IMS rating system software. This

in turn could result in the incorrect identification of road segments which are most in need of resurfacing each year.

Recommendation 2-14. The project team recommends that the current policy be revised to establish the Department of Public Works as the sole agency responsible for repairing all roadway damages, regardless of origin or cause. Those individuals or agencies receiving permits for roadway cuts should, at the time of purchasing the permit, pay a fee sufficient for Public Works to repair the cut. This variable fee should be assessed based on the proposed magnitude of damage. Once the cut is repaired, Technical Service should be notified, with that Unit making the appropriate revision in the pavement management system. Although data do not exist currently to estimate the fiscal impact of the imposition of this fee, the cost to the Department will be recovered from the utilities and other contractors.

The next issue provides a preliminary analysis of the methods currently utilized to identify street and road segments for repaving.

13. THE DEPARTMENT SHOULD AMEND ITS METHOD OF IDENTIFICATION OF STREET SEGMENTS FOR REPAVING.

The Technical Services Unit of the Streets and Roads Division utilizes the IMS pavement management system for identifying those road segments which are in greatest need of repaving. This system, administered privately by IMS, ensures the physical re-evaluation of each road segment within Metro once every five years. The Technical Services Unit collects data throughout the year regarding road damage incurred through physical observations, notices of utility cuts, analyses of base failures, and other methods. The Unit runs scenarios on the probable effect of expenditures on the repaving of streets on the overall Metro street condition index, as well as on those of specific Council Districts.

It must be noted in this analysis that, during the period of the project's on-site activities, the Technical Services Unit was informed by IMS that it had noted errors in the calculations of many of the pavement condition ratings contained in the system. The project team understands that these data errors are being corrected through the combined efforts of IMS and the Technical

Services Unit. The project team considered these developments, and attempted to determine the magnitude of their effects upon the validity of the analysis of the pavement management system and the Department's use of the system in determining the identification of street segments for repaving, and believes that, although there are errors of unknown magnitude in the data, there are meaningful conclusions which can be made regarding the use of the pavement condition ratings.

For these reasons, the project team believes that a valid analysis can be made regarding the Department's use of the pavement condition ratings, even as they currently exist. This analysis is presented in the paragraphs below.

Interviews indicated that, although the pavement condition rating influences approximately 80% of the decision regarding which road segments are repaved in Metro, the other 20% is based on Council member identification of specific road segments within their respective Districts which need repaving. The project team, in attempting to determine the effectiveness of this methodology, analyzed all road segments which were paved, as well as those which were not paved during 2001**.** The results, summarized in the exhibit on the following page, indicate that, at least on a cursory analysis, the method is succeeding in its overall purpose, as the weighted average rating (i.e., road ratings are "weighted" according to the length of the road segment being analyzed) of the roads which were actually paved in 2001 was 60.7 prior to repaving. Conversely, those road segments which were not repaved had an overall pavement condition rating of 78.1, indicating that, generally, the road segments which are being resurfaced are in greater need than those which are not being resurfaced.

A closer analysis of individual ratings of road ratings indicates that, of the 893,409 linear feet which were paved last year, 194,087 feet had pavement condition ratings of at least "72",

which represents a relatively high condition level. It should be noted that, of these 194,087 feet, there were reasonable explanations for 99,733 feet of repaving. These explanations include repaving certain segments to ensure conformity with adjacent repaved road segments, repaving utility cuts, repairing severe base failures, and other reasons. The remaining 94,354 repaved feet with ratings equal to or over 72 represent over 10% of all repaved street mileage.

On the other hand, there were 801,851 linear feet of roadway which displayed pavement condition ratings below "60" which were *not* designated for repaving. The project team did not identify the reasons for the decisions for not paving these road segments, although it is very possible that utility companies have placed "holds" on some portion of these. This reason is not likely, however, to account for the majority of this number, which represents about 152 miles.

SUMMARY OF STREET SEGMENTS PAVED AND NOT PAVED BY COUNCIL DISTRICT, 2001

District	Lengths (ft.) Paved in 2001	Weighted Avg. Rating of Streets Paved in 2001	Lengths (ft.) Not Paved in 2001	Weighted Avg. Rating of Streets Not Paved	Percent of Street Segments Paved in 2001	Street Lengths with Ratings <50 Not Paved	Percent of Streets with Ratings <50 Not Paved
1	37,484	62.3	753,384	82.3	4.20%	9,371	2.6%
2	45,739	60.9	255,210	70.7	5.12%	29,498	8.2%
3	25,154	75.4	314,361	77.9	2.82%	7,717	2.1%
4	14,055	60.6	267,350	73.8	1.57%	12,394	3.4%
5	4,294	52.1	221,974	78.6	0.48%	4,314	1.2%
6	4,990	52.3	213,937	74.7	0.56%	9,554	2.6%
7	20,028	64.8	240,624	75.3	2.24%	5,508	1.5%
8	19,510	67.1	236,981	77.4	2.18%	6,803	1.9%
9	19,064	67.5	289,731	77.8	2.13%	21,354	5.9%
10	61,282	55.2	319,204	78.0	6.86%	0	0.0%
11	43,530	60.6	297,135	81.0	4.87%	1,977	0.5%
12	23,826	76.3	329,599	79.7	2.67%	0	0.0%
13	12,469	70.1	245,818	78.5	1.40%	0	0.0%
14	5,455	67.2	237,707	82.3	0.61%	0	0.0%
15	17,327	70.4	481,707	79.5	1.94%	1,636	0.5%
16	9,493	68.2	284,921	81.0	1.06%	0	0.0%
17	7,577	66.0	206,274	84.7	0.85%	2,238	0.6%
18	17,747	62.4	127,774	79.2	1.99%	4,436	1.2%
19	23,046	72.4	284,162	78.0	2.58%	4,135	1.1%
20	0	N/A	286,862	78.1	0.00%	1,937	0.5%
21	24,346	47.3	262,442	71.9	2.73%	30,724	8.5%
22	9,848	52.5	215,259	79.8	1.10%	16,179	4.5%
23	75,076	60.0	342,922	74.8	8.40%	23,084	6.4%
24	61,976	52.3	268,611	70.2	6.94%	56,393	15.6%
25	60,794	49.5	224,631	76.2	6.80%	6,305	1.7%
26	6,839	61.8	217,088	80.7	0.77%	2,386	0.7%
27	21,365	63.9	226,578	80.5	2.39%	4,604	1.3%
28	12,224	68.9	251,968	77.7	1.37%	8,753	2.4%
29	34,596	68.6	357,018	77.6	3.87%	21,588	6.0%
30	21,084	61.2	169,790	81.0	2.36%	1,139	0.3%
31	33,977	66.3	329,793	82.5	3.80%	2,594	0.7%
32	19,324	59.8	278,902	80.1	2.16%	6,137	1.7%
33	39,826	53.4	199,759	77.1	4.46%	11,142	3.1%
34	49,943	58.5	173,336	75.6	5.59%	9,260	2.6%
35	10,121	54.3	351,678	73.9	1.13%	37,722	10.5%
Total	**893,409**	**60.7**	**9,764,490**	**78.1**	**100.00%**	**360,882**	**100.0%**

In further analyzing the street segments which were and were not paved in 2001, the project team noted that five of the 35 Districts (Districts 10, 23, 24, 25 and 24) received approximately 35% of all road surfaces which were paved, yet represent only 15% of the linear feet of roadways in Metro. Conversely, as the exhibit shows, the five Districts (Districts 2, 9, 21, 29 and 35) which contained approximately 39% of all of the road segments in the system with pavement condition ratings less than 50 received only about 15% of all of the road surfaces paved in 2001. (It should be noted that District 24, one of the five Districts receiving most of the paving in 2001, also contained 15.6% of road segments with pavement condition ratings less than 50 which were *not* paved).

The project team's data analysis indicates that the current method of identifying road segments for repaving needs refinement to ensure that the overall Metro road condition index is maximized. The current decision method purportedly places greatest weight on the pavement condition index; however, as has been shown above, there are numerous exceptions. On the other hand, there is reportedly some weight given to the wishes of individual Council members in identifying road segments for repaving, although as the exhibit in this sub-section shows, there are large variances in the numbers of linear feet repaved in individual Council Districts.

Recommendation 2-15. The project team recommends that, once each of the pavement condition ratings is corrected in the system, with sufficient procedures developed and implemented for the retention of backup data, the Department utilize only the pavement condition ratings as the source for identifying street segments for repaving, with the objective being to maximize the overall pavement condition rating of Metro streets. Although there are legitimate reasons for resurfacing streets segments which display pavement ratings greater than 70 on occasion, these should be minimized. It is therefore recommended that, in absence of compelling reasons to resurface segments greater than 70 (such as to ensure even quality with adjacent segments recently resurfaced, repairing utility cuts, etc.), that the Streets and Roads Division discontinue the resurfacing of streets with pavement ratings which are 115% more than the average rating of all streets recommended for resurfacing. The benefit to Metro from changing this procedure is in the

maximizing of the overall street condition, as opposed to those street segments in selected Districts. This has a further benefit in the overall convenience of motorists.

Recommendation 2-16. Nashville may wish to consider a more encompassing approach to planning its streets and other public work services by dividing the City according to maintenance districts. While there is no cost to this change, it would result in a more effective maintenance program by creating a consistent division of responsibilities, and improved work planning and tracking. The Department should also work with other Metro departments to utilize maintenance districts county-wide.

While many communities have the ability to report work activity by councilmanic district for informational purposes, the industry standard is to use districts that are aligned by public works need for the purposes of scheduling and carrying out work. These districts are based on such considerations as physical contiguity, similarity in size and characteristics, natural boundaries, normal traffic flow based on traffic collection and thoroughfares. Examples of well regarded communities that use maintenance districts are Phoenix, San Diego County, San Antonio, and Charlotte.

The advantages of such an alignment would include having a fixed set of boundaries rather than districts that change every ten years, a natural flow of work, and a greater emphasis on area needs and coordinated improvements. The project team encourages the City to give strong consideration to this option as it conducts its next rounds of street evaluations and its capital planning. It would be appropriate to consider the development of maintenance districts in coordination with other Metro departments that have similar responsibilities.

The next issue analyzes the effectiveness of the current organizational structure of the Streets and Roads Division.

14. THE STREETS AND ROADS DIVISION SHOULD ALTER ITS CURRENT ORGANIZATIONAL STRUCTURE TO PROVIDE A GREATER DEGREE OF FLEXIBILITY AND STANDARDIZATION.

As has been noted, the Streets and Roads Division is comprised of work centers in Traffic Control, Technical Services, Parts Warehouse, Special Operations, and the East and West Centers. Each of these Units reports to the Assistant Director for Streets and Roads, and is managed individually by a Superintendent (Special Operations), District Supervisor (East and West Centers), Manager (Traffic Control), Supervisor (Parts Warehouse), or Coordinator (Technical Services). In analyzing the work functions performed under each of these separate entities, the project team poses two separate, but related, questions. These are as follows:

- Does the Streets and Roads Division accrue operating efficiencies through the current grouping of functions?
- Are there functions, currently separate, which could be grouped under a single management structure to gain greater efficiency at less cost?

The project team poses and answers a series of questions related to these issues in the following text. These questions, along with related discussion, are listed below:

- **Functionality of the organization – are like functions grouped together?** – Although there are few opportunities for cross-utilization of personnel between the Traffic Control and Technical Services sections with those in Special Operations and the Centers, each of these separate organizations does, in fact, have as its primary focus the maintenance and repair of Metro's streets and roads infrastructure. The case may be made that the Parts Warehouse has no direct correlation with these activities, however, it functions in a supporting role, with its primary "customer" being Special Operations and the two satellite centers. Therefore, the preliminary indication is that the functionality of the Streets and Roads Division is well-served through the current grouping of organizations.

  Although the Technical Services Unit of the Division is responsible for the identification of roads for repaving, through use of the IMS Pavement Condition Rating system, it has very limited interaction with other units in the Division. Observations, as well as the experience of the project team, indicate that this function has a greater degree of contact with the Engineering Division, in that it

relies upon a high degree of communication between the two functions to ensure that roadway cuts are input into the system. As Engineering is the Division responsible for the permitting of these roadway cuts, the combination of these functions may provide benefits to the Department.

- **Is the structure designed to make daily management of the organization efficient and effective?** – Again, the differing focuses of three of the component sections (Technical Services, Traffic Control and the Parts Warehouse) indicates that it is optimal to retain these as separately-functioning organizations. It is another matter as to whether these organizations should be placed organizationally under a separate Division; however, as noted above, these functions all have as their primary underlying focus the maintenance of Metro's streets and roads infrastructure. This particular argument does not exclude the possibility that the Public Works Engineering Division should be organizationally grouped with these functions as well, however, as noted below, there are other factors that mitigate against it.

  The grouping of Special Operations and the East and West Centers should be approached differently, however. In interviews, the project team inquired as to the logic behind which activities fall under the responsibility of each of these separate organizations. The most common response to this question was that those functions which are performed in all areas of Metro are performed under the supervision of Special Operations. Further, those functions, such as milling and paving, which require a substantial capital investment, are performed under Special Operations, as it is both cost-prohibitive and inefficient to perform these particular services in multiple locations. It follows, then, that the work performed at the Centers is that which is least costly to perform, with the lowest level of skill sets, and that which is performed routinely enough that travel distances are minimized.

  Laying aside, for the moment, the preliminary finding that there is evidence to contradict the assertion that travel distances are minimized through accomplishing certain work activities at the two Centers (see the issues related to ditch cleaning productivity, and the potential inequity of work distribution between the Centers, above), the organizational structure itself does not appear to be conducive to efficient and effective management. The "separateness" of these three organizations does not in itself prohibit the sharing of personnel and equipment resources, but it is also true that there is little evidence that this is occurring (see the discussion, above, related to the degree of personnel transfer between East and West Centers in the month of June, 2001). Further, there is little evidence that the current fragmented structure is fostering proactive management of crew time and productivity, nor the establishment of unit service levels and planning of work to be accomplished.

- **Is the manager of the organization able to manage the number of functions under the Division?** – There are few enough functions under the supervision of the Assistant Director of Streets and Roads that this is not an issue at that level. The question, then, is whether it is feasible to combine certain functions which are currently separate. In this regard, the project team raises the issue of the possibility of combining Special Operations with the two satellite centers. The issue of organizational consolidation should be viewed separately from the question of the optimum number of satellite stations. Rather, the questions should be, "Is the Streets and Roads Division gaining any efficiencies through the two extra layers of Center management?", and "Would a single manager be able to more effectively manage the functions currently performed under these three separate organizations?" The answer to the first question is, in the opinion of the project team, the simpler one. If it is assumed that the primary functions of management are to plan and schedule work, and to ensure accountability within the organization that the work is completed in accordance with a pre-established plan, the answer to this first question must be that the Division is not realizing a maximum return on its investment in managerial staff at these levels. The answer to the second of these questions, although more complex, would also seem to indicate that a single manager would be more effective. If it is assumed that one of the primary factors underlying the placement of the two satellite centers was that the functions performed in these outlying locations require lower skill sets than those in Special Operations, the addition of lower-complexity functions would not pose a large obstacle to organizational consolidation.

- **Have the skills of individuals been recognized in the development of the organizational structure?** – Clearly, the skills of the managers and supervisors of each of the component sections of Streets and Roads have been recognized and accommodated in the organization of functions. The project team does, however, raise the question as to whether the Streets and Roads Division is the optimal location for the development, issuance and oversight of asphalt paving contracts. Although Streets and Roads is, in the opinion of the project team, the appropriate organizational location for the determination of street segments for repaving, as well as the functional accomplishment of this effort, evaluation of technical specifications contained in bids, and the financial and contractual oversight of the performance of the work, are typically functions performed outside the purview of a Streets Division, as functional knowledge is generally greater in the Engineering Division.

The weight of the discussion, above, indicates that the Streets and Roads Division would benefit from the consolidation of East and West Centers with the Special Operations Unit of the Division. These benefits include the following:

- A greater degree of flexibility in transferring personnel among functions. Consolidation of the currently-separate units will allow a single manager of the Unit to identify those activities which are at greatest risk of falling short of attaining goals stated in the annual plan, and transfer sufficient resources to that area.

- A more consistent approach to the development of targeted service levels, and the reporting of work accomplished. As has been noted numerous times in this report, there are many examples of inconsistent reporting of work accomplished between Centers on a monthly basis. Many of these instances have been allowed to stand for apparently long periods of time. The consolidation of these Centers would ensure that a single approach is developed and reported.

- A greater degree of cross-training among employees. As a single manager has greater flexibility in personnel transfer to those areas which are experiencing shortages, the affected personnel will develop a greater level of skill in more areas, therefore increasing productivity overall.

Recommendation 2-17. The project team recommends that the Streets and Roads Division consolidate the East and West Centers with the Special Operations Unit. The Division should retain the two satellite locations; however these should be under the direction of a single manager, and utilized as staging points to minimize travel time to work sites. The consolidation of the three currently-separate units into a single organization will allow the reduction of the two M&R District Supervisors The project team recommends the retention of two M&R Supervisors at each Center to manage and provide field supervision of the crews, to receive and disseminate work orders to the appropriate crews, and to oversee the activities of the clerical and administrative staff at those locations. The annual cost savings attributable to this reduction are approximately $104,753.

The following table provides the calculations for the estimated cost savings:

Cost Savings Attributable to the Reduction of East and West Center Management Staff

Position	Positions Eliminated	Salary at Midpoint	Extended Salaries at Midpoint	Benefits (at 30%)	Total Direct Cost
M&R Supervisor	2	$40,289.60	$80,579.20	$24,173.76	$104,752.96
Total	**2**	$40,289.60	**$80,579.20**	$24,173.76	$104,752.96

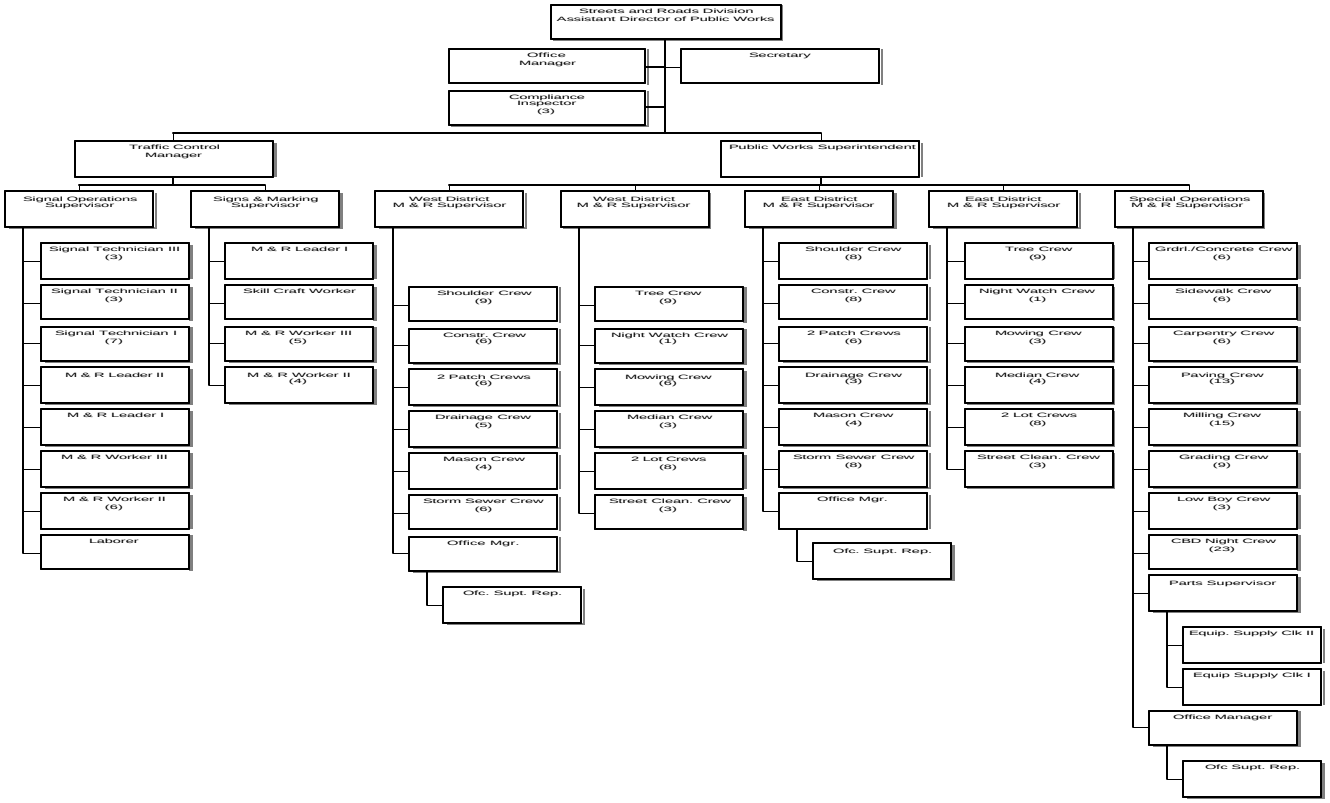
Additionally, the project team recommends that the Technical Services Unit of Streets and Roads be transferred to the Engineering Division in order to ensure adequate communication of roadway cuts through the permitting process. Further, the project team also recommends that

the Department transfer the responsibility for paving contract bids and management from Streets and Roads to the Engineering Division. This also provides greater impetus to the recommendation to transfer Technical Services to Engineering, as Technical Services maintains technical aspects of the bids currently. This recommendation is discussed in greater detail in the Engineering Chapter of this report.

The recommended organizational structure for the Streets and Roads Division of Public Works is presented on the following page:

RECOMMENDED ORGANIZATION

STREETS AND ROADS DIVISION



The next chapter provides an analysis of issues which the project team has identified in the Chipper Service Section of the Division of Waste Management.