APPENDICES

APPENDIX 1
RELEVANT STATE DOCUMENTS

CALIFORNIA MAINTENANCE CONTRACT
Example 1

Article II - Contract Management

Caltrans Contract Manager is Rich Quinley, (916)654-5651.

Article III - Contract Period

This contract shall begin on November 1, 1994, contingent upon approval by the State, and expire on October 31, 1996, unless extended by supplemental agreement.

Article IV - Cost Limitation

A. Total amount of this contract shall not exceed $_____ .
B. It is understood and agreed that this total is an estimate and that the State will pay only for those services actually rendered as authorized by the Contract Manager or his/her designee.

Article V - Scope of Work

Scope of work shall be in accordance with Rider A.

Article VI - Rates

Routine maintenance as described in Rider A shall be reimbursed $_____ monthly for November 1994 thru October 1995 and $_____ monthly for November 1995 thru October 1996, not to exceed $_____ for the contract term.

On Call Service and Repairs as described in Rider A

1) On call repair work authorized by the State, shall be reimbursed at rates stated in Rider B, Service Rate Schedule and Permanent Price List. Rider B is attached hereto and incorporated by reference.

2) All subcontracted work or other costs no included in Rider B, shall be reimbursed at actual costs.

3) Total costs for on-call repairs shall no exceed $ _____ for the Contract term.

4) Contractor shall be reimbursed for transportation and subsistence costs for on-call repair work at the rates shown in Rider B.

Article VII - Payment

RIDER A
SCOPE OF WORK

Contractor shall provide labor and materials to perform routine maintenance and on-call repairs for forty (40) existing Caltrans WIM systems at thirty-three (33) locations throughout the State.

A. Routine Equipment Maintenance

1. Contractor shall check each WIM system covered by this contract. Contractor shall schedule maintenance visits conforming to requirements of section C and shall advise State of such schedule prior to commencing service. Service shall include, but not be limited to the following:

a) visual inspection of frames & weighpads
b) visual inspection of the roadway in the area
c) visual inspection of junction box lids
d) inspection of battery voltage
e) inspection of humidity indicator on the central unit; replace drying agent if needed
f) inspect induction loop indicators and frequencies as necessary
g) inspect and compensate zero-points of weighpads
h) clean cabinet
i) provide a written service report to the State for each site within 10 working days after the service has been performed

2. Software Maintenance. Contractor shall provide software updates and technical support services as may be necessary to ensure that all existing WIM systems and the State's host computer functions as an integrated data collection system.

B. On-Call Services and Repairs

Upon notice by the State that a particular system is malfunctioning, Contractor shall begin on-site repair within five working days of notification, unless State authorizes an extended repair schedule. Contractor shall notify state if lane closures are necessary to perform repair work. Upon such notification, State shall arrange for State forces to set up lane closures and shall notify Contractor as to scheduling of such closures or shall authorize contractor to subcontract for traffic control services. Contractor shall also verbally notify state at a minimum of twenty-four (24) hours in advance as to the schedule of repairs when no lane closure is needed. Contractor shall verbally notify State a maximum of twenty-four (24) hours after completion of repairs.

The Contractor shall provide the State with a written report of the repairs made for each WIM system within ten (10) working days after the completion of the repair work.

C. WIM Systems covered under this agreement:

SITE NO.	SITE DESIGNATION	DIST-CO-RT-PM	NO. LANES	
1	LODI	10- SJ-005-43.7	4	
2	REDDING	02-SHA-005-R24.9	4	
3	ANTELOPE (WB)	03-SAC-080-17.2	4	
4	WHEELER (SB)	06-KER-005-R15.2	2	
5	INDIO	11-RIV-010-R59.4	4	
6	NEWHALL (NB)	07- LA-005-44.6	2	
7	SANTA NELLA	10-MER-005-20.2	4	
8	VENTURA (2)	07- LA-101-37.8	10	
10	FRESNO	06-FRE-099-25.0	6	
11	SONOMA	04-SON-037-2.7	4	
12	VAN NUYS (2)	07- LA-405-42.9	8	
14	SAN MARCOS	11- SD-078-10.7	6	
15	IRVINE (2)	12-ORA-005-25.8	12	
17	HAYWARD (2)	04-ALA-880-14.7	8	
20	LOLETA	01-HUM-101-65.6	4	
21	MOJAVE	09-KER-058-108.1	4	
22	JEFFREY	11-IMP-008-25.8	4	
23	EL CENTRO	11-IMP-008-40.0	4	
24	NAPA	04-NAP-012-2.3	2	
25	NEWBERRY	08-SBD-040-28.9	4	
26	CAMERON	11- SD-008-51.5	4	
27	TRACY	10- SI-005-7.4	4	
30	MT SHASTA	02-SIS-005-11.4	4	
31	WOODSIDE (2)	04- SM-280-5.6	8	
33	BURLINGAME (2)	04- SM-101-17.5	8	
35	PACHECO	04-SCL-152-26.9	4	
36	LOS BANOS	10-MER-152-23.0	4	
37	ELSINORE (2)	08-RIV-015-21.6	8	SERVICES
39	REDLANDS	08-SBD-030-31.7	4	COMMENCE
40	COACHELLA	11-RIV-086-R15.9	4	
44	BANTA	10- SI-205-9.5	4	4 / 95
45	CARBONA	10- SI-580-6.4	4	2 / 95
47	CASTAIC	07- LA-005-56.1	8	4 / 95
49	AUBURN	03-PLA-049-9.0	4	3 / 95

26 Single system sites
8 Dual system sites

Routine Equipment Maintenance shall be performed four times, at approximately six month intervals, for listed Site No's I through 40. Routine Equipment Maintenance shall be performed three times for the remaining listed sites commencing with the "Services Commence" date.

RIDER B

* Schedule of service classifications, rates, and expense allowances as negotiated

* Listing of equipment and prices

CALIFORNIA MAINTENANCE CONTRACT
Example 2

Article II - Contract Management

Caltrans Contract Manager is Rich Quinley, (916)654-5651.

Article III - Contract Period

This contract shall begin on July 1, 1995, contingent upon approval by the State, and expire on June 30, 1996, unless extended by supplemental agreement.

Article IV - Cost Limitation

A. Total amount of this contract shall not exceed $_____ .

B. It is understood and agreed that this total is an estimate and that the State will pay only for those services actually rendered as authorized by the Contract Manager or his/her designee.

Article V - Scope of Work

Scope of work shall be in accordance with Rider A.

Article VI - Rates

Routine maintenance as described in Rider A shall be reimbursed $_____ monthly for July 1, 1995 thru June 30, 1996, not to exceed $_____ for the contract term.

On Call Service and Repairs as described in Rider A

1) On call repair work authorized by the State, shall be reimbursed at rates stated in Rider B, Rider B is attached hereto and incorporated by reference.

2) All subcontracted work or other costs no included in Rider B, shall be reimbursed at actual costs.

3) Total costs for on-call repairs shall no exceed $ _____ for the contract term.

4) Contractor shall be reimbursed for transportation and subsistence costs for on-call repair work at the rates shown in Rider B.

Article VII - Payment

A. The State will reimburse the Contractor monthly in arrears as promptly as State fiscal procedures permit upon receipt of itemized invoices in triplicate. Invoices shall reference this contract number and shall be submitted to the Contract Manager at the following address:

RIDER A

SCOPE OF WORK

Contractor shall provide labor and materials to perform routine maintenance and on-call repairs for eleven (11) existing Caltrans Weigh-In-Motion (WIM) systems at eight (8) locations throughout the State.

A. Routine Equipment Maintenance

1. Contractor shall check each WIM system covered by this contract. Contractor shall schedule maintenance visits conforming to requirements of Section C and shall advise Caltrans' Contract Manager of such schedule prior to commencing. Service shall include, but not be limited to the following:

   a. Test response levels, signal levels, and lead cables for:
      - in-road instrumentation
      - WIM scales
      - piezoelectric sensors

   b. Maintain and clean electronics interface and system components:
      - clean interior and exterior of all components; remove, clean and inspect all printed circuit boards
      - maintain all electrical connectors of operation of interface components
      - test and verify control and sequence of operation of interface components; adjust zero point of WIM scale interface card if necessary

   c. Visually inspect condition of:
      - frames, weighpads, induction loops and axle sensors
      - roadway through WIM system
      - pullboxes adjacent to roadway
      - drainage outlet (when drain to side slope)

   d. Clean cabinet

   e. Provide a written report to the State for each WIM system within ten (10) working days after service has been performed**.**

2. Software Maintenance

   Contractor shall provide software updates and technical support services as may be necessary to ensure that all existing WIM systems and the State's host computer functions as an integrated data collection system.

B. On-Call Services and Repairs

Upon notice by the State that a particular system is malfunctioning, Contractor shall begin on-site repair within five (5) working days of notification, unless State authorizes an extended repair schedule. Contractor shall notify state if lane closures are necessary to perform repair work. Upon such notification, State shall arrange for State forces to set up lane closures and shall notify Contractor as to scheduling of such closures or shall authorize contractor to subcontract for traffic control services. Contractor shall also verbally notify state at a minimum of twenty-four (24) hours in advance as to the schedule of repairs when no lane closure is needed. Contractor shall verbally notify State a maximum of twenty-four (24) hours after completion of repairs.

The Contractor shall provide the State with a written report of the repairs made for each WIM system within ten (10) working days after the completion of the repair work.

C. Location of WIM systems covered under this agreement:

SITE NO.	SITE DESIGNATION	DIST-CO-RT-PM	NO. LANES
28	MACDOEL	02-SIS-097-34.5	2
29	ARCO (SB)	03-SAC-005-28.9	3
41	VACAVILLE (2)	10-SOL-080-30.6	8
43	CHOLAME	05-SLO-046-44.7	2
46	GALT	03-SAC-099-6.9	4
50	ELMIRA	10-SOL-505-2.2	4
53	NEWPORT (2)	12-ORA-001-22.6	6
51	WEST SAC (2)	03-YOL-050-0.6	8

5 Single system sites
3 Dual system sites

Routine Equipment Maintenance shall be performed two (2) times, at approximately six (6) month intervals for the above listed WIM systems except for Site No. 51. For Site No. 51, routine maintenance shall be performed one (1) time after Novermber 1995.

APPENDIX 2
LONG TERM PAVEMENT PERFORMANCE

INSTRUCTIONS FOR COST ESTIMATION SPREADSHEET

COST OF WIM EQUIPMENT

Below are instructions for using the spreadsheet file **WIMCOST.XLS,** which estimates the cost of purchasing, installing, operating, and maintaining WIM equipment.

The spreadsheet is designed for ease of use. At the simplest level, you only need to type in the number of WIM scales that will be purchased and indicate whether the WIM systems will be bending plate or piezo cable based. The spreadsheet will then calculate crude estimates of the cost and staffing required to keep those systems operating at the level expected by LTPP.

The crude estimates initially supplied by the spreadsheet are based on a number of assumed costs and levels of maintenance and operating activity. These assumptions may or may not be realistic for any given state or provincial highway agency (SHA). Consequently, you have the option of changing (and are encouraged to change) the majority of the inputs used in the cost estimation process. You should update the cost and staffing estimates supplied as defaults with the spreadsheet to reflect specific conditions within your SHA and your SHA's experiences. This will provide a more realistic estimate of the staffing and resources needed to install, operate, and maintain the WIM equipment.

STARTING THE WIM RESOURCE ESTIMATION PROCESS

The spreadsheet is stored in a Microsoft Excel 5.0 format.

> To open the spreadsheet, start Excel, and open the file WIMCOST.XLS.

Two windows open with the spreadsheet. In the left hand window are the basic data entry requirements. In the right hand window are the total cost estimates calculated by the spreadsheet.

USING THE SPREADSHEET

Basic Input Section

The spreadsheet requires the following inputs:

- the number of WIM sites to be installed, by type of WIM system
- the average number of lanes to be installed at each site
- whether a PC needs to be purchased for the central office operation
- the number of new sites that will need pavement rehabilitation before WIM installation (this is split by type of pavement).

Number of WIM sites to be installed. The number of sites at which WIM devices will be

installed is entered in three different cells, depending on the type of equipment being purchased.

> Enter the number of piezo cable systems to be installed in Cell B5.
> Enter the number of bending plate systems to be installed in Cell B6.
> Enter the number of any other systems being considered in Cell B7.

Piezo cable and bending plate WIM systems have been the most widely adopted technologies in the U.S., so default values are included in the spreadsheet for those systems. If you are intending to use a different technology, you must place the appropriate cost estimates in the lower section of the spreadsheet. (This section is described under the heading "Changing The Basic Assumptions.") Note also that the piezo cable and bending plate cost estimates should be updated if you have better cost estimates that are more specific to your SHA.

Average number of lanes to be installed. For this spreadsheet, a "site" is defined as each set of roadside electronics required. For example, if WIM will be placed on a four-lane, divided highway, this installation could be either a single four-lane site or two two-lane sites. If the median is very large, this location will likely become two separate "sites," both having two lanes of WIM scales. These two sites will have separate power and telephone connections, as well as separate equipment cabinets and data collection electronics. If the median is not too large, and the cabling from all four lanes of sensors can be hooked to a single cabinet and set of data collection electronics, then this configuration would be considered a single four-lane site.

> Enter the average number of lanes of WIM sensors for all sites in the cost estimate in Cell B10 (this number can be a decimal fraction).

PC purchases for central office operation.

> If your SHA is purchasing WIM for the first time, and/or if your SHA does not have an extra PC that is capable of automatically polling the WIM sites and storing the downloaded data, then place the number of PCs to be purchased in cell B12.

This will cause the spreadsheet to include the cost of this computer(s) in the cost calculation. Note that if your SHA is planning to purchase many WIM systems, more than one PC is usually required to poll, store, process, and report the collected WIM data. A rough estimate (subject to the traffic volumes at the WIM sites, how the sites are operated, and how the collected data are

retrieved) is that one central PC is required for every eight to twelve WIM sites.

If this is the first WIM installation to be purchased from this vendor, your SHA will also probably have to purchase the required office processing software.

> If this is the case, place a "1" in cell B13. If central office software is not required, place a "2" in cell B13.

Number of sites requiring pavement rehabilitation. The last entries concern the need for pavement rehabilitation at the WIM sites. WIM equipment can only estimate static truck weights accurately if the pavement in which they are installed is smooth, strong, and in good condition. In addition, the life expectancy of the axle sensors is substantially longer if they are placed in pavement that is in good condition. As a result, it is often necessary (and cost effective) to perform some type of pavement maintenance or rehabilitation before sensor installation.

The spreadsheet can consider two types of pavement rehabilitation efforts, asphalt concrete pavements (ACP) and portland cement concrete pavements (PCC). (The actual estimated costs of these treatments are contained in cells B26 and B27, respectively, where you can change them.) The basic input section requires that you enter the number of new WIM sites that require each type of preliminary pavement rehabilitation.

> If no pavement rehabilitation is required, enter "0" in both cells B15 and B16. Otherwise, enter the number of sites that need ACP rehabilitation in cell B15 and the number that need PCC rehabilitation in cell B16. (Note: the sum of these two cells does not have to equal the total number of new WIM sites.)

Results Section

The spreadsheet outputs (right hand window) include (1) the total initial costs for system purchase and installation and (2) the estimated **annual** cost and staffing requirements for maintaining the systems purchased. These estimates are shown in **bold** type. These costs assume that some initial pavement rehabilitation is needed at the WIM sites for the equipment to operate correctly. (See "Site Preparation Costs" for more information on this subject.)

Below these cost calculations are additional estimates of the annual budget for pavement maintenance and rehabilitation needed to keep equipment at the WIM sites operating within ASTM and LTPP specifications. These estimates reflect the fact that your SHA will need to budget for the repair and replacement of WIM systems because those systems will fail as the pavement deteriorates.

Below the pavement rehabilitation estimates is a cell that shows the initial cost of the proposed WIM system after pavement rehabilitation costs have been removed. This cell assumes that the pavement at the WIM site is in good condition and does not need further rehabilitation, or that the required rehabilitation will be part of a more general pavement construction project and will thus be paid for from a different budget.

The last two items in the Results Section are the number of WIM sites and the number of lanes used to estimate the budget figures. These numbers should equal the values entered in the Input Section in the left hand window. They are placed in the Results Section both to make a printed summary of the results more useful and to serve as a check that the spreadsheet is working correctly.

CHANGING THE BASIC ASSUMPTIONS

The inputs described above must be supplied by you. All other variables used to estimate WIM costs are initially supplied by the spreadsheet. **However**, these estimates are simply reasonable values synthesized from a variety of sources. They do not necessarily accurately reflect local conditions for your SHA. **Consequently**, you are encouraged to change the remaining input assumptions on the basis of experience, professional judgment, and known site conditions.

Although all formulas and text in the spreadsheet are write protected, all input values can be readily changed. Where the spreadsheet provides a default value for an estimate, that default is also listed in a text field near the cell in question (usually one or two cells to the right). Thus, if you change a value and decide later to revert to the default estimate, you can refer to the text field to obtain the default value and re-enter it in the appropriate field. (For example, the cost of ACP rehabilitation per lane is given in cell B26. The default for this cell is also listed in cell D26 under the heading “Default Rates.”)

The table on the following pages indicates the input variables that can be changed. Each of these items is discussed in the text of this document that follows the table.

Input Variable	Cell Location
ACP rehabilitation cost per lane	B26
PCC rehabilitation cost per lane	B27
Basic system cost for a one-lane piezo-cable based WIM site, including installation	B33
Basic system cost for a one-lane bending plate based WIM site, including installation	B34
Basic system cost for a one-lane WIM site for some other technology of interest to the SHA, including installation	B35
Cost reduction factor for multi-lane WIM sites	B37
Piezo-cable sensor failure rates	B40
Bending plate sensor failure rates	B41
Other technology sensor failure rates	B42
The replacement cost of a piezo-cable sensor (including installation)	B45
The replacement cost of a bending plate sensor (including installation)	B46
The replacement cost of a sensor from another technology (including installation)	B47
The staff time required to replace a piezo-cable sensor (including installation)	C45
The staff time required to replace a bending plate sensor (including installation)	C46
The staff time required to replace a sensor from another technology (including installation)	C47
The number of sensors required per lane for a piezo-cable WIM system	B50
The number of sensors required per lane for a bending plate WIM system	B51
The number of sensors required per lane for a WIM system using some other technology	B52

Input Variable (continued)	Cell Location
Cost of a single central computer to perform the required office functions (usually a high-end PC)	B55
Cost of the central office software used by the WIM system vendor to poll the remote WIM sites, store and process the data, and create the necessary reports	B56
The cost of an FTE of office staff time	B63
The staff time needed to monitor the operation of, and process data from, a WIM site	C63
The monthly power cost for a WIM site	B66
The monthly telecommunications costs for a WIM system	B67
Expected maintenance expenses per WIM site (but not including expected pavement rehabilitation expenses)	B70
Expected maintenance staff requirements per WIM site (but not including those needed for pavement rehabilitation expenses)	C70
The number of calibration trips expected per site per year	B72
The cost of a single-lane calibration effort when that effort is performed by pulling trucks from the passing traffic stream and weighing them both at the WIM scale and at a nearby static scale	B75
The staff time needed to perform a single-lane calibration effort when that effort is performed by pulling trucks from the passing traffic stream and weighing them both at the WIM scale and at a nearby static scale	C75
The cost of a single-lane calibration effort when that effort is performed by bringing two loaded test trucks of known weight to a WIM site and having them pass repeatedly over the scale.	B76

Input Variable (continued)	Cell Location
The cost of a single-lane calibration effort when that effort is performed using a different calibration technique.	B77
The staff time needed to perform a single-lane calibration effort when that effort is performed using a different calibration technique.	C77
A cost/staff reduction factor that indicates the cost savings associated with calibrating more than one lane of sensors at a single location	B79
An indicator of which calibration technique should be used in the cost estimation procedure	B81
An estimate of the costs required to outfit a maintenance technician so that s/he can diagnose problems with the WIM equipment	B86
An estimated cost for rehabilitating the pavement at an existing scale site (i.e., once the pavement at a site has deteriorated, the cost to bring that site's pavement back up to par).	B89
The percentage of sites that need rehabilitation during any given year.	B90

Site Preparation Costs

As noted above, accurate operation of a WIM system requires that it be placed in strong pavement that is in good condition. Consequently, pavement rehabilitation is often necessary before sensors are installed. The cost of this rehabilitation effort will vary considerably from site to site, depending on the type existing pavement and its condition.

In general, the 200 to 500 feet of pavement immediately surrounding the axle sensors should be in excellent condition (no cracking, no visible rutting). (See the LTPP SPS Traffic Data Collection Protocol for LTPP's recommended pavement specifications for WIM sites.) To achieve this standard may require anything from grinding the surface of an existing PCC pavement to completely rebuilding it. Consequently, costs can vary considerably from site to site.

Because of the cost of pavement rehabilitation, in many cases WIM equipment is only placed in the road as part of an otherwise planned road construction project. In this way, the pavement rehabilitation effort is paid for from a different funding source and is not considered part of the cost of the WIM system.

Each SHA should determine the true cost of pavement rehabilitation at the proposed site with the help of its own pavement engineering section. This requires that the engineering section know the

proposed WIM system location, the condition of the existing pavement, and the pavement requirements for the WIM system site. The cost value provided by the engineering section should then be entered in the appropriate cell (B26 or B27), expressed as a cost per lane.

Where multiple sites require pavement rehabilitation, you should total these costs and then divide the sum by the total number of lanes to be rehabilitated. This will compute the average cost per lane to be entered into the spreadsheet.

Hardware System Costs

The cost of installed WIM systems (excluding pavement rehabilitation) will also vary from SHA to SHA and from contract to contract as a result of differences in vendors, the size of different equipment orders, and the special conditions SHAs place on specific vendors.

The estimates included in cells B33 and B34 are approximate values developed from telephone conversations with various SHA personnel involved with the LTPP program. These estimates may not represent well the costs that any one SHA may encounter. More accurate system costs can be obtained from neighboring SHAs that have recently purchased equipment.

The estimates in cells B33 through B35 include the cost of installation, as well as the costs of installing power, communications, and other site necessities. The cost reduction factor (cell B37) is designed to account for the fact that a multi-lane site requires only one power source, one communications line, and one set of central electronics. In addition, there are economies of scale in the areas of traffic control, equipment use, and other construction related items. This cost reduction factor is applied to the cost of all additional lanes at each site.

Sensor Failure Rates, Costs Per Sensor, and Sensors Per Lane

Axle sensors fail for a variety of reasons, including poor installation, pavement failure, sensor fatigue, and faulty sensor design and construction. Sensors tend to fail more quickly under heavy loading and poor environmental conditions. This failure occurs both because of increased fatigue and because pavements tend to deteriorate more quickly under those same conditions.

The “default” sensor failure rates are based on a series of conversations with SHA staff involved with traffic data collection for LTPP. These figures include all kinds of sensor failure and may over-estimate the failure rate of a sensor that is carefully placed in good pavement. (Also note that the failure rate is not linear and can be expected to increase as sensors age. The rate given in this spreadsheet is intended to reflect conditions two or more years from installation to give the SHA a feel for anticipated funding needs.)

If an SHA has experience with specific sensors, more specific failure rates should be substituted for the default rates. Similarly, the replacement costs for sensors listed in the spreadsheet should be overridden whenever possible with more specific values.

The number of sensors listed per site assumes the following sensor configurations. For the piezo cable installation, two 12-foot cables are used along with one 6-foot square loop for vehicle presence detection. For bending plate sites, two 6-foot bending plate scales are placed side by side (one for each wheel path), with 6-foot loops both up- and downstream of the scale.

If the SHA plans on purchasing a WIM system with a different sensor configuration, the number of sensors per lane should be changed accordingly. (Note that the cost of inductive loops is so low in comparison to the other WIM system components that they are not accounted for separately in the spreadsheet.)

Central Computer Hardware and Software

An SHA usually has to have at least one large central PC to collect, store, process, and report the WIM data collected in the field. If your SHA is adding to its existing WIM devices, it may not have to add an additional CPU. This can be accounted for in the spreadsheet by entering "0" in cell B12. If a one or more PCs are required, the appropriate number should be entered in cell B12.

The cost of these PCs should be entered B55. In most cases, this CPU should be the fastest Pentium-based machine available, with a 28.8-bit per second modem, a minimum of 1 GB of hard disk storage, and some kind of disk back-up device (e.g., removable optical storage, tape back-up).

In addition to the basic hardware requirement, the CPU will need the central processing software supplied by the WIM system vendor. If your SHA already owns this software and is simply purchasing additional WIM scales, enter a "2" in cell B13. This removes the cost of the software from the spreadsheet calculations. If central software is needed, enter a "1" in cell B13, and enter the actual cost of the software in cell B56.

Operating Costs

Operating costs are divided into four categories: utilities, calibration, maintenance, and office processing.

Utilities primarily include power and telecommunications costs. These costs are entered as average monthly costs per site in cells B66 and B67. Note that if solar power is used at a site, there may be no monthly power cost. Instead, include the cost of the solar panels in the initial system cost (Cells B33, B34, or B35).

WIM system calibration is crucial to obtaining usable information. Most WIM systems have some

kind of “auto-calibration” capability, but work with the traffic data submitted to LTPP has shown that these systems do not always work reliably. Therefore, your SHA should continually monitor the performance of its WIM equipment and periodically perform complete calibration tests.

The “default” in the spreadsheet is that the calibration of each scale will be independently tested and confirmed four times per year. Approximate costs are given for two different calibration methods. The first weighs trucks from the traffic stream at both a static scale and the WIM scale in question. This is an excellent method for calibrating WIM scales, but it is only economically feasible when a static scale is located up- or downstream of the WIM scale.

The second calibration approach for which a cost estimate is included relies on the use of two loaded test trucks (of known weight). These trucks make multiple passes over the scale being calibrated. This method is not as effective as calibrating from the traffic stream, but it is more economically feasible when a static scale is not located near the WIM scale being calibrated.

A number of other calibration techniques are also possible. SHAs selecting one of these techniques should use the category “other techniques” and provide a cost per lane for that technique in cell B77.

When calibration costs are added and/or changed, it is also important to change the staffing requirements listed in Column C. Calibration tends to be staff intensive, regardless of the technique selected, although some techniques are more labor intensive than others.

After specific calibration technique has been selected, make sure to enter a “1,” “2,” or “3” in cell B81 to indicate the appropriate technique. “1” means that your SHA will use the traffic stream and an existing static scale. “2” indicates the use of two test trucks, and “3” indicates the use of an alternative methodology.

Finally, make any necessary changes to the number of calibration efforts per year (cell B72). When a scale is first installed, multiple calibration efforts are required to ensure that it operates accurately throughout the year, as different climatic conditions can change sensor and pavement responses to axle loadings.

Routine maintenance is required for both the site and the equipment at the site. The site maintenance cost estimates are located in cells B70 (funding) and C70 (staff). These estimates do not include major pavement repair, which is covered by the estimates for pavement rehabilitation. They do include electrical repair, repair to the WIM system electronics, and a variety of minor site maintenance tasks.

The last operating expense is for office processing. Although many office tasks have been automated by vendors, the volume of information generated by WIM devices and the need to monitor the calibration and operating condition of these devices to ensure their reliable operation require some fairly substantial office staff time. An estimate of the staff time is given in cell C63. The spreadsheet assumes 0.2 FTE for the very first WIM system purchased and installed. Cell

C63 contains the marginal staff time required for each additional WIM device. Because some central office tasks only need to be performed once, there is some economy of scale in the operation of multiple WIM devices.

Other Potential Costs

If your SHA is just getting into WIM system deployment, some additional "one-time" costs will be incurred to equip your SHA's maintenance technicians. The items required vary from technology to technology but can include oscilloscopes and volt meters (to measure signal performance) and specialized electronic diagnostic tools. The estimate in the spreadsheet assumes that a vehicle for the maintenance technician is already available through other SHA sources.

Annual Pavement Rehabilitation Costs

The last cost included in the spreadsheet is an annual component for pavement rehabilitation. As pavement ages it deteriorates. As the pavement deteriorates, WIM sensor performance deteriorates and sensor life expectancy decreases. In many cases, sensor failure is caused not by the failure of the sensor itself but by the failure of the pavement around the sensor, which causes the sensor to quit operating correctly or results in sensor damage that would not otherwise have occurred.

Therefore, the pavement that contains WIM system sensors must be rehabilitated periodically. When the pavement is repaired or replaced, the WIM sensors almost always have to be replaced. This repair/replacement needs to be budgeted. In many SHAs, sensors are replaced as part of routine pavement maintenance actions (i.e., overlays). The cost of new sensors and installation is simply included in the cost of the new pavement. However, when this occurs, the data collection function is often interrupted from the time the sensor fails to when the pavement is reconstructed or rehabilitated. This time period can be several years.

Regardless of whether the pavement reconstruction pays for the sensor replacement or the WIM system replacement pays for the pavement reconstruction, it is important that the SHA acknowledge the role of pavement reconstruction in the life-cycle cost of the WIM system. Consequently, this spreadsheet includes these costs (Cell B89 lists the average pavement rehabilitation cost per lane for the WIM site, and cell B90 lists the percentage of sites requiring pavement rehabilitation each year). The "Results" section of the spreadsheet lists them separately.

Major Changes (Unprotecting) to the Spreadsheet

To prevent accidental changes to formulas and default values included in this spreadsheet, the majority of cells in the spreadsheet have been locked. If your SHA determines that it wants to make major revisions to the spreadsheet (as opposed to simply changing the input values), you must "unprotect" the spreadsheet. To do this within Excel, you have to enter a password.

The password for the spreadsheet's protection mechanism is "**LTPP**."

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