10. MAINTENANCE AND OPERATIONS

as of 7/27, need to check CTC concepts, and get red lines of changes from MCDOT.

Introduction

The physical maintenance of a highway has been described by AASHTO as: *"The preservation and upkeep of a highway, including all of its elements, in as nearly as practicable its original as-constructed condition or as its subsequently improved condition."* It can, therefore, be said that the condition of the highway is a measure of maintenance quality. AASHTO defines traffic services as: "*The operation of the highway facility and the services incidental thereto to provide safe, convenient, and economical highway transportation.*" The legislative authority of a county to maintain county roadways has been discussed in Chapter 4, Role of Board of Supervisors and is expressed in A.R.S.§11-251 and A.R.S.§18-201. This chapter discusses legal implications regarding maintenance and operation programs and emphasizes important elements in such programs.

Legal Implications

Arizona counties are frequently confronted with lawsuits as a result of alleged road defects or allegations with respect to signing and road conditions. Even when lawsuits are won, the costs and the effort, which go into the defense of such cases, are formidable. It is becoming increasingly important to train highway personnel about the causes of the growing number of lawsuits and to take steps, which will reduce the number and amount of judgments as well as the cost of defense in these types of law cases.

Establishment of Formal Road and Sign Program

It is essential that each county establish a formal road and sign inspection and maintenance program. The county attorney should be ~~**solicited**~~ **asked** to provide advice and guidelines regarding the laws involved.

It is also important to keep and maintain records with respect to maintenance of roads and signs. One of the most difficult problems faced in the defense of ~~**these cases**~~ **lawsuits involving these issues** is that, quite often, ~~**the facts are meager or there are no maintenance records.**~~ **maintenance activities are not documented well or that records are not kept. The lack of documented factual information can require the use of "recollections" of employees and witnesses. These recollections are often inadequate evidence.** ~~**This results in calling upon either employees or witnesses with respect to their recollections. This is often inadequate evidence.**~~ Sign records can be kept **in a** ~~**on**~~ computer **database or** in card files and should include every new installation and **maintenace activity.** ~~**repair.**~~

Public Education

A public campaign can be used to educate the public about vandalism, and the need for reporting alleged defective roads or sign conditions. It should provide awareness about the problems associated with the maintenance of roads.

Coordination

Coordination and cooperation between the county highway department and the **Sheriff's Department (or local municipal police department)** ~~**local police officials**~~ is **very important.** ~~**critical.**~~ The ~~**police**~~ **Sheriff's Department** can be very helpful in the initial investigation of cases, which may result in **law**suits against the county. A very thorough investigation and preservation of evidence can be crucial to the defense of a case. With cooperation, the Sheriff's Department can furnish the highway department officials **with timely** notification ~~**as soon as possible**~~ of defective road conditions or crashs involving defective road conditions. **Sheriff's Department** ~~**Police**~~ officials should also be advised to report only the facts in their reports of crashs, **but** ~~**and**~~ not to ~~**surmise possible**~~ speculate as to the causes of crashes without sufficient supporting facts. In recent years, counties have had to defend ~~**cases**~~ **lawsuits** that where the **Sheriff's Department** ~~**police**~~ **staff** inaccurately reported that signs were defective in some manner or that road conditions caused the crash.

Coordination of legal effort is also necessary. It is important in the defense of lawsuits against the county for all attorneys involved - county, state, insurance companies, etc. - to coordinate their efforts ~~**and put forth**~~ **to support** the same defense.

Inspection Program

Lack of maintenance, improper maintenance and failure to make timely response are probably the most common reasons **for alleging county liability.** ~~**assigning liability to a county.**~~ Once a road has been constructed or a **traffic** control device installed, county maintenance personnel must maintain it properly. Defensible inspection and maintenance programs assist in reducing the occurrence of lawsuits against the county. Good maintenance records are a tool in defending against a lawsuit. **In addition to maintaining accurate records of all maintenance activities,** ~~**the good maintenance records required of daily activities,**~~ it is necessary to accurately record ~~**to have a complete record of**~~ all alleged road or signing **problems** ~~**faults**~~ that come to the ~~**organization's**~~ **county's** attention and the action **taken** to correct them. Records of these occurrences should include **the origin of** ~~**who made**~~ the complaint, the time it was received by the dispatcher, the time it was given to the repair crew, the time the repair crew responded, the time the repair was completed, ~~**what trouble was found including other**~~ **any** defects found by the maintenance personnel, ~~**what**~~ **the** repairs ~~**were**~~ made, and the ~~**what**~~ materials ~~**were**~~ used. All such information will assist the defense attorneys in tort liability actions.

In many cases (Walker v. Coconino County, City of Phoenix v. Kenly, Matts v. City of Phoenix) a county is negligent if it knows, in the exercise of reasonable care, about a defect and fails to correct it.

Common Elements of Maintenance and Operations Programs

~~**Realistically,**~~ County highway departments do more than just perform ~~**pure**~~ **routine** maintenance functions in conformance with the AASHTO definitions. The expenditure of highway funds for these activities should be fully understood by both the public and by county officials. All work performed by the county highway department personnel should be defined in specific programs. Definitions of typical programs and their categories are summarized below.

Maintenance (per AASHTO definition)

- Preventive
  - Potential failures are identified and work, materials, and methods are applied to prevent failure from occurring.
  - Renewing the physical resistance to deterioration from abrasion, loads, water, sun, and etc., further considered as normal wear and tear and weathering.
- Corrective
  - Repair of physical structures or material failures.
  - Reconstruction of storm damage or natural catastrophes.
  - Reconstruction of inadequately designed facilities.
- Operational
  - Housekeeping - mowing, vegetation control, cleaning, sweeping, litter collection, etc.
  - Snow and ice removal and control.
  - Traffic device maintenance - striping, signing, and signalization.

Betterments

A "betterment project" is a single project at a specific location for the purpose of improving an existing facility or structure. A betterment project may, for instance, add a few feet of pavement width without changing the original pavement structure; enlarge a culvert capacity; or widen or realign a sharp curve. A betterment project will improve an existing facility for a defined purpose, such as adding safety or capacity. However, it is not a repair project nor is it construction of a whole facility.

Rehabilitation

Rehabilitation defines an action that will make an existing portion of a highway or a major structure "like new". Thick full width overlays of an asphalt concrete pavement or removal, recycling and replacing an asphalt concrete surfacing are examples of a rehabilitation project. Rehabilitation normally does not add capacity or improve grade lines. It renews existing roadway **pavements to a "like-new"** ~~**to top**~~ condition.

Construction

"Construction" **means** ~~**is**~~ to build or to **rebuild** ~~**reconstruct**~~ ~~**a whole**~~ **the complete** highway facility. It includes all of the highway structure and its component parts.

Work for Others

Most county highway departments perform various forms of activities not on the highway system for others. Since highway-dedicated funds by statute cannot be used for such purposes, such projects must be budgeted, and paid ~~**out of**~~ with funds from other ~~**fund**~~ sources.

Preventive maintenance needs, together with betterment, rehabilitation and construction projects can be anticipated, budgeted, and programmed. These functions may be executed by either contract or by county maintenance forces. Corrective and operational maintenance needs are more abstract and the analysis of the activities and costs is a more sophisticated procedure.

Planning and Organizing a Maintenance Program

Planning and organizing might be described as defining the "what, who, how, when, and where" of a highway maintenance program. A work program fully describes the street or highway system and defines **the** ~~**what**~~ kind of work and how much work is needed to keep the system at an acceptable level of **service** ~~**repair**~~ for safe ~~**use**~~ **travel**. The resources required to perform this work must be determined and the expected results defined. The component parts of the work program are as follows:

- Work Activities
- Maintenance Inventory
- Quantity Standards
- Quality Standards
- Performance Requirements

Work Activities

Maintenance work is divided into activities, which have definable and distinct characteristics both from **the** standpoint of the nature or objective of the work, and **from the standpoint of** the work method involved. Only that work which is performed frequently and which requires a significant work effort is identified as a separate maintenance work activity, and is considered a component of the total maintenance program.

Work measurement units for maintenance work activities must be readily identifiable and measurable by field personnel. This will provide a basis for describing how much work is planned or accomplished. Work may be measured in cubic yards, square yards, miles, feet, number, passes or swaths, lane miles, etc.

A maintenance feature is defined as a distinct element of the roadway system for which one or more activities will be required to maintain it in as good a condition as possible with the resources available. A maintenance feature must be definable with work measurement units and

work activities, and must be easily identifiable both in the field and from records or collected data.

Maintenance Inventory

A physical inventory must be prepared that lists all of the maintenance features of the highway or street system requiring periodic maintenance work. This inventory must quantify each item of the highway structure or environment requiring maintenance attention. The first step in preparing an inventory is to establish a ***location identification system***. The state of Arizona uses a milepost system, which is simple but expensive to establish. A simple road section system may be used that defines and numbers a section of road between identifiable objects, locations or features. Post office address systems, if completely organized, may be used or, perhaps, a county coordinate map program may exist. ~~**In any case,**~~ **Regardless of the location reference used,** the location system used must identify and locate each feature on the roadway in an easily understood manner. For ease of documenting maintenance features at described locations, the inventory items may be classified into continuous features (miles, lane miles, feet, etc.) and discrete features (numbers, acres, each, etc.).

Quantity Standards

A quantity standard is a measurement of the average expected production of each work activity. A realistic basis must be developed for estimating the amount of each work activity required during the year to maintain a desired standard of service. When applied to the maintenance feature inventory, quantity standards determine the annual workload.

Performance Requirements

A performance requirement summarizes quantity and quality standards to make a statement about each maintenance activity as it is to be applied to each maintenance feature. The rate at which work is accomplished and the effectiveness, with which resources are utilized, depends on the manner in which crews are staffed and equipped and the work methods employed in performing activities. Performance standards provide a factor to define the resource requirements to perform an annual work program at a predetermined level of service desired. Performance standards for each work activity specify:

- Name and number of the activity.
- Description and purpose of the activity.
- Scheduling emphasis (time of year).
- Work quantity limitations.
- Determination of need.
- The number and classification of personnel required for a typical crew.
- The kinds and numbers of equipment best suited for the work.
- The kinds and quantity of material needed.
- The step-by-step work methods necessary to assure the desired quality of workmanship.

- A realistic estimate of the daily production range expressed in terms of work units to be accomplished (where applicable).

Non-routine Maintenance Programs

As described earlier, there are certain work classifications (betterments, preventive maintenance, rehabilitation and construction) that easily can be done by county forces. These kinds of projects can be budgeted within their own limits and need not conform to the annual maintenance work program design. Such projects can be described as "non-routine maintenance" and might include:

- Projects covering maintenance, which do not occur with enough constancy or frequency to establish performance standards nor to be routinely scheduled.
- Projects to improve roadway safety and appearance.
- Projects to eliminate maintenance trouble spots, and thereby, reduce routine maintenance.
- Projects for initial installation of maintenance features, such as, right-of-way fences, signs, cattle guards, new pavement markings, etc.
- Projects that do not fit routine activity schedules or standards established for the annual work program.
- Special projects requiring individual cost compilation.

Some amount of project work is useful in balancing or leveling **the** resource demand during periods of low seasonal demand in the annual routine maintenance program. Resources for this kind of work must be carefully calculated and provided in addition to resources required for routine maintenance.

Staffing

Most existing county highway departments' staffing **and** organization is the result of a historical growth with annual adjustments made for each budget year, ~~. W~~ with budget preparations normally supervised ~~by cash flow,~~ cost accountants. A normal addition of full-time personnel is analyzed by the limitation of the percent of increase allowed in personnel or in payroll. In some instances, the justifications for additional personnel are ill-prepared and lack objective rationale resulting **in** understaffed highway maintenance organizations.

Using a ~~file~~ **system** of "performance ~~requirements~~ **measures or standards**," ~~one can logically calculate~~ **the necessary** manhours and ~~the~~ equipment ~~complement~~ **resources** required to accomplish an annual work program **can be calculated**. This **calculation can** ~~approach will clearly~~ show that a reduction ~~of~~ **in** the level of work activities **will result in** ~~provides~~ a reduced level of service and will require fewer workers and **less** equipment. Conversely, an increase in the feature inventory (a new road, for instance) or an improved level of service (increase in work activity frequency) will justify an increase in staffing.

Performance Budget

The AASHTO Manual of Uniform Highway Accounting offers this definition: *"...budgeting is a work program, a conversion into money terms of program objectives, and a statement of the resources required to obtain these objectives."*

The annual work program must be expressed in financial terms. The resource requirement of each maintenance activity must be converted into dollar requirements. This requires a compilation of costs for labor, equipment, and materials for all activities.

The specific compilation of individual payroll rates is not necessary. In fact, these rates change during the year with attrition, promotions and other changes. A standard labor rate is identified for productive manhours. The following example will illustrate calculations for a standard labor rate.

Gross man-hours in 52 weeks x 40 manhours/week = 2,080 manhours

Average holiday and leave time:

Holidays = 10 x 8 manhours/day = 80 manhours
Annual Leave = 10.66 manhours/month x 12 months = 128 manhours
Sick Leave = 8 manhours/month x 12 months = 96 manhours

Total average holiday and leave time = 304 manhours

Gross man-hours less average holiday and leave time = Annual productive manhours = 2,080 minus 304 = 1,776 manhours

(The values shown are for illustration only.)

The unit cost of a productive manhour is determined by dividing the total annual expenditure for personnel performing work under maintenance activities, including salaries and employee-related expenses (social security, retirement, industrial insurance, etc.) by the total productive manhours available (number of employees times productive annual hours calculated above). The resulting hourly unit cost should be adjusted to accommodate any increases anticipated during the budget year.

Hourly rates for equipment classes as assigned to maintenance must be established or assumed at some defensible rate (see Chapter 16, Procurement and Management of County Equipment). Material unit costs can be based on actual contract costs or other sources but must be utilized as an annual average unit cost. The unit costs developed are then used to calculate labor, equipment, material, and total costs for a standard crew day of work on each activity listed in the performance standards.

An annual work program is prepared by multiplying each performance standard by the number of times or days it will be applied or scheduled during the year to meet the planned level of service.

By applying the calculated, average crew-day unit costs for all resources to the summation of the crew days for each activity, a total budget is defined. This is called a "performance budget." This proposed budget must be adjusted to include:

- Project budget costs planned (special projects).
- Anticipated increases or decreases in maintenance responsibilities (new miles, bridges, or other maintenance features) planned to come on-line during the proposed budget year.
- Other forecast cost increases or decreases, and any overtime allowance for emergencies or planned overtime.

Work Scheduling

The most effective tool for ensuring efficiency of work performance is the development of work schedules well in advance. The schedule should be based on a work emphasis calendar, which indicates the months of the year **that** the various work activities should be performed (**due to** ~~**because of**~~ **major** weather **events** ~~**occurrences**~~, temperature, growing season, or other seasonal factors). Using the work emphasis calendar, an annual work schedule can be developed to serve as a guide for preparing actual weekly or monthly schedules.

To schedule work activities, each activity should be grouped into categories that reflect the way they are treated: emergency, seasonal, and fill-in.

- Emergency - Work that must be performed as soon as possible ~~**to schedule because of**~~ **due to** a dangerous or hazardous condition.
- Seasonal - Activities directly related to weather **events** ~~**occurrences**~~, growing seasons, ambient temperatures, moisture, or other seasonal factors.
- Fill-In - Activities that can reasonably be performed almost anytime of year when resources are not required for emergency or seasonal work.

A "Maintenance Needed" reporting system will ensure the work scheduling process is also responding to the needs of the highway system. All employees engaged in the highway maintenance work force should report any maintenance needs or problems observed during their workday. In addition, a regularly scheduled inspection of the road network by responsible supervisors will keep the work scheduling process on target with the annual guide schedule. Effective guidelines to scheduling work are contained in the performance standards, the work schedule calendar; maintenance needed reports, the inspection reports, and previous work schedules. Additional factors requiring consideration in preparing schedules are:

- The degree of conformity with performance standards required for each activity.
- The number of **personnel** ~~**men**~~ available for work.
- Weather forecast conditions.
- Availability of equipment.
- Special requirements for work directed by management or the Board of Supervisors.

Maintenance Records

The preparation, collection, and filing of data and records of all highway maintenance activities is the responsibility of all supervisors and managers of a county highway **department** ~~**organization**~~. ~~**Because of fiscal responsibility and the constant exposure to tort liability (see Chapter 5, Function of a County Engineer), the importance of maintenance records cannot be overemphasized.**~~ **Accurate records are necessary as part of the county engineer's fiscal responsibility and his need to respond to the county's exposure to tort liability.**

As part of the ~~**For**~~ fiscal ~~**purposes**~~ **responsibility**, **it is necessary to produce** mandatory reports include employee time reports, equipment utilization reports, and material-use reports. These reports document the **daily use of resources** ~~**expenditures**~~ in performing road maintenance. Employee time reports show name of each employee, attendance or leaves of absence, regular time, any overtime and are used to prepare payrolls and other cost assignments.

Equipment utilization reports should itemize the time of use **and the** miles or hours ~~**consumed of each item of**~~ **of each piece of** equipment utilized on each activity performed. Material reports document the amount and cost of all material used on each activity.

Work activity documentation provides data for ~~**accomplishments compared to planning values**~~ **comparing the work completed with the work planned,** and establishes a record of the efficiency of a work program. Documentation of work activity is also essential in providing factual data as evidence in tort liability proceedings. Work activity documentation reports time (day, month, and year) and location (route or highway name and specific location or area) of each activity performed, and ~~**who performed**~~ the **personnel perfoming** the work. **Some county highway departments** ~~**organizations**~~ have developed reporting formats that register on one document all of the foregoing reporting data for each activity and for each day of the week. The data gathered ~~**from the above-mentioned**~~ can be utilized to develop several types of useful reports to measure or analyze performance, program adequacy, planning values, utilization and program or activity costs. These report capabilities **are** useful in evaluating programs and budget needs.

Maintenance/Construction Work Zone Safety

A significant portion of crashs resulting in liability claims against state and local highway agencies involves maintenance and/or construction work sites. Consequently, it ~~**behooves all involved**~~ is **important for all related** agencies to carefully plan and implement traffic control ~~**techniques in these areas.**~~ measures in these roadway work sites. The five fundamental principles of work area traffic control include:

1) ***Safety***: Maintenance work should be planned and performed with the safety of the driver, pedestrian, and worker in mind at all times and in conformance with accepted standards and procedures.

2) ***Smooth Traffic Flow***: Traffic through work areas should flow as smoothly as possible avoiding frequent or abrupt changes in roadway geometrics, which would require the driver to make rapid or unexpected maneuvers.

3) ***Motorist Guidance***: Drivers approaching and traveling through work zones should be guided in a clear and positive manner through the use of appropriate markings, signs, and channelizing devices to assure adequate warning and delineation of the traveled way.

4) ***Inspection***: Effective inspection of traffic control at work sites includes careful monitoring under varying conditions of traffic volumes, weather, and light to assure the traffic control elements conform to safety standards.

5) ***Maintenance***: During the **duration** ~~**life**~~ of a maintenance project, **frequent repairs and adjustment** ~~**constant attention is**~~ **are** necessary to **ensure that** ~~**make sure**~~ all necessary traffic control devices are in proper working order and are in place, particularly those devices vulnerable to knockdowns, vandalism, or run-off-the-road incidents.

The standards to which traffic control devices must conform are set forth in Part IV of the **Manual of Uniform Traffic Control Devices** (Ref. 2). Guidelines for applying these standards are provided in the **Traffic Control Devices Handbook** (Ref. 4). Examples of a typical work site and plans for a traffic control zone are provided in a later chapter of this manual. Another important reference is the ADOT publication **Traffic Control Manual for Highway Construction and Maintenance** (Ref. 5).

The Arizona Legislature has mandated that ~~**all work on roads, streets and highways utilize proper traffic control devices in A.R.S.§28-650 Warning devices at construction sites:**~~ **proper traffic control devices be utilized on roadway work on all roads, streets, and highways. A.R.S.§28-650 states that:**

> *Any contractor, firm, corporation or political subdivision performing work on roads, streets or highways shall post and maintain at the work site until the work is completed or until such time as the governing body authorizes removal, such warning signs, signals, markers and barricades in compliance with the manual and specifications for uniform system of traffic control devices adopted by the director to warn those using such street or highway.*

It is imperative that proper traffic control be used **to protect the workers and traveling public** when any maintenance work activities are being performed on or near the traveled roadway. ~~**surface**~~. Effective traffic control must satisfy the following needs:

- Command the driver's respect.
- Command attention of the driver.

- Convey a simple but clear message to the driver. ~~of what he is to do.~~
- Allow the driver adequate time to react.
- **Meet a specific need.**

Maintenance Factors

Before any roadway maintenance work begins, there are several factors that should be examined and understood in planning and designing traffic control through **roadway maintenance sites.** ~~areas.~~ These include type of work, location on roadway, time involved to accomplish work, type of roadway, and the speed and volume of traffic.

The type of work is defined in terms of ***stationary operations, moving operations, and mobile operations***. *Stationary operations*, as the name implies, is performed at one specific site such as the repair of a concrete bridge deck. This type of work usually requires rerouting, channelization, or other restrictive traffic control techniques. ~~Whether the job is considered short-term or long-term, it will usually disrupt traffic in some way.~~ **This type of roadway work will usually disrupt traffic flow in some manner, whether the work is short-term or long-term in duration.**

A *moving operation* is one in which workers and equipment move slowly **along** ~~down~~ the roadway. Striping is an example of this type of operation. Truck or trailer-mounted arrow-boards or other warning device moving in front and behind the equipment are usually more effective than ground-mounted signs.

Mobile operations consist of activities that can be completed in a short time at any one location. ~~spot are termed~~ Examples are sign maintenance, litter pick-up, and surveying when only brief stops are necessary.

The location of the work site is very important as there is a **significant** ~~vast~~ difference **in the degree of traffic disruption and hazard among** ~~between~~ work~~ing~~ on the roadway itself, on the shoulder, or just within the right-of-way. Each site location has its own set of safety requirements as well as traffic control procedures. The time necessary to complete the **roadway** work is also important and will depend on the nature of the work to be accomplished and the resources (equipment and crew) available.

The type of roadway must be thoroughly understood in terms of shoulder or curb treatment, number of lanes, and ~~natural~~ sight ~~obstructions like~~ **limitations due to** hills or curves.

The final two critical factors in **determining the necessary traffic control** are traffic speed and traffic volume. ~~The safety problem is obviously~~ **For example, hazards are** quite different for ~~heavy~~ traffic **traveling** ~~moving~~ at 55 mph than for low speed ~~volume~~ traffic on a residential street with a 25 mph speed limit.

Federal Bridge Inspection Requirements

Under federal law, all bridges existing on a public road must be inspected and a report filed with the Federal Highway Administration every two years. The Arizona Department of Transportation (ADOT) is charged with directing the inspection program for all bridge structures in Arizona subject to these federal regulations. All inspections must be performed by **especially** ~~**specifically**~~ qualified personnel must perform all inspections.

Each county is responsible for properly programming the inspection schedule for bridges on their county highway system. The actual inspection activity may be accomplished by the county's own personnel, by a consulting professional engineer, or by the ADOT structural section inspection team under contract to the county. The AASHTO Manual for Maintenance Inspection of Bridges provides detailed guidance on this topic.

Pavement Management System

Implementation and consistent use of a formal "pavement management system" can be a valuable tool in optimizing the cost of roadway pavement. The pavement itself represents one of the larger capital investments in the road system. The objective of the pavement management system is to help develop pavement maintenance strategies that will result in the lowest life cycle cost for a predetermined level of service. Numerous systems are available in the market, from fairly simple to highly complex. Consulting services are also available.

Maintenance Policies for Non-county Roads

Maintenance policies for roads that are not on a county-designated system are described in A.R.S.§28-6705 and A.R.S.§28-6707. A.R.S.§28-6705 allows for maintenance of public roads or streets, which are not, a part of the county designated system, which are not within an incorporated city or town. There are certain restrictions for such maintenance activities such as the expenditure of public funds for certain roadway materials. The complete statute states:

> *A.R.S.§28-6705. Maintenance of public roads and streets not within city or town.*
>
> *A. The board of supervisors may expend public funds for maintenance of public roads and streets other than legally designated state and county highways located without the limits of an incorporated city or town. Before expending public funds thereon, such roads or streets shall be laid out, opened and constructed without cost to the county, and fully completed in accordance with a plat approved pursuant to A.R.S.§11-802 and 11-806.01, and in accordance with standard engineering road specifications adopted by the county board of supervisors to insure uniform compliance.*
>
> *B. Public funds may be expended by the board of supervisors for maintenance of public roads and streets laid out, constructed and opened prior to June 13, 1975 even if such roads and streets were not constructed in accordance with subsection A of this section.*

C. Maintenance on public roads and streets shall not be construed to include purchasing or laying cement or petroleum product materials, except that maintenance on public roads and streets which are paved with cement or petroleum product materials may include seal coating and patching. To reduce long term maintenance costs for maintenance authorized under this section, the board of supervisors may expend monies to add rock products, gravel and processed materials to the base of roads and streets."

The above statute refers to A.R.S.§11-802 and A.R.S.§11-806.01 regarding plat standards. These standards are discussed in Chapter 9, Planning and Zoning.

A.R.S.§28-6707 allows for the maintenance of streets that are within an incorporated city or town. The same requirements apply as are enumerated in A.R.S.§28-6705. A.R.S.§28-6707 reads as follows:

A. That part of a highway lying within an incorporated city or town may through cooperation be constructed, improved or maintained under the provisions of this article in the same manner as if lying without an incorporated city or town.

B. As part of such cooperation, the board of supervisors may enter into an agreement with the governing body of a city or town for the lease of:

1. *County equipment for use to construct, improve or maintain highways located within the boundaries of the city or town.*
2. *City or town equipment for use to construct, improve or maintain roads located within the boundaries of the county.*

In summary, the law does not require the county to perform maintenance of roads that are not on the county designated road system. Such maintenance is clearly a prerogative of the board of supervisors. On the designated system, maintenance is mandatory.

Maintenance policies for non-county roads vary from county to county. Counties with well-developed professional staffs tend to develop such policies in accordance within the legal guidance of the Arizona Revised Statutes. Well ~~**developed**~~ **-qualifed and well-staffed** legal staffs, an awareness by elected officials of lawsuit potential, and a confidence by elected officials in their professional staff ~~**tend to**~~ **will** support a more well-defined policy.

Selected Maintenance Activity Definitions & Work Units

This list of selected maintenance work activity definitions and work units illustrates the varied work activities **that** county highway maintenance entails. The list is by no means complete nor will some items be necessary in all ~~**organizations.**~~ **county highway dpartments.** Records needed to **address** ~~**satisfy**~~ both fiscal and legal details ~~**as well as**~~ **and** planning data should cover any work activity, as illustrated here, that is a substantial cost to perform.

Description of Work Activities	Work Unit
PAVED SURFACE MAINTENANCE	
Hand Patch With Premix - Hand patching of potholes, severe depressions, edge raveling and breaks in road and shoulder surfaces using bituminous premix.	Cubic yards of Premix
Level With Premix - Leveling of badly distorted and rutted areas of the pavement and shoulder.	Cubic Yards of Premix
Fill Cracks - Cleaning and sealing cracks in bituminous pavement with liquid sealant.	Gallons of Sealant
Spot Seal Patching - Patching of short sections or isolated areas of cracked and raveled surfaces with liquid asphalt and cover material.	Gallons of Asphalt and Cubic Yards of Cover Material (or square yards)
Surface/Base Replacement - Removal and replacement of badly cracked and broken asphalt surface and deteriorated base with new material.	Cubic Yards of Material
Seal Coating (Major) - The surface treatment of full surface width on continuous sections of bituminous pavement with one application of liquid asphalt and cover material to seal the surface and to restore surface life, flexibility and skid resistance.	12' Lane Miles
Seal Coating (Minor) - The surface treatment of full surface width on short sections of bituminous pavement with one application of liquid asphalt and cover material to seal the surface and to restore surface life, flexibility and skid resistance.	12' Lane Miles

?? Definition/distinction of "chip sealing"

Flush Coating - An application of emulsified petroleum resin or liquid asphalt to continuous sections of asphaltic concrete as a flush coat to reconstitute aged asphalt, deter surface deterioration and seal surface of new construction.	12' Lane Miles
Spot Flush Coating - An application of emulsified petroleum resin or liquid asphalt to short or isolated sections of asphaltic concrete as a flush coat to reconstitute aged asphalt, deter surface deterioration and seal new surface replacements.	Gallons
Temporary Hand Patching - Make temporary repairs to roadway surfaces using patching materials to eliminate hazardous condition until permanent repairs can be made.	Cubic Yards of Premix
Fill Cracks with Asphalt-Rubber Sealant - The routing, cleaning, filling of cracks in bituminous or P.C.C. pavements to prevent passage of water through pavements and into the base or sub grade.	Pounds of Sealant

GRAVEL AND DIRT SURFACE MAINTENANCE

Blade Gravel or Dirt Roads - Grading of gravel or dirt roads or to restore proper shape and smoothness.	Miles Bladed Pass Miles Bladed
Spot Recondition Gravel Road - To restore sections of gravel surface to original condition by adding additional material as used originally or add a better material if available.	Cubic Yards of Material
Other Gravel and Dirt Surface Maintenance - Miscellaneous gravel and dirt surface maintenance activities.	Manhours

UNPAVED SHOULDER MAINTENANCE

Blade Gravel or Dirt Shoulders - Blading and reshaping of gravel or dirt shoulders and drainage ditches to correct pavement drop off.	Miles or Pass Miles of Shoulder Bladed

Shoulder and Slope Repair - Adding and compacting material to shoulder and slope to eliminate pavement drop off, rutted or eroded conditions. — Cubic Yards

VEGETATION

Swath Machine Mowing - Machine mowing of roadside areas for purposes of controlling weeds, eliminating snow drift lines, and improving roadside appearance. Does not include mowing of lawns. — Swath Miles

Chemical Control of Vegetation - Applying chemicals to vegetation along the roadside to eradicate, prevent or retard the growth of vegetation. — Gallons or Pounds of Mixed Chemical

Tumbleweed Disposal - The removal and disposal of tumbleweeds which have accumulated along fences, in cuts, in and around drainage structures, etc. — Lineal Miles

Tree and Brush Removal - The cutting, trimming and removal of brush and trees which are encroaching onto or overhanging the shoulder of the highway. — Lineal Feet of Shoulders Cleared

Other Vegetation Control - Miscellaneous vegetation control maintenance activities. — Manhours

ROADSIDE

Crash Maintenance and Repair - This activity covers all effort expended by maintenance personnel which occurs as a direct result of a **crash**, ~~**except**~~ **excluding** guardrail replacement, ~~**and**~~ repair, and delineator and milepost maintenance. Examples **of this type of activity** are: — Manhours

A. Roadway surface repair
B. Fence repair
C. Removal and disposal of dead animals
D. Flagging
~~**E. Fence repair**~~
E. Post After-crash cleanup

Full-Width Litter Pickup - The scheduled litter pickup **in** ~~**of**~~ the full width of right-of-way to remove unsightly objects and those potentially dangerous to mowing equipment. — Right-of-way Miles

Spot Litter and Debris Pickup - The removal of isolated areas of debris and litter from the roadway and right-of-way. — Manhours

Crash Guardrail Maintenance - Repair and replacement of guardrails damaged **only by vehicle crashs.**	Guardrail Panels Repaired
Annual Fence Inspection - The inspection and minor repair of right-of-way fencing.	Miles of Fence Inspected
Routine Fence Maintenance - The maintenance and replacing of right-of-way fencing with the exception of repairs required because of **crashs**.	Panels or Lined Feet or Fence Repaired
Cattle Guard Maintenance - Maintaining and repairing cattle guards.	Cattle Guard Grilles Serviced
Urban Curb Sweeping - The sweeping of the curbed portion of the roadway with a self-propelled sweeper in urban area.	Curb Miles
Other Roadside Maintenance - Miscellaneous roadside maintenance **activities, such as:** A. Removal of **graffiti** ~~**marking**~~ on rocks and walls B. Sidewalk maintenance C. Seeding, sodding, and mulching D. Roadside retaining wall maintenance E. Viewpoint maintenance	Manhours

DRAINAGE AND STRUCTURES

Routine Drainage Maintenance - The removal of debris from pipes, boxes, and bridge culverts.	Drain Openings
Emergency Drainage Maintenance - Emergency maintenance of culverts and catch basins, roadway dips and their inlets and outlets.	Drain Openings
Clean Cuts - The removal of material from roadway cuts and restoration of drainage.	Lineal Feet
Minor Slide Removal - The removal of minor rock, or mud as required to ~~**insure**~~ **ensure** drainage.	Number of Slide Areas
Routine Major Structure Maintenance - The repair, maintenance, and cleaning of decks, joints, bridge footings, abutments, wing walls, superstructures and rails performed by maintenance personnel.	Structures
Storm and Rock Patrol - Patrol of roadways during storms	Manhours

and periods of expected rockfall for the removal of rocks and debris from the roadway.

Other Drainage Maintenance - Miscellaneous drainage maintenance **activities, such as:** — Manhours

A. Minor sand drift removal
B. Minor channel and dike repair
C. Occasional blading of crown or diversion ditches
D. Cleaning or reshaping grader ditches
E. Minor riprap and bank protection repair
F. Retaining wall, cribbing repair

SNOW AND ICE CONTROL

Plowing, Sanding and Salting - The plowing of snow and/or application of chemicals and abrasives to the roadway. — Miles

Snow and Ice Patrol - Patrolling critical snow and ice removal areas to determine the development of hazardous conditions requiring maintenance attention. — Manhours

Other Snow and Ice Control - Miscellaneous snow and ice control activities, such as: — Manhours

A. Equipment preparation before storm (mounting plows and spreaders, etc.)
B. Equipment cleanup after storm
C. Mounting and preparation of snow and ice signs
D. Setting up and manning roadblocks
E. Filling sand barrels
F. Removing snow from urban streets
G. Removing snow from bridges
H. Emergency operation of radio
I. Cleanup after storm, sweeping, etc.
J. Mixing salt and cinder
K. Opening or closing ice signs
L. Loader operator for heavy storms
M. Erecting and dismantling snow fence
N. Emergency supervision (other than crew supervisor)
O. Repair and maintain snow fence
P. Repair snowmakers

MAJOR DAMAGE AND DISASTER MAINTENANCE

The type of work covered under this activity are major slides, slip outs, washouts, flooding, structural damage, etc. of an extra-ordinary nature. Damages or failures which are unexpected and are of such size and scope as not to be handled on a routine work activity.	Manhours

LANDSCAPE MAINTENANCE

Lawn Mowing - Mowing of landscaped roadside lawn areas.	Acres
Edging and Trimming Lawns - The edging of lawns along curb areas and the trimming of grass around trees.	Manhours
Trimming Shrubs and Trees - Trimming of shrubs and trees in landscaped areas.	Trees
Fertilize Lawns - Fertilizing of lawns.	Lbs. of Fertilizer
Manual Weed Control - The hoeing, cutting, and hauling of grasses and weeds growing in tree, shrub and ground cover beds.	Weed Units
Chemical Weed Control - The application of chemicals for the control of weeds.	Gallons Sprayed
Manual Irrigation - The watering of trees, shrubs and ground coverings in landscape areas with either a water truck or a manual water system.	**No.** of Waterings
Irrigation System Maintenance - The maintenance and adjustment of all irrigation systems.	Manhours
Policing Landscaped Areas – **Monitoring** ~~**Policing**~~ and removal of litter and debris from the landscape areas.	Landscaped Acres
Fertilizing Trees and Shrubs - The fertilizing of trees and shrubs.	Pounds of Fertilizer

Other Landscape Maintenance - Landscape maintenance activities, such as:

Manhours

A. Insect treatment/rodent control/special plant treatment
B. Repair of berms and basins
C. Sweep grass clippings
D. Removal and replacement of trees and shrubs
E. Mowing weed areas
F. Hand mowing
G. Following day pickup and disposal
H. Removal of dead shrubs and trees only

TRAFFIC SIGNING AND STRIPING

Maintaining Delineators and Mileposts - The maintenance of delineators and mileposts as required to insure readability, visibility, good appearance, and alignment.

Del. & M.P. Units

~~**Paint**~~ **Long-line Striping** **Guidelines** - The painting of ~~**traffic lines.**~~ **dashed lanes lines and solid edgelines.**

Gallons of Paint or ~~**Pass**~~ **Roadway CL Miles**

Special Pavement Marking - Painting of crosswalks, channelizations, and other pavement messages and markings.

Gallons of Paint

Sign Inspection Maintenance and Installation - Inspection, repair and replacement of existing signs and installation of signs.

~~**Sign Work Units**~~ **Manhours & Material**

Other Traffic Maintenance - Miscellaneous traffic and signing activities, such as:

Use Manhours or other appropriate units of measurement

A. Raised pavement marking maintenance
B. Spotting centerline and edge lines prior to striping
C. Sweeping ~~**for**~~ **prior to** striping
D. ~~**Night**~~ Inspection of paint reflectivity **at night**
E. Paint barrel handling and recycling
F. ~~**Night sign**~~ Inspection of sign visibility **at night**
G. Removal of highway paint
H. Washing signs and delineators

GENERAL

Supervision - Planning, scheduling work activities under the responsibility of maintenance.	Manhours
Record Keeping - Assisting the foreman, part-time, in keeping records for maintenance. Not to be used by individuals whose full time duties are clerical.	Manhours
Building and Yard Maintenance - The maintenance of buildings surrounding grounds performed by maintenance personnel, including minor repair.	Manhours
Equipment Servicing - The servicing of equipment performed by maintenance personnel.	Equipment Units
Training - Attending schools, conferences, meetings, films, and training programs for maintenance personnel.	Manhours
Leave - All annual, sick and leave without pay taken by maintenance personnel.	Manhours
Standby - Time lost, 1/2 day or more, due to equipment breakdown, weather or other reasons beyond control. A. Equipment breakdown B. Weather Conditions C. Other Reasons	Manhours
Work for Other Divisions or Departments - Work performed by maintenance personnel outside of their identified **work** responsibility.	Use Manhours or other appropriate units of measurement
Transporting Equipment - The transporting of equipment for use in performing maintenance activities.	Manhours
Material Handling - The hauling and handling of supplies and materials.	Manhours
Work for Equipment Shops - Mechanical work performed on equipment by maintenance personnel and described on an equipment repair order is to be reported on this activity.	Manhours

The work must be performed with approval and under direction of the shop foreman.

A. Transporting **equipment** to and from shop
~~**B. Transporting to turn in**~~
B. Making minor repairs
C. Help equipment shops with repairs
D. Maintenance and repair of shop facilities

Administration and Supervision of Contract Maintenance Manhours

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NON-ROUTINE MAINTENANCE

Non-Routine Maintenance - This activity applies to maintenance work which does not fall under the routine work program: work of a size or scope which does not warrant ~~**letting to contract;**~~ **contracting out;** projects which would improve roadway safety and appearance, **improvements** to reduce routine maintenance, **or to** eliminate maintenance trouble spots; and the installation of new or additional features. Manhours

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MATERIAL PROCESSING

Plant Screening - The screening of material by large capacity plants. Cubic Yards

Making Premix Material - The windrowing, applying liquid asphalt, and mixing. Cubic Yards

Stockpiling Material - The ~~**hauling**~~ transporting and stockpiling of material. Cubic Yards

Screening - Screening of material using a truck screen. Cubic Yards

Straightening Guardrail and Sign Posts - The straightening of bent guardrail or sign posts. Linear Feet

REFERENCES

(Many of these references, and their revision updates, can be accessed or ordered directly on-line at the agency's or organization's internet website.)

1. Highway Maintenance Management Manual, Arizona Department of Transportation, Maintenance Section, Phoenix, Arizona, ~~**v.p.**~~ **1998.**

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3. Pivnik, Sheldon I., Legal Liability in Traffic Engineering.

4. Traffic Control Devices Handbook (GPO 1983 0-409-573), Federal Highway Administration,
Washington, D.C.,~~**1983, vp.**~~ **2001 revision.**

5. Traffic Control Manual for Highway Construction and Maintenance, Arizona Department of Transportation, Traffic Engineering Department, Phoenix, Arizona, ~~**vp.**~~ **1996. Also see 2001**
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6. Transportation and Traffic Engineering Handbook, **5th** ~~**2nd**~~ Edition, Chapter 27, Institute of Traffic Engineers, Washington, D.C., ~~**1982.**~~ **1999.**