

# US/ICOMOS

## PETRA MANAGEMENT ANALYSIS & RECOMMENDATIONS

### Table of Contents

INTRODUCTION.....	1
CARRYING CAPACITY DEFINED .....	1
METHOD.....	2
STATEMENTS OF SITE SIGNIFICANCE, MANAGEMENT OBJECTIVES, AND PRIMARY INTERPRETIVE THEMES .....	3
Significance .....	4
Management Objectives.....	5
Primary Interpretive Themes .....	6
DEVELOPMENT OF MANAGEMENT ZONES .....	8
The Arrival Zone .....	8
The Siq.....	9
The Theater.....	9
The Elbow.....	9
The City Center .....	10
The Basin .....	11
Turkmaniyya Road .....	11
Trails (Near country).....	12
Trails (Back country).....	12
INDICATORS, INSTRUMENTS, AND STANDARDS FOR MONITORING .....	12
Indicator: Loss of surface artifacts at archaeological sites.....	16
Indicator: Status of vegetation .....	17
Indicator: Active erosion at archaeological sites.....	19
Indicator: Visual intrusion by modern or incompatible landscape elements, occurring inside or outside Petra .....	21
Indicator: Numbers of people by month, and by sample period day and hour....	22
Indicator: Distribution of people in zones (using trail counters).....	23

Indicator: Number of people at one time (PAOT) at key locations.....	24
Indicator: Amount of graffiti present.....	25
Indicator: Visitor satisfaction (survey and comment cards).....	28
<b>CONTROLLING AND LIMITING FACTORS .....</b>	<b>30</b>
Distribution of Visitor Use .....	30
Types of Visitors .....	30
Organized Tours.....	30
Individuals and Small Groups of Visitors .....	30
Al-Khazna is the Controlling Feature for Carrying Capacity.....	31
<b>ANALYSIS OF CARRYING CAPACITY LEVELS.....</b>	<b>32</b>
<b>FIGURES: MANAGEMENT ZONES, DISTRIBUTION OF TRIPS BY LOCATION, VISITOR HOUR OF ARRIVAL .....</b>	<b>36</b>



## PETRA SANCTUARY CARRYING CAPACITY ANALYSIS

### INTRODUCTION

The Jordanian Minister of Tourism and Antiquities is concerned that the numbers of people visiting Petra are exceeding the capacity of the site. At the time this study began, two carrying capacity studies had been completed for the site, one by UNESCO in 1994 and the other by JICA in 1996. There are significant differences in the findings of the two reports. Consequently, the Jordan Sustainable Tourism Development/Sites project, US/ICOMOS Site Management Team was asked to study the carrying capacity of the Petra Sanctuary.

Included in this study are:

- 1.) a detailed monitoring program that recommends the means by which to measure vital changes in resources at Petra *and* the mechanisms by which monitoring can be linked to management of the site,
- 2.) an analysis of carrying capacity that considers limiting factors, maximum use levels, and potential management strategies, and
- 3.) estimates of maximum numbers of people that can visit Petra on an hourly, daily, monthly, and annual basis without deterioration of the visitor experience or serious threat to site resources. **It must be emphasized that these estimates are based upon current site conditions, which are subject to change and so must be constantly monitored in order to avoid damage to site resources.** These estimates also are based upon management conditions at Petra expected in the foreseeable future.

This study is based on existing information due to the short time frame in which the report is needed.

### CARRYING CAPACITY DEFINED

Carrying capacity is a term that implies to some a fixed number of people that a site can hold at either one time or over a day, month or year. Park management experience indicates that carrying capacity is not fixed. It is influenced by many factors and so may change over time. It is determined in part by measurable effects stemming from visitor

use, but as much and perhaps more so by efficiency of management and visitor expectation, and also by changes to resources brought about by natural processes.

Carrying capacity for parks, wilderness and cultural sites has been studied at least since 1978 when the U.S. Congress required the U.S. National Park Service to determine the carrying capacity of each one of the 370 parks in the U.S. National Park System. The National Park System has a wide variety of sites from urban historical sites to large wilderness areas in Alaska and remote archeological parks in the Southwest.

Based upon experience and numerous studies, the U.S. National Park Service now uses a management system in which carrying capacity is defined as, "The type and level of visitor use which can be accommodated while sustaining the desired resource and social conditions that complement the purposes of a park and its management objectives." This definition is used in this report.

Inherent in the definition is the need for site management objectives. Management objectives are derived from an explicit statement of the significance of the site on a regional and national scale, and to the world. From this significance statement site interpretive themes are determined. Site managers consider significance, management objectives, and interpretive themes in order to specify the appropriate resource conditions for both natural and historical resources, and the appropriate social conditions for an optimum visitor experience at the site. Site significance, management objectives, interpretive themes, and resource and social conditions for management zones in Petra are described in this report.

## METHOD

There are several methods used to determine carrying capacity. The first system, developed for measuring carrying capacity in U.S. Wilderness areas, is called Limits of Acceptable Change (LAC). It uses impact indicators and standards to monitor and evaluate resource conditions to meet predetermined management objectives. Similar processes, all based on the same principles, including the Recreational Opportunity Spectrum (ROS), the Visitor Activity Management Process (VAMP), and Visitor Impact Management (VIM) are being used by several agencies and organizations. The processes differ in the specific steps one should take to go through them and not by the principles on which they are established.

The method being utilized for the Petra carrying capacity study is the Visitor Experience and Resource Protection Process (VERP), which was developed by the U.S. National Park Service. The process provides a systematic, rational and well-documented method to address carrying capacity for parks, preserves, and protected areas and is being used at wilderness parks, historic sites and urban areas. It is designed to both safeguard the quality of site resources and of peoples' experience at a given park. The above definition of carrying capacity is used in this process.

In the VERP process, a carrying capacity analysis does not necessarily have to specify visitor numbers at a site unless it is beneficial to do so. As long as resource and social conditions can be measured and maintained, counting numbers of people is of secondary importance. In this particular instance we know that the very large numbers of people visiting Petra are negatively effecting the archeological sites and the visitor experience. Therefore, this analysis has determined the appropriate number of visitors for two selected management strategies in order to provide for sustainable use. Several management strategies are discussed and evaluated but only two are analyzed after a determination of feasibility. The study will not select a specific management strategy for implementation. Rather the analysis provides both maximum numbers of visitors and identifies the potential management concerns. This will provide the Ministry with useful information to help them determine which management strategy to use for Petra.

Indicators (defined later in this report) are identified in order to measure the status of archeological, natural resource, and social conditions. An appropriate standard (also defined later) used to evaluate each indicator was also developed. Development and use of indicators and standards in the site monitoring system is an iterative process. Indicators and methods were chosen to be indicative, comparatively easy and cost effective to monitor, and useful for long term application. Other indicators and processes will be developed in the future. Other indicators may be identified as necessary for a specific issue. These should all be tried and added to the system when they are appropriate. The real need is to stick with the basic indicators over time and evaluate the level of the standards to improve them with experience.

In addition, this analysis defines management zones within the Petra Sanctuary. These are also used by other Chemonics studies at the site. These are used in combination with the controlling and limiting factors are for the site to determine critical use areas and help determine overall levels of use.

## STATEMENTS OF SITE SIGNIFICANCE, MANAGEMENT OBJECTIVES, AND PRIMARY INTERPRETIVE THEMES

There must be clear statements of site significance, long term management objectives, and primary interpretive themes in order to provide a basis with which to make proper decisions for carrying capacity and for other management purposes. This step clarifies the most basic assumptions and sets the foundation for the carrying capacity analysis. These statements will also be useful to MOTA policy makers, Petra managers, and to others interested in evaluating management decisions. These people will be consulted during the development of these statements. Long term management objectives as used in this context are the same as the purposes for which a park is established.

Primary interpretive themes are the important concepts and information which all

visitors to Petra should learn and understand in order to understand the site's significance. Note that primary themes do not have to include all information which may be given to visitors. Identifying the themes will help define the appropriate experiences a visitor should have helped to define zones.

## Significance

The city of Petra contains remarkably preserved ancient structures and monuments of enormous aesthetic and historical value and subterranean archeological sites that contain invaluable information about the ancient world. It was originally the creation of the Nabataeans, Arab nomadic pastoralists who developed interests in the desert caravan trade hundreds of years before constructing the city. From southern Arabia they moved into the canyon system where they would build Petra in about the fourth century B.C.E. Perhaps two centuries earlier, the Edomites migrated to southern Palestine following the destruction of Jerusalem (ca. 586 B.C.) and the depopulation of Judea at the hands of the Babylonians. Operating not only from Petra in the region that in the Bible is called Edom, but throughout biblical Moab and other regions from southern Syria to the western Sinai as well, the Nabataeans after the fourth century B.C.E. controlled the spice and incense trade from Arabia to Mesopotamia.

Petra flowered in the first centuries B.C.E and C.E. This was made possible in an extremely arid environment by the engineering of a sophisticated hydrological system. The system brought water in channels and clay pipes from a spring at present-day Wadi Musa, outside the sandstone canyons in which the city was set. The system also harvested the meager yearly rainfall, and mitigated the effects of the rare downpours that would otherwise have produced destructive flash floods.

Rome annexed Petra in 106 C.E., motivated by the desire to ensure access to trading routes that linked the empire to the mid-East, India, and Asia. A growing reliance on sea rather than land routes as well as the ascendancy of Palmyra eventually caused commerce through Petra to decline. Many buildings were never rebuilt after a severe earthquake in 363 C.E., although Petra was not long after then designated the seat of a Byzantine bishopric. Recent archaeological excavations at Petra have indicated a substantial complex of structures associated with this last function, but by the middle of the seventh century C.E. Petra appears to have been largely deserted. In the twelfth century, Crusader forts were built and then soon abandoned. Petra was "lost" to the Western world until its "rediscovery" during the early nineteenth century, an event not unrelated to European colonialism, and perhaps a desire to capture in print the last bits of the world that remained unknown to and uncolonized by Europeans.

In continually seeking to improve their position in a trading network that including Greece, Persia, Rome, India, Arabia, and that stretched ultimately to China, the Nabataeans provided a conduit for goods and ideas among these groups. The architecture of Petra that survives today testifies to the exchange of cultural traits that occurred on a global scale even in ancient times. Tombs and buildings display

Assyrian, Egyptian, Hellenistic, Babylonian, and Roman characteristics incorporated into a Nabataean style that, especially in its earlier expressions, owes much to the architectural tradition of the East.

The universal significance of Petra is in how well its striking architectural and archaeological remains convey the geographically and culturally diverse roots of the classical world, the influence of which now permeates Western, and indeed global, culture. Visible to the visitor there are roots that run even more deeply than those just mentioned. Beida, an archaeological site excavated in the 1950s and still open to public view, is located just outside Petra proper, and is an example of one of the earliest settled communities. It is a neolithic, pre-pottery settlement from circa 6,500 B.C.E. displaying masonry construction, a squared plan, spatial complexity, and evident areas of specialization remarkable at this early date. The similarly excavated village at Umm al-Biyara was inhabited by the Edomites during the Iron Age, ca. the seventh century B.C.E., a group that figures importantly in Christian, Islamic, and Jewish traditional histories. A visit to the High Place of Sacrifice, which may date to a time before the occupation of the area by the Nabataeans but was used by them, provides an experience that resonates with accounts of rituals as they appear in these histories, and is one of the best preserved of all such ritual complexes.

## Management Objectives

The management objectives of a cultural site are built upon the significance of the site. The interpretive program should be formulated with reference to a concise statement of management objectives. For Petra, management objectives in order of importance are as follows:

1. Preserve the archeological artifacts, monuments and sites at Petra.
2. Protect the scenic quality of the site.
3. Ensure a written determination is made of potential impact of all planned actions on both the preservation of the archeological monuments and sites and on the experience of visitors to Petra.
4. Provide for visitor education and appreciation with the opportunity of a high quality experience in such a way that archeological resources are not significantly impaired.
5. Ensure that visitor facilities and services are adequate to meet basic needs, are maintained to the highest standards, and provide for visitor safety.
6. Ensure that local people are involved in planning and management of the site and that opportunities for employment of local are provided whenever possible.

7. Take an active role as a member of the Petra Regional Planning Council and with local governments especially Wadi Musa, Umm Sayhun, and Tabet Saman in order to:

a. ensure that potential impacts to park resources and visitor experience from inadvertent community actions do not occur, and

b. ensure that the park supports local communities as much as possible without impacting park resources and the visitor experience.

8. Support research activities and ensure that research activities do not impact the preservation of archeological resources or the visitor experience. All researchers should provide for proper conservation of artifacts in accordance with the law.

9. Ensure that all fees are collected in the most efficient and accountable manner possible.

10. Ensure that local populations and the Jordanian people understand the role of Petra in their cultural identity and history.

### Primary Interpretive Themes

Primary interpretive themes include:

The reason for the occupation of the Petra area by different groups that displayed cultures unusually complex and sophisticated for their times over almost 10,000 years of human history (with special attention to early Neolithic inhabitants, biblical Edomites, and Nabataeans).

The geology and biology of the Petra region, and how this is related to the theme just above.

Development and control by the Nabataeans of a key segment in the trading network that linked the great urban centers of East and West.

The technology necessary to live and travel in the desert, and the uses to which this was put by the Nabataeans in establishing their empire.

The construction of the complex hydrological system at Petra: how and when the technology was acquired, how this was done, how this is related to the establishment of a city by a nomadic people.

Important aspects of Nabataean cultures visible today in the practices of the Bedouin, specifically the Bdul.

Current research at Petra, addressing questions such as these:

Why was the first pottery produced by the formerly nomadic Nabataeans of such high quality?

What characteristics of Nabataean culture can be traced to the influence of the previous occupants of Petra, the Edomites?

The nature of Petra: necropolis, ritual and political center, caravanserai, or habitation area for 15,000 to 30,000 people?

Who lived in Petra, what did they do, and how did they live?  
How the Roman annexation of Petra in 106 B.C.E. affected the city.

Petra in the Byzantine era.

Global trading systems and their role in the exchange of cultural traits, particularly technology and belief systems.

The origin and development of agriculture and its effect on human society.

The ongoing program of ruins stabilization and conservation of artifacts.

The role of the visitor in preserving the site.

The influence of Mediterranean, mid-Eastern, and Eastern civilizations as seen in the material culture, especially architectural, of Petra.

Features in the landscape of Petra, both natural and those made by humans, related to traditional Islamic, Christian, and Jewish histories.

## DEVELOPMENT OF MANAGEMENT ZONES

A careful analysis of topography and landscape, significant or sensitive resources, potential visitor use attributes was conducted. Locations where these factors naturally grouped together were mapped and developed into zones. Within the Petra Sanctuary nine zones were identified. These are mapped and named:

### Petra Sanctuary Management Zones

ARRIVAL ZONE, from the Visitor Center to the Bab al Siq  
SIQ, which includes the Siq and Al-Khazna

THEATER, the area near the Roman Amphitheater  
The ELBOW or Bend, from the theater to the Nymphaeum  
CITY CENTER or Street Zone, dominated by the colonnaded street & Qasr  
al-Bint  
BASIN, area where the restaurants, museum, and other facilities are located  
AT-TURKMANIYYA Road, along Wadi Turkmaniyya and Wadi Nasara  
NEAR COUNTRY TRAILS  
BACK COUNTRY TRAILS

What follows for each zone is a written description of the physical setting found there, the type of experience which a visitor potentially may have there, and significant and/or sensitive resources found there. (These zones are being used by all members of the Chemonics team as a basis for their portions of the project.)

#### The Arrival Zone:

The walk from the visitor center to the Bab al Siq contains some of the most interesting architecture in Petra, including tombs that display Assyrian, Babylonian, and Egyptian motifs, and the Djin Blocks. Because visitors have not been presented with information about the significance of what they pass by in this area and how it relates to what else lies beyond the Siq, the great majority simply rush by what if properly interpreted would operate like the overture to a symphony. The arrival zone could not only be a rich experience in itself, but could also sensitize the visitors to the motifs he or she will encounter later on.

#### The Siq:

There is much information here that could contribute to the basic understanding of the site. The Siq itself was a vital element in the defense system of the Nabataeans. Visible are portions of the hydrological system that brought water from the spring at Wadi Musa. The side channels of the Siq could be points of departure for a discussion of the importance of the hydrological system to flood control, as well as to the water harvesting function of the system. At the end of the Siq, of course, lies Al-Khazna. The view of Al-Khazna from the Siq is the "signature experience" in a visit to Petra, an experience that will be remembered, and so should be tied to the overall Petra interpretive themes at the visitor center, in brochures and other interpretive devices, and at the museums in the "Basin." For the sake of visitor circulation and the visitor experience, it is best that most of this is done elsewhere, since too many people gathered at once in the area of Al-Khazna not only impedes visitor circulation but degrades the experience of viewing the structure.

## The Theater:

The area of the theater introduces the theme of the incorporation of Petra into the Roman empire. This is a provocative subject because it raises the issues of the position of Petra and the Nabataeans in the ongoing struggle for hegemony between first Persia and Greece, and then Persia and Rome; how the Nabataeans through their mastery of water were able to carve out fortresses in the desert at Petra and elsewhere; and what became of Petra after it was taken by Rome in 106 CE. This last is important because it prepares the visitor for the journey from the theater through the "Elbow," where some context must be provided in order that the visitor understand that the seemingly vacant landscape is actually the remains of numerous structures, and onto the "City Center." The visitor should be led to understand that more can be learned about the Roman/Nabataean interface at the City Center and that this experience will require at least three additional hours, not counting the trip back to the visitor center. The visitor should also be reminded where water, food, and restrooms are, and presented with the idea that the City Center and its environs might be worthy of an additional day's visit.

## The Elbow:

The walk through the Elbow can be a thought-provoking experience if one is aware that the immediate landscape contains the ruins of numerous standing structures that once occupied this area near the center of Petra. Brochures with written descriptions of what were once here, plan views taken from archeological research done in the area, and line drawings informed by scholarship of what the area might have looked like being perhaps among the most effective, non-intrusive ways to convey this. Many visitors, however, by the time they have reached the Elbow after a long walk from the visitor center, might be fatigued to the extent that they are less likely than were they rested to appreciate this experience. Adding to their discomfort will be that they will probably be walking through this unshaded area in early to mid-afternoon, if they have started their tour of Petra as do most people in the morning. This is an area more likely to be appreciated on the morning of a second day.

## The City Center:

This area holds material that might be developed through interpretative presentations and eventually through archaeological research sufficiently to draw the visitor back for a second day or a second visit. Excellent line drawings of some of the more aesthetically impressive of the structures that once stood here have been in existence (see Iain Browning, 1989). These and similar materials should be provided to

the visitor to increase her or his understanding of the area. Archaeological excavations underway on either side of the Roman road will do a great deal to enhance the visitor experience in the City Center. The current excavation of the South Temple (or Great Temple), located on the south side of the Colonnaded Street, is intriguing in itself, in part because it is of a structure that appears on the list of the world's most endangered cultural sites compiled by the World Monuments Fund in 1996. The Great Temple therefore can be used in interpreting dangers to the site from flash flooding and the erosion that results, deterioration of stonework especially because of salts that degrade sandstone, seismic activity, looting, and more casual pocketing of archaeological materials found on the ground surface. It also can be used in an explanation of stabilization by anastylosis. Finally, it can be utilized in a discussion of the history of the occupation of Petra, since it seems that the remains of the temple are located over those of earlier temples. On the north side of the Colonnaded Street, excavations of a Byzantine church are underway, which can provide a point of departure for the interpretation of what happened to Petra in its late history. Because of the impressive archaeological findings at the church, and its historical importance, it could be the focal point for a tour or brochure of its own. These finds included papyrus scrolls charred in a fire that followed the earthquake of 363 CE, which are now being conserved and translated, as well as mosaics and marble screens of high aesthetic value, now being restored. Also, on the north side of the Colonnaded Street are the remains of the Temple of the Winged Lion. Artifacts received from excavations at this temple that illustrate important aspects of Nabataean religion should be displayed at one of the museums in the nearby "basin" area, as should artifacts taken from the South Temple, the Byzantine Church, and other excavations that have been conducted in the City Center. The Colonnaded Street itself is a key providing the visitor an understanding of the changes that occurred at Petra in 106 CE; in fact, along the road are stones inscribed in Greek proclaiming the annexation of the city by the emperor Trajan (these stones should be moved to a controlled environment, logically to one of the nearby museums where they can supplement the interpretation of the City Center).

#### The Basin:

The Basin area contains many of the site facilities, including restaurants, museums, restrooms, and administrative offices. Museums display artifacts from all over Petra; while this is a logical location for such displays, more use of the museums could be made to convey information pertinent to the adjacent City Center, and to the ruins in the Elbow. Were this done, it would help to establish the area as one with experiences enough for a separate day's visit. Visitors should be made aware of visitor services at the Basin by all appropriate media (at the visitors center, in brochures, guided tours, and audio taped tours, and by means of non-intrusive signage).

#### Turkmaniyya Road:

Turkmaniyya Road provides another route to the City Center, one that is closed now to all but official traffic and those who have obtained special permission in advance. It is slated to become an alternative means of entry and egress to the site. Expected use will be by those leaving the historic area who do not wish to retrace the rather lengthy walk through the Siq and Arrival Zone, and those entering the historic area on the second (or later) day of their visit; the latter would probably leave via Turkmaniyya Road, also. Visitor access to the site through Turkmaniyya Road, then, will encourage a two day or longer stay at Petra by making it easier for the visitor to revisit the City Center and the western part of the historic area in general. Nonetheless, providing access via Turkmaniyya Road is not without threat to the integrity of Petra. Only the small vehicles should be allowed to use the road (and the road should be constructed so as to only accommodate small vehicles). Large tour buses would visually and aurally intrude upon the road itself, along which may be seen not only Turkmaniyya Tomb but also many smaller tombs, as well as Umm Sayhun. Vehicles should not be allowed in an area from which they can be seen from anywhere in the Basin. Visitors should be dropped off and picked up over the first hill from the Basin. This would entail a short walk, or perhaps a ride on a camel or donkey for a small fee from a Bdul owner of such an animal. Interpretive talks should be provided by the drivers of the small transportation vehicles. Part of the interpretation should be a presentation of what visitor facilities are available at the destination of the drive.

#### Trails (Near country):

Trails provide an opportunity to observe antiquities in the company of fewer people, and so in a quieter environment that might invite contemplation. They also guide one to some of the more spectacular views and constructions at Petra, like the High Place of Sacrifice and Ad-Dayr. But because behavior on trails is less likely to be observed, vandalism and looting on sites near trails is more likely to go unchecked, and visitors who might be injured or suffer from health problems because of the rugged and harsh environment of Petra are less likely to be provided assistance quickly. Falls and heart attacks are special problems on trails; site personnel have indicated that four or five persons die each year from these causes. More become lost. These people are often found by the local Bdul. Thus a vital part of the interpretive program for trails should be to make visitors aware of both the dangers and their responsibility to the resources they will encounter. The trails to the High Place of Sacrifice and to Ad-Dayr, while they are not back country trails, are extremely demanding. It should be well publicized that only those in very good physical condition should take these trails. Trails should also be well marked. Markers can be keyed to interpretive brochures.

#### Trails (Back country):

Backcountry trails are all those from which some part of the central area of Petra (the Theater, the Elbow, the City Center, or the Basin) cannot be seen at all times (excepting trails to the High Place of Sacrifice and ad-Dayr, which for the purposes of this document are considered Near country trails, if very challenging ones). Backcountry trails require a guide, and often a camel or donkey, at the guide's discretion. Interpretation of backcountry trails should be provided by the guide, supplemented perhaps by a brochure. It should be expected that only a small percentage of visitors will experience backcountry, and only a minority will experience any trails at all. The main thrust of the interpretive program at Petra should be directed to the central area of Petra. Interpretive emphasis at trails should be on protecting resources and visitors.

## INDICATORS, INSTRUMENTS, AND STANDARDS FOR MONITORING

Monitoring is accomplished by measuring variables pertinent to a desired condition, and determining if the quantified variables lie within or exceed standards previously established for those variables. A measurable physical, social, or ecological variable is called an *indicator*. Indicators are ideally 1.) easily measurable, and 2.) sensitive to minor changes in the condition being measured. Indicators should be easily measurable so that measurement can occur on a regular basis despite eventualities such as the loss of completely trained personnel, or reduction in program funding. Easily measurable variables are also often more easily understood by the variety of persons who must take action to correct deteriorating site conditions. Indicators should be sensitive so that negative effects to conditions can be identified before they become irreversible.

The *instrument* is the means by which a measurement is taken. The instrument should be easily used by minimally trained persons, if at all possible. The more simple the instrument to operate, the more desirable the instrument. Highly sophisticated instruments (that might be used to measure stone deterioration at Petra monuments, for example) are less likely to provide dependable monitoring data over the long term than are instruments employing a technology familiar to many people.

*Standards* are based upon the best knowledge of the desired condition that will be measured. *It should be recognized that at Petra not enough baseline information exists at present about some of the resources there to inform very well the determination of desired conditions.* Numbers of people through the site as a whole or in many of the site zones (defined above) are examples of quantities for which desired levels have yet to be determined with precision. It is not known, because records have not been kept, how visitor density at the site as a whole or in site zones might correlate with visitor satisfaction, or with the rate of loss of artifacts from archeological sites, with the

occurrence of graffiti, vandalism, erosion or loss of vegetative cover produced by increased visitor traffic, or indeed, very precisely, encroachment on the site by development in the area surrounding the site. As monitoring is introduced and records are compiled, correlations should become evident that will guide the establishment of standards for numbers or people through the site or in zones over a given period. Other standards are more evident. It is patently desirable, for example, that no deterioration be observed in sandstone monuments, or that no artifacts be lost from archaeological sites, or that no erosion occur on site.

Both day-to-day and periodic monitoring is recommended here, described below. The day-to-day monitoring will be the least demanding of training and time, as it is assumed that park staff, already burdened with many other responsibilities, will carry this out for the most part. Periodic monitoring may often be carried out under contract or another sort of agreement with universities, NGOs, consultants, or cooperating international organizations.

The instruments to be employed are various, and are described in detail below. Some are largely in place (keeping track of numbers of people entering the park by hour, for example), others require little equipment but do require regularly scheduled activities by park staff (counting numbers of people that can be seen at one time at various locations sensitive to crowding), some will require that equipment be purchased and that trained persons be obtained to operate the equipment (taking photographs of monuments and sites is an example of this), and some will involve obtaining data acquired commercially or by other organizations that will be analyzed by park staff or consultants.

Whatever the instrument used and by whomever it is used, the monitoring program to be successful must ensure that remedial actions are taken when standards are exceeded. This management infrastructure to accomplish this is set out in "Management Analysis and Recommendations for Petra," to which this carrying capacity study is intended to be a companion. To quote from the management report (pp 57-58):

*Coupled with the monitoring procedures that will be described later in this section, effective monitoring at Petra will require the following:*

- 1. A rigorously followed procedure for reporting monitoring observations; and*
- 2. Adequate numbers of qualified personnel to carry out the monitoring.*

*Every incident of observation should generate a written document, whether the observation is being done by Petra site personnel on daily rounds of the site or by technical specialists visiting the site during inspections scheduled at five year intervals.*

*The form of the written documentation will of course vary depending upon the nature of observations made. Monitoring observation forms might be prepared for use by park staff during regular rounds at the park that would include spaces to be filled in with information about the exact location of the observance, the date and time, what was observed including any activities or conditions that have produced or may produce damage or deterioration, any preliminary recommendations, and the name of the observer. Observations made by technical experts should include a summary that can be easily used by Petra site management in taking subsequent steps to correct the observed problem.*

*It will be the responsibility of the Petra National Park Agency Director to review each written monitoring observation with the assistance of a Petra Site Monitoring Officer. The Petra Site Monitoring Officer will be selected from among the staff of archaeologists at Petra, and may be the Chief Inspector for Archaeology at Petra if that person's workload permits this. The Monitoring Officer will keep a file of every written monitoring observation, discuss each with the Agency Director, and prepare a report each year that includes each observation, actions taken to correct observed problems, and further actions required. The Petra Agency Director will also have the responsibility for requesting resources adequate to the task of correcting observed problems.*

*In summary, the procedure for reporting monitoring observations is as follows:*

- 1. Written documentation is prepared for each monitoring observation.*
- 2. Documentation is submitted to the Petra Site Monitoring Officer, who discusses each observation with the Petra National Park Agency Director (the Monitoring Officer) also maintains a file on each observation.*
- 3. Requests for funding, expertise, and equipment adequate to correction of problems observed by monitoring is made by the Petra National Park Agency Director.*
- 4. Yearly report of each monitoring observation, actions taken to correct observed problems, and further actions required is drafted by the Petra Site Monitoring Officer and approved and submitted by the Petra National Park Agency Director (the report may, at the discretion of the Park Director, be included in the Petra National Park Annual Report). This report should be submitted to appropriate officials in Amman as well as to UNESCO.*

## **Indicator: Loss of surface artifacts at archaeological sites**

### **Instrument:**

**Two meter by two meter monitoring locales should be established on the ground surface at each archeological site.**

As with monitoring locales on facades and standing structures, the locales should be photographed *yearly* and a report prepared describing any degradation of the resource revealed by comparison of photos with photos taken in previous years. In this case, changes revealing degradation would include the loss of artifacts (the pottery shards, lithic fragments, and other small artifacts commonly seen on the ground surface at Petra).

### List of Archaeological Sites Requiring Monitoring

A partial list of archaeological sites requiring monitoring would include:

Temple of the Winged Lion  
Byzantine Church  
Qsar el-Bint  
Great Temple  
Beidha  
Edomite village at Umm el-Biyara  
Petra town dump  
Nabataean kiln sites located near the visitor center

### **Standard:**

**The tolerance for loss of surface artifacts is zero.**

Any observed loss should trigger management action to arrest such loss

## **Indicator: Status of vegetation**

### **Instrument:**

**Vegetation can be monitored by analysis of aerial photography and other aerial remote sensing imagery.**

Black and white or color aerial photography should be used to detect changes in vegetation type or cover, as well as erosion and the encroachment of development (see below) Photos at about the scale of 1:25,000 should be obtained and retaken at a minimum of five year intervals of Petra and the region surrounding it, including Wadi Musa and Umm Sayhun, as well as of outlying portions of Petra National Park. (Aerial photos Petra of approximately this scale are on file with the Royal Geographic Society and are very informative of alterations to the landscape of Petra over the past 40 years. Aerial back and white stereo pair photos of Petra on file there include the following series: 1:30,000 taken in 1992, 1:10,000 taken in 1981, and 1:25,000, taken in 1953.)

Even lower altitude and therefore larger scale photos of the historic core of Petra should be obtained in order to identify in greater detail changes in vegetation (as well as changed in topography, inappropriate development, or looting activity.) Excellent low altitude photographs of areas in the core of Petra, particularly along the Colonnaded Street, have been taken by J. Wilson Meyers and Eleanor Emlen Myers in the past few years, which form an extremely valuable archive of current site conditions. Scales range from about 1:3,500 to as large as 1:500. Similarly large scale photographs should be obtained at time increments of, at maximum, five years to chart the condition of the core historic area. Such photos could be obtained by balloon, as has been very well done in the past, or by radio controlled model airplanes or helicopters carrying photographic equipment.

Aerial photographs of the Petra area, because of its outstanding architecture, striking natural setting, and historical importance have been taken at irregular intervals for almost the entirety of the twentieth century. Changes observable in the aerial photos can be matched to the current scene on the ground, providing a useful baseline against which to measure future developments.

If more information about vegetation type, variety, and health and water pollution is needed than can be obtained from an examination of black and white and standard color photography, the use of color infrared film to obtain images may be helpful. Electronic multi spectral scanning can often detect topographic changes, and so may be used to identify erosive processes underway. SPOT and LANDSAT imagery of Petra exists. Lower altitude color infrared photographs may have been taken of the Petra area, and the area may have perhaps been the subject of lower altitude multi spectral scanning as well.

**Standards:**

Management action should be triggered by:

- \*A reduction in gross vegetation 10%,
- \*Any reduction of vegetation likely to produce erosion
- \*A reduction by 5% of desired vegetative species
- \*Vegetation growing on monuments or structures

## **Indicator: Active erosion at archaeological sites**

**Instrument:**

The same aerial surveillance techniques described just above can be employed in detecting active erosion at archaeological sites.

**Standard:**

**The tolerance for such erosion is zero;** any erosion observed should trigger management action.

## **Indicator: Looting at archaeological sites**

### **Instruments:**

**The aerial surveillance techniques described above, particularly the lower altitude photographs, can be used to detect looting by means of unauthorized excavations.** Such photographs should be obtained and examined every five years for evidence of this.

**Looting activity should also be reported on forms supplied to park personnel carrying out routine tours of the site.**

### **Standard:**

**Tolerance for looting activity is zero.** Any detected should prompt management action.

**Indicator: Visual intrusion by modern or incompatible landscape elements, occurring inside or outside Petra**

**Instruments:**

**The aerial surveillance techniques described above can be used as a clue to the presence of such intrusion**, especially when used in conjunction with landscape modeling software. The key monitoring mechanism for the indicator of visual intrusion, however, is quite simple:

**Photographic documentation of vistas should be made from various key points in the cultural landscape** each year. These key points should include:

The Theater  
The High Place of Sacrifice  
The center of the Roman Colonnaded Street  
Ad-Dayr

**Standard:**

**Any intrusion by modern or incompatible landscape element should trigger management action.**

**Indicator: Numbers of people by month, and by sample period  
day and hour**

**Instrument:**

**Number of visitors to Petra by month and by sample period day and hour can be determined by ticket sales, which should be sold as adult international, child international, adult national, child national, adult local, and child local tickets.**

**Standard:**

**Numbers of people exceeding standards for the site as a whole by 10% should prompt management action.**

## **Indicator: Distribution of people in zones (using trail counters)**

### **Instrument:**

**Trail counters placed at location in zones where those entering must (or most probably will) pass by.** Some training will be necessary to who will utilize data gathered by the trails counters so that they can interpret is correctly by weighting for typical numbers of reentries and exits past the locations of the trail counters.

### **Standards:**

**Reliable standards for visitor zones must be established by correlating numbers of visitors in zones with deterioration of desired conditions** as indicated by surveys of visitor satisfaction, numbers of accidents, reported conflicts, incidents of theft, and, over the longer term, erosion of soil or degradation of historic fabric in the zone, or other environmental or experiential changes.

**Interim standards, at minimum, should be established over a the first year of monitoring by determining typical numbers of people in zones by days of the week in each month; interim standards would be numbers greater than 20% of these.**

## **Indicator: Number of people at one time (PAOT) at key locations**

### **Instrument:**

**A count of the number of *people at one time (PAOT)* that can be seen from certain places most sensitive to overcrowding** should be taken *on Thursdays one week and Fridays the next during the months when visitation is markedly higher* than in other months (March, April, May, August, and October at present). This count should be taken at the same time for each place, but for all places between 8:30 a.m. and 10:30 a.m.

Locations for PAOT counts should be established at:

A point midway down the Siq  
Al-Khazna  
Ad-Dayr  
The High Place of Sacrifice  
Beidha  
The Edomite village at Umm el-Biyara

### **Standards:**

**Reliable standards for visitor PAOT locations must be established by correlating numbers of visitors at the locations with deterioration of desired conditions** as indicated by surveys of visitor satisfaction, numbers of accidents, reported conflicts, incidents of theft, and, over the longer term, erosion of soil or degradation of historic fabric in the zone, or other environmental or experiential changes.

**Interim standards, at minimum, should be established over a the first year of monitoring by determining typical numbers of people at PAOT locations by days of the week in each month; interim standards would be numbers greater than 20% of these.**

## **Indicator: Amount of graffiti present**

### **Instrument:**

**Two by two meter facade monitoring squares should be selected at vulnerable locations on the facades of tombs, monuments, and other sites including natural sandstone walls highly accessible and visible to the public. These squares should be photographed every five years** to document graffiti or other vandalism, as well as erosion or deterioration produced by natural causes. The first two by two meter photograph taken at each locale should set the frame for subsequent photographs. A print of the first photograph obtained at each monitoring locale should be taken into the field when additional photos are being taken, and the field of view in the initial photograph should be replicated as closely as possible.

Photography square monitoring locales should be established at:

Bab as-Siq: one monitoring locale at each Djin block, the Obelisk Tomb, and the Bab as-Siq Triclinium.

The Siq: at approximately every two hundred meters on alternating sides of the Siq.

Outer Siq: one monitoring locale at each facade along the "Street of Facades."

Wadi Mudhlim: at approximately every two hundred meters on alternating sides of the siq.

Al-Khazna: two exterior locales and two interiors.

Ad-Dayr: two exterior locales and two interiors.

The path to Ad-Dayr: one monitoring locale at each major tomb on the path.

The High Place of Sacrifice: at least one face of each obelisk and the alter itself.

Sextius Florentius Tomb: Two two by two meter grids, one of which should be of the inscription (the longest in Petra).

At each of the following, one monitoring locale:

Urn Tomb  
Silk Tomb

Corinthian Tomb  
Palace Tomb  
Carmine Tomb  
The Theater, lower section  
The Theater, upper section  
The Nymphaeum  
Temenos Gate  
Qasr al- Bint  
Habees High Place  
Turkmaniyya Tomb  
Unfinished Tomb  
Columbarium  
Convent Group  
Broken Pediment Tomb  
Renaissance Tomb  
Triclinium  
Garden Triclinium  
Roman Soldier Tomb  
Lion Monument  
Al-Najr Tomb  
Snake Monument

At Siq al-Barid (Little Petra) near Petra, both full facade photos and two by two meter monitoring locale photos should be obtained at all major facades. Two by two meter photos should also be taken of all frescos there.

A two by two meter monitoring locale should also be established at the fresco in the small tomb in Wadi e's-Siyagh

**Standard:**

**Any additional graffiti or other damage caused by vandalism or natural processes should be the basis for management recommendations that would curtail such damage in the future.** These recommendations might include closer surveillance of the area by Petra staff or volunteers, placing the area off-limits to visitors, or focusing interpretive efforts on the irreversible harm produced by vandalism. These management recommendations should be made as appropriate if they are indicated by the very first, baseline set of photographs taken, especially if comparison of these photos with historic photos indicates deterioration.

*All photographs should be reviewed by Petra site management within one month of the time they are obtained, and any graffiti or other damage or deterioration noted in a memo to the Director-General of the Department of Antiquities. Photos and any resulting memos should be provided to friends' groups and advisory committees on*

*request, or at any scheduled meetings of such groups.* All of this should be done in addition to the normal monitoring reporting procedures described at the beginning of this recommendation section. This documentation will be extremely valuable to any effort to secure grants or other funding for the preservation of facades.

## Indicator: Visitor satisfaction (survey and comment cards)

### Instruments:

**Mechanisms that can detect changes in the experience of visitors and the local population are surveys of these groups.** Questionnaires should be prepared, suited to each population. The questionnaire measuring customer (visitor) satisfaction should contain the following two questions:

"In your last (current) visit to Petra, which best describes your experience?"

Excellent..... Satisfactory .....Unsatisfactory

10 9 8 7 6 5 4 3 2 1

and,

"Would you recommend this tourist destination to your friends?" (This can be followed with, "Why, or why not?")

These questions should be supplemented with others that deal with issues of special importance to Petra, such as satisfaction with visitor facilities like the visitor center, comfort stations at the site, accessibility of food and drink. Information about the effectiveness of the interpretive program would also be helpful; this could be obtained by questions about what the visitor expected to learn from his or her visit and what was actually learned by the visitor.

It is important that surveys be conducted so that results are valid and useful. They should be stratified according to groups about which information is required, that is, questions should be filled out by international, national, and local tourists, who should be identified as such on the questionnaires. If informative answers are not forthcoming to written questions, a statistically valid sample should be obtained through oral interviews. Nationality, age, and length of stay information should be obtained on each questionnaire, and occupation and income information if possible.

As important is that questionnaires be obtained at different times of the day, week, and year. Visitor satisfaction may well vary considerably according to crowding at Petra or in the visitor zones there. Furthermore, satisfaction may be found to correlate especially well with PAOT crowding at certain locations for which visitation figures have been obtained as suggested above (Al-Khazna, Siq, Theater, and so forth).

**Standard:**

**A drop in the satisfaction index of 10% should prompt action by site management.**

## CONTROLLING AND LIMITING FACTORS

Controlling and limiting factors are those factors which relate directly or indirectly to how the Sanctuary is used. Some of these factors may change over time while others are fixed. For example, the physical configuration of the Sanctuary in general and at key locations are fixed, while visitor profiles and use patterns may change over time.

### Distribution of Visitor Use

Visitation patterns to Petra include two high use times of the year beginning with the period from March to May and then in October. The busiest days of the week are Thursday and Friday. The average duration of stay in Wadi Musa is 1.15 days indicating that one trip into the Petra Sanctuary is the average.

### Types of Visitors

There are two basic types of visitors who come to Petra. The first comes in organized tours generally by bus. The other comes in individually or in small groups. These two types of visitors have very different types of use patterns which may have significant implications when evaluating specific management strategies.

### Organized Tours

The first groups, those who come in organized tours, come to Petra primarily in buses and make up 80% of all visitors. They tend to be foreigners. They also tend to be older, 50+ years old, and less physically fit. They travel with the group and very rarely explore away from the group. Guides are with the group at all times when in the Petra Sanctuary. The guide provides information at designated spots and sets the pace for the visit. They usually stay in the main visitor use corridor along the wadi and frequently only get as far as the Roman Theater. This may be because the guides don't go any further. It may also be because of their physical fitness and the strenuous nature of the hike into the Sanctuary. Their average stay in the Sanctuary is approximately three hours. They travel into the Sanctuary only once although their stay in the area generally includes an overnight stay in a hotel. This class of visitors tends to have more money and use the better hotels in the area.

### Individuals and Small Groups of Visitors

The second group made up primarily of individuals and small groups or families comprise about 20% of all visitors. They may be either Jordanian or foreigners. From the limited nature of our observation it appears that young people, 20-30 years, made up the largest number of this group. They are generally physically fit. They may travel with a guide or only with a guide book. They use all zones within the Sanctuary and frequently stay two or more days. They tend to stay in the Sanctuary in the 4-5+ hours

on the average. They do not tend to have a high level of funds available to them. Al-Khazna is the Controlling Feature for Carrying Capacity

There is only one way into and out of the Petra Sanctuary for visitors. They must hike in and out via the Siq. If they travel to the Basin Zone it is 3 kilometers one way making a hike of 6 kilometers for the round trip if they don't travel off the path to visit attractions such as the Royal Tombs. The topography and attraction of the spectacular monument known as Al-Khazna at the end of the Siq make this area the controlling topographical feature of the site.

The Basin area is very different from the Siq zone. It is more open than the Siq or the Al-Khazna. It contains site management visitor service facilities. The topography and use of the area made determination of a carrying capacity much more difficult than the Siq and Al-Khazna. The restaurant seating capacity was considered as one way to accomplish the task. The location of the Siq at the beginning of the wadi made determining an absolute number for the Basin much less meaningful. In the end no fixed number was used. Instead the 7/3 ratio determined by the transportation study was adopted where the ratio represents the number of people who enter by the Siq and those that can enter by the road.

## MANAGEMENT STRATEGIES

Five different management strategies were evaluated. These are: the present system; the addition of a second entrance by opening the At-Turkmaniyya Road; a one way visitor use system using the road; a mandatory reservation system; and a reservation system for tour companies only.

1. Present Management system; walk in & out through the siq. This is the only practical way into the site at this time. There is crowding at Al-Khazna during much of the day. Almost half of the visitors see the area up to the Roman Theater because of the time and effort it takes to walk out. The present management organization is having a difficult time in managing the site now. The visitor experience is being impacted as indicated by the UNESCO Management Plan and other studies. A site as spectacular as Petra should have a 90-95% visitor satisfaction rating. It is not achieving that now.

2. Second Entrance via At-Turkmaniyya Road. Developing and using the At-Turkmaniyya Road as a second entrance to the site would require the development of a transport system. This has potential of extending the average visitor stay for those not in tour groups and would extend the time of day people could go to the site. It would also extend the area of the site that is visited. Administering a second entrance requires a sophisticated management organization to control the shuttle bus system, the access and use of the road and, the increased numbers of visitors. The present management organization is having a difficult time managing the present system and could not manage this one.

3. One Way System; Walk in the Siq and transport out via At-Turkmaniyya Road. This system would allow the highest number of visitors. However, it would be difficult and expensive to administer. It would have a significant impact on visitor experience by the lack of visitor freedom, especially for the 20% of visitors the government would like to have stay in the area a second day. It will not be considered.

4. Mandatory Reservation System. A mandatory reservation system for all visitors would require a large, sophisticated management organization and an elaborate control system. Visitors would have to plan their itineraries in advance. It would have a significant impact on the visitor experience. It would also be expensive and difficult to administer. It will not be considered further.

5. Reservation System for Tour Companies. This system would have the government develop a reservation strategy only with tour bus companies. They would reserve tour slots by date and time. This would effectively have 80% of the visitors on a reservation system with minimum impact to their experience. Visitors not on tours would be unaffected. Administration of the system would take a coordinated effort by the government with all tour companies. Companies would have to determine their schedules well in advance, at least one year. The system would be difficult to set up and initiate. Once in place would be less difficult to administer. There would be little impact, if any, on the visitor experience. It is preferable to the mandatory permit system. However the complexity of the system would not be worth the cost and effort needed for implementation. It will not be considered further.

## ANALYSIS OF CARRYING CAPACITY LEVELS

The daily carrying capacity of Al-Khazna was determined based upon the number of people at one time (PAOT) that the site could sustain who would have a good visitor experience. PAOT and the average length of stay at the Al-Khazna were correlated to establish the number of people per hour the site could sustain. The area can hold a maximum of 375 people. This is using level of service average for a plaza or piazza of 25 square feet per person. However, it is a confined space with high rock walls. Large groups of people, with guides giving talks and general conversation, make it very noisy and produce a sense of crowding. Therefore, the optimum use limit should be about 200 people. People tend to use the about half of the area, i.e., the half near the exit from the Siq. This is so they can get a good view of Al-Khazna. Observation and analysis indicated that the area can hold a maximum of 6 organized groups 20-30 people at one time. This is about the size of the bus tour groups in the area. Larger buses with groups of 50 or more would lower the number of groups to about four at one time. The hourly capacity for Al-Khazna ranges from 400 to 600 given the maximum number of PAOT of 200 and the average length of stay of 20 to 30 minutes per person and per group.

Visitor use statistics indicate that most visitors arrive at Petra during the first five hours of the day, 7 a.m.-11 a.m. This has been lengthened up to two additional hours during the peak season. The long walk needed to see the site and tour company schedules appear to cause this pattern. This study will use the yearly average of five entrance hours per day to determine daily use figures.

Visitor distribution statistics indicate that 95% reach Al-Khazna and only about 60% get as far as Qasr al-Bint. These figures were combined with the daily carrying capacity figures for Al-Khazna to develop the table below comparing the capacities for the present system of use and one potentially opening an access point on the At-Turkmaniyya Road. Again given the difficulties of topography in determining a maximum capacity for the Basin Zone, the ratio of 7/3 was used to determine the maximum numbers of people that could access the Sanctuary via the At-Turkmaniyya Road.

Comparison of Two Management Systems					
Mgmt System	Hourly Maximum people/hr	Daily Maximum no./day	Monthly Maximum no./month	Annual Maximum people/ yr	Mgmt Concerns
<b>Present System, only entering the Siq</b>	400-600	2000-3000	60,000 to 90,000	730,000 to 1.1 million	During individual days in the high use season Petra may be exceeding its capacity now.
<b>Second Entrance, using the Siq and the At-Turkmaniyya Rd.</b>	575-860	2900-4300	87,000 to 129,000	1.1 million to 1.6 million	Would not be able to manage without coordinated management system.

Note: *The high and low figures in each cell are based upon calculations in which groups of 200 PAOT are the maximum number that can occupy the Al-Khazna area and they are on a schedule of either two or three periods of maximum PAOT per hour. For the Second Entrance scenario, the ratio of 7/3 (Siq vs At-Turkmaniyya Road) entrances to the Petra Sanctuary was used in calculations (see discussion above).*

## CONCLUSIONS AND RECOMMENDATIONS

The table above indicates that, under the present and foreseeable management system and under current site resource conditions, the maximum carrying capacity for Petra is 2000 to 3000 people per day or 60,000 to 90,000 per month. This figure was exceeded during one month this year. Managers had a very difficult time in dealing with this amount of use.

**The monitoring program should be implemented as soon as possible.** If the increase in use that is expected occurs, the site will frequently exceed its capacity numbers in the near future. Managers should be concerned about impacts to the historic fabric and the visitor experience if this happens.

The much higher figures for the Second Road System assume that those coming in that road would become more widely distributed by using the trail system. It will be essential that visitor experience and use patterns be closely monitored and the capacity numbers adjusted based on experience and monitoring data. Capacities and levels of maximum use from the Second Entrance Road are estimates made without access to this kind of data. **The second entrance should not be opened until more data are available and Petra has an organization in place to manage the large numbers of people.** Again, getting the monitoring program started as soon as possible is important.

Carrying capacity numbers are both appealing and often misleading because they seem to provide definitive answers to our questions about carrying capacity. They are easily quoted, and so can be quoted inappropriately, at a time when site conditions have changed and the numbers are no longer relevant. It is important to remember that carrying capacity is much more than numbers of visitors. Carrying capacity is "the type and level of visitor use which can be accommodated while sustaining the desired resource and social conditions that complement the purposes of a park and its management objectives." This means that carrying capacity is dynamically determined by management objectives, indicators, and standards. This is not to say that level of use is not a basic and very important indicator. The numbers in this report are a first attempt to develop a standard for managers to use in evaluating level of use. Setting standards, however, is an iterative process; all standards need to be continually updated to ensure accuracy, based upon information gained from site monitoring. Having a clear set of management objectives is the foundation. Then the monitoring system needs to be implemented. The monitoring must be carried out on a regular, long term basis.

We recommend that the management objectives be reviewed and approved, that the monitoring system be implemented by developing baseline data and beginning data collection, and that all data are evaluated at least annually to compare them to standards so that capacity conditions can be assessed and standards can be continually updated.



FIGURES: MANAGEMENT ZONES, DISTRIBUTION OF TRIPS BY LOCATION,  
VISITOR HOUR OF ARRIVAL