

### 3.0. PREREQUISITES FOR RAMP METERING

---

Before ramp meters are implemented and considerable time and resources are spent planning this effort, staff responsible for these activities need to verify and justify that ramp meter implementation is feasible and beneficial and supports NDOT's various transportation management programs and policies. Staff should also confirm that resources needed to support ramp meter life-cycle activities will be available.

#### 3.1. Program and Policy Understanding

Successful ramp metering requires those responsible for its day-to-day operation to understand how ramp metering fits into the agency's traffic management program. Therefore, transportation management program goals and objectives should be reviewed and well understood before ramp meters are implemented. (If these goals and objectives don't exist, staff needs to develop them. If they are out-of-date, staff needs to update them.) Staff members need to determine if it is appropriate to deploy ramp meters and whether or not ramp metering has the potential to deliver expected benefits. Staff members need to keep in mind that ramp metering is not an independent function, but rather one that supports NDOT's overall mission. An understanding of transportation management programs goals and objectives also lays the foundation for ramp meter implementation by addressing the high-level issues that affect it. For instance, if one of the goals of the transportation management system is to improve regional mobility, the focus of the ramp metering program may be broader and larger in scale than if the goal was to address location specific problems.

The mission of the NDOT is to efficiently plan, design, construct and maintain a safe and effective seamless transportation system for Nevada's economic, environmental, and social needs. To the extent that ramp metering furthers this mission at specific locations, ramp metering is an appropriate action. Because ramp metering has the potential to reduce collisions at merge points and on congested freeways and can help reduce congestion, making the transportation system more effective, ramp metering supports the mission of NDOT and is an appropriate action to consider within Nevada.

In 2004, NDOT began work on its strategic plan with the following goals:

- ▶ Improve safety in public transportation
- ▶ Develop and deliver beneficial projects in a timely manner
- ▶ Effectively communicate to improve customer satisfaction
- ▶ Make the most of the department's assets and minimize its risks

Ramp metering relates directly to the first, third, and fourth goals stated above. As mentioned above, ramp metering can reduce collisions, improving the safety of the system. It can also reduce congestions, helping NDOT to make the most out of its existing assets (urban freeways). Because metering is not always understood by the public and can be controversial, it is critically important for NDOT and RTC staff to effectively communicate with the public about ramp metering in order to maintain or improve customer satisfaction.

NDOT created performance measures that indicate if they are accomplishing their goals and embracing their values. The measures that are most affected by ramp metering are shown Table 3-1.

**Table 3-1: Ramp Metering Performance Measures**

<b>Performance Measures</b>	
<b>Highway Safety</b>	Fatal crash rate per 100 million vehicle miles of travel.
	Injury crash rate per 100 million vehicle miles of travel.
<b>Congestion</b>	Portion of daily vehicle miles of travel on congested urban roads.
<b>Customer Satisfaction</b>	Portion of complaints yielding a satisfactory outcome.
	Portion of complaints resolved in one workday.

The first three measures can be improved by appropriate and effective use of ramp metering on congested urban freeways. The last two measures can be positively affected with a proactive, well-designed information campaign when ramp metering is implemented. In contrast, the customer satisfaction measures can be compromised if the ramp metering system does not meet its stated goals or if NDOT or RTC does not have an effective public information campaign in place.

Staff responsible for the review of transportation management goals and objectives should take into consideration how ramp metering can be applied with other transportation management strategies to more effectively accomplish NDOT’s transportation management goals and objectives. When possible, efforts should be made to combine the ramp meter program with other freeway management elements “to promote efficient and effective movement of goods, to improve the safety of the traveling public, and to improve the environment by reducing both the duration and extent of recurring and nonrecurring congestion on the freeway system”. Typically, ramp meters are used to reduce congestion, reduce collisions, and improve reliability. As a result, improvements to travel speed, travel time, delay, and crash rates are commonly observed.

### **3.2. Organizational Support and Buy-in**

As shown in the previous section, ramp meters do support NDOT’s mission. It is also important that ramp metering is supported by decision-makers and managers within NDOT and its partner agencies. Upper management support is needed to secure funding for additional ramp meter implementation and for ramp meter operation and maintenance. In addition to upper management, the organizational structure within NDOT also needs to be assessed. For instance, the support of department managers is likely needed to verify that ramp meters fit into current operations and can be effectively integrated. Department managers may also identify challenges before ramp meters are installed, which helps to reduce unanticipated costs and delays.

Meeting with agency managers prior to expansion of the system to determine their views on the effectiveness of ramp metering and what can be done to improve ramp metering would be an effective way to gauge management support. If concerns are raised, staff should address those concerns and implement appropriate suggestions for improvement.

### 3.3. Resource Needs

Successful ramp metering requires that the appropriate resources be provided to those responsible for specific activities including; implementation, operation and maintenance. Funding is needed to:

- ▶ Acquire and deploy physical ramp meter components,
- ▶ Train and hire staff,
- ▶ Conduct public information and outreach activities,
- ▶ Provide enforcement,
- ▶ Perform on-going maintenance,
- ▶ Monitor and report the performance of ramp meters, and
- ▶ Purchase the equipment and tools needed to keep meters operating as efficiently as possible (e.g., software, hardware, supplies, and vehicles).

Besides funding, NDOT also needs to provide training so staff can complete activities correctly and in a timely fashion. NDOT and RTC should be aware of the various technical issues that may affect an operator's ability to perform his or her duties. Additionally, the agencies must also identify and make known the tools operators can use at their discretion to improve operations. Specific resources needs, including funding and training, are discussed in greater depth in the following sections.

#### 3.3.1. Funding

Funding for sustained operation and maintenance of the ramp metering system should be considered a prerequisite for implementing metering. Funding needs include typical capital project functions (planning, design construction administration, and the cost of the capital project) and operations costs, such as staffing, training, and equipment maintenance. Agency staff should first identify current funding levels, estimate future funding needs in all of the categories noted above, and then make decisions regarding deployment.

It is vital that estimates of all of these costs be included in budget development and capital programming activities. If the operations and maintenance costs cannot be budgeted, then the capital ramp metering projects should not be included in the program. Operations and maintenance costs can be funded from local, state, or Federal (e.g., STP) funds. If funding through traditional means is not available, then it is important to look at alternative funding, such as Federal STP funds.

Agency staff should also look for cost effective ways to tag onto other funded projects. For example, if it is desired to re-stripe the on-ramp for a new dual lane ramp metering system, it would be advantageous to "piggyback" with a resurfacing project that is already funded. With adequate knowledge of the funding structure, there may be more than one way to fund additional ramp meters or support for ramp metering.

#### 3.3.2. Staffing

Before ramp meters are installed and/or turned-on for the first time, NDOT should review existing staff skills and levels to determine if additional staff need to be hired, or if additional training is needed to successfully deploy, operate, and maintain ramp meters. Based on the results of this review, and anticipated funding levels, it may not be possible to effectively operate all the meters proposed for implementation. In these situations,

ramp meters could be phased in as funding levels permit existing staff to be trained or additional staff to be hired.

In the Las Vegas region, RTC's Freeway and Arterial System of Transportation (FAST) program operates the existing meters. When new meters are being planned in the Las Vegas region, it will be important for NDOT staff to work closely with RTC FAST to determine if FAST has sufficient staff to operate the additional meters effectively. Until RTC FAST and NDOT agree that adequate staffing exists, new meters should not be turned on.

If ramp metering is proposed for areas of Nevada outside the Las Vegas region, NDOT will need to determine if its own staff, staff from another agency (such as RTC staff), or contracted staff (outsourcing) will operate and maintain the ramp meters. NDOT should identify and select a course of action best suited to its needs, culture, and existing situation.

### ***In-House***

NDOT may operate and maintain ramp meters using solely the individuals they currently employ. Using a staff comprised of all agency employees is often considered ideal because managers and team leaders have a single personnel management system to deal with and team cohesiveness is easier to establish and maintain. But given today's trends of downsizing and doing more with less, NDOT may have a difficult time in finding, training, and keeping the required talented staff to operate and maintain ramp metering systems. Maintaining the skills necessary to support the fast changing technologies is a problem with utilizing in-house support. If required in-house support can be supplemented by outsourcing.

### ***Out-Sourced***

A second approach that may be used to provide operations and maintenance support is outsourcing. This approach usually becomes attractive when it is difficult to fill highly technical positions that require higher wages. The difficulty in providing higher wage rates is due in part to difficulties justifying the pay scales necessary to attract qualified staff and pressures to cut staffing and/or freeze existing vacancies. Outsourcing can often by-pass this problem. Staffing through outsourcing does not result in more staff counted on the agency's payroll. The budgetary item for outsourcing is often treated by the agency administration like a line item for electricity to run the equipment, with none of the negative perceptions involved in financing new staff positions. It is also often easier for a private firm to fill vacancies with appropriately skilled personnel as well as fire poorly performing employees.

While outsourcing offers solutions to the types of staffing problems noted above, it is not without its own set of problems. Some of the problems with outsourcing include the necessity of continuing tight administration of performance under the contract, potential higher turnover rates in contractor personnel than in-house staff, scarcity of private sector personnel with adequate experience, and friction with in-house staff. Outsourcing requires careful development of a detailed, clearly defined set of contractor requirements, including task descriptions, schedules, performance standards, and payment terms.

Regardless of how NDOT will staff ramp metering systems outside the Las Vegas region, determination of staffing levels and how the staff will be provided is a prerequisite to installing ramp metering systems.

### 3.3.3. Training

Depending on the review of staff knowledge, skills and abilities (KSAs), existing staff may need to be trained when new or additional ramp meters are installed. Training can be categorized in two forms: technical and operational. Technical training covers how the equipment, communications network and software work and includes how to design, install, troubleshoot and repair the system. Operational training is directed toward understanding the theories behind ramp metering, and how to use ramp metering to achieve operational goals and objectives. Designing, building, operating and maintaining systems is different than designing and building roads.

NDOT may wish to rely on the numerous training programs available through the National Highway Institute (NHI), Institute of Transportation Engineers (ITE), American Society of Civil Engineers (ASCE) and other organizations for training staff. All of these organizations have courses available to suit staff with differing levels of knowledge. Training should include technical training (details of how the hardware and software work) that is often available through equipment and systems suppliers and functional concepts training (how to plan, design, operate and maintain the system).

NDOT should identify training needs as part of the planning process. This is a key factor because the process to identify qualifications and hire staff is time consuming. In addition, the needs are on-going as staff turns over and the system expands. There should be a training program to provide opportunities for training on an on-going basis. Even in the case of the Las Vegas region, where another agency will be operating the ramp metering system, it is important to assess the training needs of that agency and determine how NDOT and RTC in partnership can provide those needs.

The training program should provide training manuals to those who operate and maintain ramp meters. Information on how to operate the system under various conditions can be incorporated into operating procedures, however, there is no substitute for initial training so staff will gain the basic skills and know where to look when they have questions. For ramp meters, training manuals should include the information on the following:

- ▶ Theories behind ramp metering
- ▶ What type of adjustments should be made based on performance
- ▶ How to track ramp performance and associated measures of effectiveness
- ▶ How to use the existing tools in the traffic management center to monitor ramp performance

The reason for including theoretical background information in the training manual is so that operations staff can understand why ramp meters are being employed and what to expect. This will allow the operator to better identify when ramp meters are producing the desired effect or is not improving ramp performance.

For maintenance personnel, their training manual should include at least summary information of the above information as well as detailed information on how the actual ramp metering equipment is to be maintained or replaced. In addition, it should include

equipment manuals, installation and maintenance instructions, maintenance schedules, troubleshooting guides, and equipment vendor contacts.

#### **3.3.4. Public Information and Outreach**

Projects that involve ramp metering require more extensive involvement with the public. Public involvement for ramp metering extends beyond that needed for a typical highway construction project and includes the operational facets of the project. These elements may include informing the public users of the systems and obtaining support from the media and public officials as well as local agencies. This will require additional staff time and effort. It may also require significant investment to develop and disseminate marketing materials that convey the benefits of proposed ramp meters. NDOT must be prepared to deal with and fund the public outreach efforts. Failure to actively market ramp meter systems, may eventually lead to public dissatisfaction and contempt for systems, which may delay ramp meter implementation.

Many of the same concepts discussed for public outreach for HOV/Managed Lanes are relevant for ramp metering. The major difference is that ramp metering does not require that the public make changes to their travel behavior, like taking the bus or joining a carpool to use the HOV lanes. However, the educational and outreach concepts are very similar. More on the details of what should be included in a public outreach campaign for ramp metering can be found in Section 5 (Intra- and Inter-Agency Coordination and Outreach). It is important to note that a commitment to a public outreach campaign is critical in implementing ramp metering and is a prerequisite to a successful program.

#### **3.3.5. Maintenance and Equipment**

Maintenance personnel will require the proper diagnostic equipment and tools to maintain ramp metering systems and their various components (e.g., detectors, signal, controller). Maintenance vehicles should be made available and equipped similarly to that of a traffic signal technician's vehicle with the associated tools and replacement equipment. It is imperative that the hardware and software be kept up-to-date for staff to be effective. Similarly, supply inventories should be routinely re-stocked so maintenance activities can occur as needed or scheduled.

Whether the staff maintaining the ramp metering equipment is NDOT staff, FAST, staff from another agency, or contracted staff, NDOT should assure that maintenance staffing is sufficient for the number of devices implemented in the field and that adequate equipment is provided. Although there are no firm guidelines on maintenance staffing, a study for the City of San Jose recommended 100 ITS devices (CCTV cameras, video detection units, dynamic message signs, ramp meters) per maintenance technician. This is a reasonable number and is similar to the staffing levels in other agencies. NDOT should assure that staffing work load does not exceed this level much in order to assure long-term successful operation of the ramp metering system.

NDOT should also determine preventative maintenance periods and life cycle or replacement cycle for ramp controllers and other field equipment. The Ministry of Transportation in Ontario developed maintenance guidelines for a variety of ITS devices. Table 3-2 shows those elements related to ramp metering.

**Table 3-2: Elements of Ramp Metering**

<b>Subsystem</b>	<b>Minor Maintenance</b>	<b>Major Maintenance</b>	<b>Major Rehabilitation</b>	<b>Life Expectancy</b>
Cabinets	--	26 weeks	10 years	20 years
Power Supply	26 weeks	5 years	10 years	20 years
Grounding	1 year	5 years	10 years	25 years
Signal Wiring	13 weeks	5 Years	--	15 years
Signal Heads and Hardware	13 weeks	1 year	1 Year	10 years
Poles and Footings	1 year	5 years	10 Years	25 years
Loops and Cables	13 weeks	26 weeks	5 years	10 years
Sensor Units	--	13 weeks	--	7 years
Controllers	--	13 weeks	2 years	7 years

NDOT should consider using similar guidelines or establishing their own, whether they maintain the ramp metering equipment with in-house staff, rely on another agency to maintain the equipment, or contract maintenance activities to a private company.

Maintenance staff will also need diagnostic equipment to troubleshoot failures and maintain ramp metering equipment. Typical equipment needed to maintain ramp metering systems include:

- ▶ Cabinet tester
- ▶ Controller tester
- ▶ Detector tester
- ▶ Load switch tester
- ▶ Flasher tester
- ▶ LED tester
- ▶ Chip tester and programmer
- ▶ Communication tester
- ▶ Oscilloscopes
- ▶ Multimeters
- ▶ Bench-built simulators
- ▶ Computers used for database inventories and equipment diagnostics

NDOT should work with the staff that will maintain the ramp metering equipment to determine the diagnostic and maintenance equipment needed for the ramp metering systems in Nevada.

### 3.3.6. Software

Software is critical in order to have ramp metering systems operate the way they are intended. At a minimum, controllers in the field will need software to operate ramp meters and to collect operational data. If a central computer is available, controllers should be programmed to transfer data to the central computer where it can be easily processed by operators at a Traffic Management Center (TMC) or similar facility. Software will also be needed to process loop detector data so it can be incorporated into metering algorithms. In this regard, software helps to synthesize the significant amounts of data that are collected.

Software requirements also extend to operator workstations so operators can remotely monitor and control ramp meter operations. Software functions for operator workstations are also established so operators can view ramp meter databases.

Software has already been selected for the TMC and for ramp meter controllers in the Las Vegas region. When ramp metering is proposed for other regions of the state, it will be important for NDOT to assess the needs of the region and determine if the software from Las Vegas will meet those needs or if different software will be needed.

Software products that support ramp metering can be commercial-off-the-shelf software or contractor developed products. The procurement of software (i.e., software development and integration) does not meet the normal linear process that highway or even TMC construction projects follow. Further, it is complicated with ownership and intellectual property rights. With this in mind, NDOT should beware that procuring and implementing software may be a lengthy process that should be undertaken well in advance of when meters will be turned on.