EVALUATION OF EVACUATION PLANNING IN WILDLAND-URBAN INTERFACE ENVIRONMENTS

EXECUTIVE ANALYSIS OF FIRE SERVICE OPERATIONS IN EMERGENCY MANAGEMENT

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writing of another.

Signed:_____

ABSTRACT

Grand Canyon National Park has had a written evacuation plan in place since 1997. Recent wildland fires have tested the effectiveness of that plan. An After Action Review of the evacuation operations uncovered material weaknesses that resulted in delayed community notification, lack of community education, and preparedness. The purpose of this research was to evaluate evacuation planning efforts by Arizona communities to determine best practices in community notification, education, and crisis communication efforts.

This evaluative research project surveyed county emergency managers throughout Arizona regarding evacuation planning and notification channels used to alert community residents. The research also reviewed After Action Rollups of wildland-urban interface fires in Arizona and California to examine lessons learned. The following research questions were answered:

1. What methods are utilized by communities for effective mass notification to evacuate?
2. What information is provided to community residents in order to properly prepare for an evacuation?
3. In reviewing evacuation events, what lessons were learned from efforts to notify the community of an impending evacuation and maintain communication links with displaced community residents.
4. What are the best methods for evaluating planning efforts and how preplanning impact the success or failure of an evacuation event?

The results from this research indicated that communities with a risk of wildland fire have developed successful evacuation plans. The planning efforts in all counties with wildland urban interface risk resulted in better executed evacuations. New technologies, such as reverse

911, for rapid notification have been slow to be adopted by Arizona. Community education programs that involve all levels of stakeholders and governments have proven successful in raising the public awareness level of the risk and need for protective action. The recommendations from this research project were used to implement a crisis communication plan model for the park.

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INTRODUCTION

Grand Canyon National Park, located in northern Arizona, encompasses q.2 million acres. Approximately 750,000 of that will support fire. Fire management's goal at Grand Canyon is to provide for firefighter and public safety while protecting life and property. Although prescribed fire and wildland fire use fires have reduced the threat of catastrophic fires, several years of drought have minimized that effort. Forested lands through Arizona have seen an increase in serious fires and destruction of homes and property. The wildland-urban interface fire threat to Grand Canyon has been heightened over the seven years of drought. Two fires in 2004 came dangerously close to the residential and commercial community of the park. Step up plans for impending evacuation were instituted. After Action Reviews of those operations, found weaknesses in the crisis communication and evacuation strategies used.

The purpose of this research was to evaluate evacuation planning to determine best practices in community notification, education and crisis communication planning efforts. This research involved an evaluation research method including: a survey of county emergency managers, a review of evacuation plans interviews with community emergency managers, and an incident Commander of Interagency fire teams which have experienced wildland fire related evacuations in the last few years. The following research questions were addressed:

1. What methods are utilized by communities for effective mass notification to evacuate?
2. What information is provided to community residents in order to properly prepare for an evacuation?

3. In reviewing evacuation events, what lessons were learned for efforts to notify the community of an impending evacuation and maintain communication links with displaced community residents?
4. What are the best methods for evaluation planning efforts and did preplanning impact the success or failure of an evacuation event?

BACKGROUND AND SIGNIFICANCE

The current national attention to wild land fire threat to homes was initiated in1985 when 1400 homes were destroyed in the western United States. The following year the National Wildland/Urban Interface Fire Protection Program, a multi-agency endeavor was established. The program is sponsored by all federal land management agencies, the National Association of State Foresters and the National Fire Protection Association. The program also has an advisory committee associated with the multi-agency National Wildfire Coordination Group (Cohen, 2000).

The wildland fire threat to homes is commonly termed the “wildland–urban interface”. Similar terms such as wildland-urban intermix refers to an area or location where a wildland fire can potentially ignite homes (Cohen, 2000). Every year thousands of people are evacuated from their homes as a result of catastrophic wildand fire. As communities continue to grow and impinge upon the forests, the urban interface areas will be at risk for wildland fire threats. Grand Canyon National Park is a classic example of this mixture of forest, residential, and commercial development. Visited by 5 million visitors a year, the park is supported by 2500 residents. There are 1152 structures located within the park, 377 are considered historic and listed on the historic register. There are 1117 lodging units and 700 campsites located within the park. Additional

infrastructure includes four sewage treatment facilities, two water treatment facilities and a trans-canyon pipeline. The North Rim and South Rim are separated by the canyon and Colorado River. The South Rim is 7,000 feet in elevation and the ecosystem is composed of Pinion-Juniper/ Ponderosa pine forest. The North Rim at 8,000 feet is forested with primarily conifer Spruce/Fire/ Aspen (Grand Canyon National Park, 2004).

Prescribed fire has been the primary mitigation tool within the wildland - urban interface zone. During the 2000 high fire danger season, some efforts were made to reduce fuel loading around the residential areas on both the North Rim and South Rim. Defensible space is not enforced within the community even though the residences are government controlled. Compliance with defensible space recommendations from the Fire Management Office is completely voluntary. Some effort has been made to improve building codes to meet fire resistant roofing construction, but often such modifications are reduced due to historic preservation mandates.

Evacuation planning efforts began in the park in 1997 with joint agency meetings between National Park Service, United States Forest Service, Coconino County Sheriffs Department, and State of Arizona Department of Public Safety. Public safety agencies served as the primary contributors with minimal input by local concessionaires, businesses and community members. The initial plan focused on three demographic locations, South Rim Village, Desert View and North Rim developed area. In 2001 during a spring prescribed fire effort on the North Rim, an escape fire triggered the evacuation of the developed area of the North Rim. Numerous problems were encountered in the after action review including a significant delay in implementing the evacuation order. Managers disagreed on whether the evacuation should be mandatory or voluntary. Problems occurred because of only one egress route out of the area

which became overrun by fire and falling trees. As a result, numerous visitors were "sheltered in place" at overlooks and lodging facilities for the night.

In May of 2004 another prescribed fire located on the South Rim, also resulted in an escape fire which impacted the developed area of the park and visitor use areas. An Incident Management Team was assembled and the beginning stages of evacuation were initiated. An after action review of this fire, the Long Jim Fire, showed numerous problems with the community notification, warning and lack of crisis communication plan. (Author, meeting notes, June 17, 2004). In addition, the lack of table top exercises and simulations identified a lack of knowledge by many commanders of the plan. As a result of these events, the park began to reevaluate the evacuation plan and means of improving identified weaknesses.

This research project was completed in accordance with the applied research requirements of the National Fire Academy's Executive Fire Officer Program. The problem of evacuation planning addressed by this research project related specifically to Unit 7 of the Executive Analysis of Fire Service Operations in Emergency Management course, "Media relations". In this unit of instruction, students were introduced to the role of the Information Officer in emergency operations and its value in both media and public relations. The other unit that applies to this research project is unit 9, "Emergency Operations Center" and the need for joint cooperation between agencies managing large scale emergency operations. The lessons learned from experiences of emergency managers in wildland-urban interface fires would be helpful in assisting other agency administrators in the both developing community education and evacuation notification procedures. This information would also help in the development of a crisis communication plan for either an Emergency Operations Center (EOC) or Information Officer (IO)'s toolkit.

LITERATURE REVIEW

The focus of the social science literature review looked at research on evacuation behavior and risk communication, communication tools utilized by organizations to notify the public, and lastly what are best practices evacuation planning tools needed to have a successful outcome.

Warning and Evacuation Behavior

Much research has been conducted on the behavior of the public during emergencies and evacuation. Although interviews with several emergency mangers indicate that citizens' response to an evacuation order is unpredictable, the social science research literature does not bare this out. Reactions to warnings follow certain behavioral patterns that are defined by people's perceptions (Aguirre, 1994). According to T.E. Drabek (1991) evacuation behavior is based perceptions that are formed by (1) perceived personal risk, (2) age, (3) gender, (4) ethnicity, (5) socioeconomic status, (6) contact with community groups or organizations, (7) length of residency, (8) previous disaster experiences, and (9) family make-up. Fitzpatrick and Mileti (1994) identified five stages of hazard communication and warning. People who receive warnings attempt to form personal definitions about the risk and what to do about it. This is characterized by the following model:

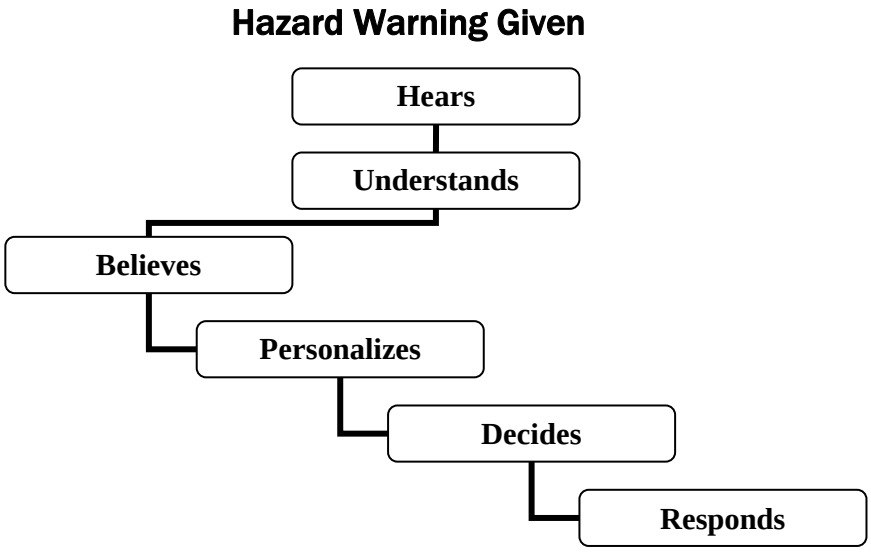

Figure 1. Communication persuasion model.

People hear (a siren) which leads to an understanding (attaches meaning to this- this is an evacuation siren). In understating, people must attach personal meaning to the message. A single warning message might be understood as involving no risk to some, but as a threat to human life by others.

People are affected by their past experiences with disasters and hazards, their values, ideologies and personal goals. Previous experience increases receptiveness to warnings and the need to take protective action. Once a person believes that the warning is real and a true risk, the belief becomes internalized and personalized. They believe this is meant for them. A decision is then made as to how the person will react to the hazard. Once the decision is made to react, individuals will then make the personal preparation he/she feels is appropriate and has been educated to do.(Fitzpatrick & Mileti, 1994) A person will typically process these phases each time a new warning is received,

The more people can see, hear and sense the threat or hazard, the more they believe the warning (Fitzpatrick & Mileti, 1994). It stands to reason then that the sight of a large smoke

plume and ash falling has a greater impact to neighborhoods faced with a firestorm on the run would initiate a desire to evacuate faster than a hurricane twenty-four hours away with clear and sunny skies preceding it. Environmental clues, including the reaction of others, are strong influences on people's belief processes. If neighbors are evacuating, maybe so should I. Lindell & Perry (2004) described the influence of environmental clues, "

> …protective action is more likely when those at risk are exposed to social behaviors that attract attention and are readily interpretable as indicating that the risk is certain, severe and immediate..Thus the behavioral clues facilitate protective action search protective action assessment and protective action implementation." (pg.70).

People will not passively await new information; they will seek out additional confirmation in forming their own belief. This behavior of confirmation is what ties up both 911 and telephone circuits as people call neighbors, family, and friends. People are information hungry. Rarely do emergency managers overwhelm people with information. Usually it's quite the opposite. Confirmation therefore plays an important role in the warning process, at each stage of the social process by facilitating understanding, belief, personalization and decision-making. (Fitzpatrick & Mileti, 1994) Therefore repetition of the message should be factored into the crisis communication planning.

Risk Communication

Having understood the behavior of the receiver in hazard communication, there are also sender determinants that can influence evacuation behavior. Five warning message qualities have been found to influence evacuation behavior: (1.) credibility of source; (2) official status of source, (3) specificity of content, (4) number of contradictory messages and (5) length of forewarning period. (T.E. Drubek, 1986; Fitzpatrick & Mileti, 1994)

Agencies must be viewed as credible and reliable to people receiving the warning. Local officials must be viewed as trustworthy. New York Mayor Giuliani post 9/11, functioned as key spokesperson, because of this trustworthiness. Authorities must be viewed as having expertise (Lindell & Perry, 2004). One effective tool is to use a mixture of authority in sending a message. For example, "The county sheriff and incident commander have just conferred with fire behavior specialists and the National Weather Service and we now must warn you that…" Warning messages must contain accurate, timely, and complete data. The message must provide the public with sufficient information to describe the event about to happen and specific location. For example, when describing flood waters, a warning should describe it "as a wall of water 20 feet high moving at 40 MPH". The message must contain clear instruction about how people are to react. It can not be assumed that the public know what constitutes an appropriate protective action. It must be explained. A study of the Big Thompson Canyon Flood which occurred in 1976, found that people who receive warning during the flood were not necessarily advised on what to do (Gruntfest, 1977). As a result, many who were warned attempted to drive out of the canyon and were killed.

A common phase among information officers is "tell them what you know when you know it" (Author, personal conversations with Information Officers). If people learn and suspect that they are not receiving the "whole truth", they are likely to ignore instructions regarding how they respond. In terms of specificity of the warning message, Drabek (1991) found that the public wants information about the risk; its location if known, what people should and should not do to minimize the risk, what time constraints exist, and finally the source of the message.

The frequency or number of times a message is delivered affects the behavior response process. According to Fitzpatch and Mileti (1994) dissemination of messages should be geared to

the dynamics of the disaster (i.e., its severity and changes in threat levels). Frequency is best dictated by the needs of the community at risk, the time to impact, etc. People want updated information even is there is no new information in the message.

Crisis Communication Tools:

Warnings can be disseminated through a number of different channels. Frequently used mediums are face to face contacts (door to door), siren, mobile radio and public address systems, radio (emergency alert tones and normal broadcasts), television, telephone (reverse 911, telephone trees), and newspapers. Each of these channels has different characteristics. Often referred to as the precision of dissemination, the ability of each medium to target all of those at risk (sensitivity) and only those at risk (specificity) can be evaluated. At one end of the spectrum, face to face notification precisely targets the receiver with great detail. On the other end is broadcast media which is imprecise because the warning can be received by anyone in their reception area, including people not a risk (Aguirre, 1994; Lindell & Perry, 2004).

All of the technological warning channels appear to have the ability to influence threat beliefs, protective motivation and decision sets, evacuation plans and protective actions. However the time of day and social activities play a role in the effectiveness of the warning channel. Lindell and Perry (2004) have argued that risk communicators who need to provide immediate warnings should select warning channels that are most likely to penetrate the dominant activities that are taking place at the time of the day and day of the week. For example, if an impending evacuation is called during the middle of the night as was seen in the southern California fires of 2003, a warning channel is needed that will wake people from their sleep. NOAA weather channel radios do this. In the case of the 2003 California firestorm, door

to door and law enforcement public address systems also do this, whereas television and normal radio would not.

Best Practices for Evacuation Planning

Quarantelli's (1977) research has pointed out common errors in disaster planning efforts. The first is to recognize that disaster planning is a process not a product. Continuous training and exercise simulations are what make disaster/evacuation planning effective. Disaster planning should not be done as an isolated activity. In other words, all agencies must participate in the planning process to ensure that all aspects of public safety and community interest are met. Failure to distribute relevant information about the plan to all community stakeholders has been cited.(Mission Centered- Solutions & Guidance Group, Inc., 2003; Lindell & Perry, 2004). Another problem that was seen in Quarantelli's research and case studies of the southern California fires was the failure to integrate Incident Command Centers and the problem of interorganizational cooperation during times of crisis.

In a study of tourist communities, Drabek(1991) found that a number of rural communities had written disaster plans. However, many people in executive positions within tourist oriented firms had failed to disseminate the plans to subordinate managers and had not provided regular training. This suggests that the evacuation plans would have average or below average effectiveness.

PROCEDURES

Definition of Terms

After Action Review (AAR): A review of incident which focuses on tasks and operations that went well and those that needed improvement. Emphasis on best practices and safety.

Wildland/Urban Interface: An interface zone is an area where development and wildland fire fuels meets a well defined boundary (National Fire Protection Association 1991b).

Sheltering in Place: A term used to describe an alternative to evacuation where residents are instructed to remain within their homes or at a nearby safe location while the risk or hazard is mitigated.

Information Source: A person or organization that uses expertise to identify a threat and to collect and disseminate information. Examples are police, fire, political authorities (Lindell and Perry 2004)

Warning Channel: Technological means by which a message is disseminated. Examples are print media (newspapers, brochures), electronic media (radio, television, and internet), loudspeakers, telephones, public meetings and face to face conversations.

Research Methodology:

An internet-based survey was constructed with use of an internet program called "Advanced On-Line Survey". Fourteen questions consisting of both multiple choice and text responses were distributed to fifteen county emergency managers via email. This purposeful sampling design was chosen in order to achieve representation of all counties within Arizona and to establish a comparison of tools used by emergency services coordinators during evacuations. This questionnaire appears in Appendix A.

In addition to the surveys, a number of interviews with County Emergency Managers, Incident Commanders from the Southwest Incident Management Teams, and Fire Management Officers were conducted.

After action reviews of the 2002 and 2003 fire seasons were evaluated for lessons learned experiences. These two years represented two of the most destructive fire seasons on record. In October and November of 2003, thirteen fires created a disaster situation in Southern California's urban interface that was unprecedented in scope and impact. The statistics are staggering; 12,000 firefighters committed; 750,000 acres burned, 4,000 homes destroyed resulting in billions of dollars in cost, $120,000,000 in suppression efforts and 22 people killed (National Interagency Coordination Center, 2004). Two After Action Reports were reviewed from the National Interagency Coordination Center. The first was Firestorm 2003-Wildland Fire Lessons Learned Center Report (Mission–Centered Solutions & Guidance Group, Inc., 2003). The second Ventura County After Action Report dated October 2003(Ventura county Fire Department, 2003). The focus was to look at lessons learned from the massive evacuations that were undertaken in communities well experienced in wildland fire and emergency management.

Limitations and Assumptions

The use of the internet based survey was chosen because of its convenience to the respondent. An e-mail was sent with a direct link to the survey site, facilitating a quick turn around. However, many of the respondents did not respond because theyexperienced difficultly accessing the site. This resulted in delayed data and the need for personal interviews.

This research was further limited by the lack of or limited participation of the county emergency services coordinators that had experience in wildland-urban interface fires and

evacuations. Of the five evacuation plans requested only two were forwarded to the author for review.

RESULTS

Of the fifteen surveys sent to county emergency managers only 12 were completed. Of these, eight represented counties where wildland fire was prevalent and where in recent years, urban-interface fires and evacuations had occurred (National Incident Coordination Center Statistics 2001-2003).

Answers to Research Questions

All respondents in the survey had either a written policy or procedure for implementing evacuation. Severty-five percent of the respondents reviewed their written plans annually. Twenty-five percent reviewed theirs every two years. Table-top or real time simulations were conducted each year for every county. (Appendix A)

What methods are utilized by communities for effective mass notification to evacuate?

Of the five variables in the survey, all of the counties that responded indicated that more than one methods of notification is used to effect an evacuation. The most frequently used channels were the emergency alert system(television, radio,100%), the NOAA weather channel (100%) and door to door. Of the 12 responding counties, only two had implemented a subscription service for reverse 911. One county was in the process of obtaining the service with federal grant dollars. Community emergency sirens were utilized in 8 of the 12 counties (75%)

In reviewing the lessons learned from the California Fires of 2003, where the EAS was used early in the evacuation notification, it proved to be useful according to both emergency manager's interview and the after action reports reviews. This facilitated evacuation behavior

and quicker evacuations. In the Ventura County AAR, the EAS was not activated because county officials had forgotten to use it. However many emergency managers feel the emergency alert system is obsolete and needs to be upgraded to meet current technology and wireless formats. It works on a tiered system of notification to 24 hour primary stations through digital warning tones with audio messages embedded in the tones. Secondary stations then pick up the tones and broadcast them. If something happens to the first tier of the pyramid, the system falls apart. NOAA has been expanding the use their weather alert radios in include all-hazard alert (FEMA 1999). These radios turn on automatically when tuned into the alert frequency channel. In 1999, Vice President Al Gore declared that NOAA weather radios should be "as common as smoke detectors" in homes across the country. (pg.1) Reverse 911 was not used in any of the evacuations reviewed.

What information is provided to community residents in order to properly prepare for an evacuation?

In Arizona most of the counties used a variety of information channels to reach community residents and provide educational platform. Of the survey respondents, all have developed brochures or pamphlets. During high fire severity, many provide newspaper articles and all hold public meetings, either as "town hall" style meetings, or through service organizations such as Lions Club, etc. Four of the counties have utilized the 'FireWise" presentation program to teach residents about defensible space preparations around the home. Fifty percent of the counties used a website as well.

The survey asked emergency managers to indicate what types of information was included in evacuation instructions. All of the respondents (100%) give information concerning:

- Utility shutoff

- Taking of valuables
- Signal to emergency responders of departure(white towel on door)
- Collection Center locations

Seventy-five percent of the respondents include information about evacuation routes to take.

One of the findings of the Firestorm 2003 was that many managers stated that pre-incident planning played the biggest role in determining efficiency and effectiveness of the evacuation. These included helping residents determine what protective actions to take prior to leaving their homes. Some counties included instruction on shutting doors and windows, and removing flammable materials from window area.

In the Cedar fire where residents had only minutes to evacuate, those families that had prepared, reacted to the evacuation order quicker and showed less hesitation, which may have made the difference between life and death. (Dan Oltrogge, Incident Commander, Southwest Incident Management Team, personal interview, September 20th, 2004)

In reviewing evacuation events, what were the lessons learned from efforts to notify the community of an impeding evacuation and maintain communication links with displaced community residents and public?

In the after action review of the southern California Firestorm 2003, the implementation of joint information centers proved to be successful in keeping up with the demands of community residents and media. The combination of municipal and federal fire agency's information officers along with community public affairs personnel provided the broad range of expertise needed to manage this disaster. The report stated that the Joint Information Centers (JIC) allowed all agencies…" to project a proactive unified message to the media and the public

which was critical in communicating the latest fire and evacuation information to the public". (pg 23)

In counties where a JIC was not established, many respondents indicated that the public and media received scratchy information, often confusing and conflicting in nature. This resulted in rumors being circulated and the public/media filling in with whatever information they could find.

When asked whether disaster/evacuation plans included planning for re-entry procedures, 75% of the survey respondents answered yes (Appendix B). All of the survey respondents stated that they would use public service announcements via the television or radio, websites, notification through Red Cross collection centers, and community public meetings to notify residents of re-entry procedures.

One problem that was encountered in both the AAR of Southern California and also in the Ventura County AAF was that many of the plans focused on egress procedures and not on re-entry or long term evacuations. Incident Management Teams also states that they were burdened with the consequences of managing evacuation collection centers issues which diverted resources.

What are the best methods for evaluating planning efforts and did preplanning efforts impact the success or failure of an evacuation event

In reviewing the surveys, all respondents agreed that preplanning impacted the success of their evacuations. Fifty percent of the respondents rated their plans as "good" when asked how useful the written plans were during a wildland urban interface fire. Twenty five percent rated their plan as very good and twenty-five percent indicated that the plan was fair. None of the respondents rated their plan as excellent. (Appendix A) Said one of the respondents, "Each

evacuation comes with a different twist. Although the plans are generally useful, they should not be rigid. Flexibility is essential." Said another emergency services manger," A major, full scale evacuation exercise was conducted 12 days before the Indian Fire. There was no question that the exercise had a profound and positive effect on the evacuation"

In the after-action reviews of Southern California Firestorm 2003, much credit is given to San Bernardino and Riverside Counties Mountain Area Safety Taskforce, commonly referred to as MAST. These taskforces are comprised of federal, state, county and local pubic safety, public works and volunteer support agencies that have been empowered to develop evacuation plans, hazardous tree and fuel removal, planning and public information (Mountain Area Safety Task Force, 2004). Prior to the fall of 2003, the MAST had conducted tabletop rehearsals of evacuations in the event of a catasphopic fire. As a result of that pre-planning effort the actual evacuation of large communities (100,000 residents) went smoothly and without incidents. Emergency managers credit that success with the MAST efforts.

Evacuation Routes/ Traffic Control:

Both interviews with emergency managers and the after action reviews stated that a significant weakness in evacuation planning and implementation was designating evacuation egress routes quickly. Often neighborhoods streets became congested with evacuees moving out and emergency responders attempting to gain entry. Evacuation directions were limited, incomplete and often issued without authorization (Ventura County Fire Department, 2004). Evacuations are typically made when a wildfire reaches two to eight miles from a community. These are known as trigger points. (Kim 2004, Cova 2002)

A study of neighborhood evacuation in the wildland urban interface was conducted by Thomas Cova and Justin Johnson (2002) using traffic micro simulation for a rural canyon

community in Utah. Their computer modeling indicated that a controlled departure when utilizing a single egress route was essential in improving overall evacuation times. Urgent evacuations, during populated times and high vehicle use resulted in significant traffic congestion. Staggered evacuation of neighborhoods within the community could improve egress times significantly. The simulation allowed researchers to look a "what if' scenarios to create worst case consequences. This modeling could prove beneficial to emergency planners.

In regards to Incident Management teams and urban interface fires, many of the AAR recommended that law enforcement become a critical part of the Incident Management team. In Arizona, both Type 1 IMT have standing law enforcement liaison positions assigned to Command Staff. These positions proved invaluable in communicating evacuation strategies with fire fighting efforts. Law enforcement was also cited as the agency responsible for ordering mandatory evacuations although the legal basis for this does not exist in Arizona.

The question was asked of emergency managers in Arizona whether they have considered "sheltering in place" as part of their planning efforts. 75% of the respondents indicated that they would consider sheltering in place as an alternative to evacuation. However many were quick to add that public education efforts needed to be made and understood prior to implementation. One respondent added, "Sheltering in place is difficult, citizens are exposed to smoke and often HAZMAT issues. We would only consider shelter in place if the duration of the incident was short and did not expose citizens to any unsafe conditions".

DISCUSSION

Crisis Communication Planning:

Knowing your Community

Recognizing the social demographics of a community needs to be factored into a citizen's perception of risk and the personal protection actions they may take. As Robert Browning discovered in his role as Structural Protection Specialist in Idaho and Montana during the fires of 1994 (1997), residents with long standing occupancy or where their homes represented value were less likely to leave. Community meetings, town halls, surveys of community residents can contribute to understanding for both authorities and citizens regarding risk perceptions and needed personal protective actions. In a survey of public education needs within a wildland-urban interface Carl Paulson (1991) discovered that most residents recognize the risk of fire but have not made pre-evacuation plans. Community outreach can improve this planning effort.

The likelihood that a wildland fire would occur during the height of the tourist season creates greater demands on rural communities catering to visitors as a Grand Canyon. Additional needs of transients and tourists who are away from home and without normal support systems needs to be assessed with input from concession operators. These factors need to be included in the planning efforts and simulations.

Information Sources:

Multiple sources are needed to ensure both credibility and reliability, and to provide means of confirmation by individuals. Message consistency is also a determinant of understanding belief and personalization. Of course disasters, especially wildland fire emergencies create inconsistencies in messaging as the risk changes or threat increases. As in the case of fire, the direction of the fire changes due to weather changes. Frequent updating of the

situation can help to overcome such inconsistencies. What needs to be monitored by information officers and Emergency Operations Centers are inconsistencies in the message delivered. Telling the public they need to evacuate but that their children will be kept in neighborhood schools may be good logic and strategy, such as the decision to "shelter in place", but such messages create confusion and uncertainty which leads to loss of credibility in the message being broadcasted.

Information Channels:

Emergency Sirens

Emergency siren such can only provide an alert indicating that there is an emergency but fails to tell people what the emergency is or what to do. Grand Canyon's current evacuation plan relies on emergency sirens. This method relies on the community knowing what protection procedures to take. It lacks specificity of information which can create further confusion as to proper behavior to take. Sirens should be used in conjunction with another information channel.

Telephone / Wireless Systems

Distortion of messages can occur with telephone trees and media broadcasts. If telephone trees (i.e. one person called a pre-determined list of names) are used to transmit evacuation notices, the message must be a standard message that people have been trained to use (Lindell and Perry 2004). Current automatic telephone alert systems commonly referred to as "reverse 911" systems, have excellent dissemination since many of the systems can simultaneously transmit telephone calls, cell phones, pagers and email. This allows for maximum penetration into household activities. There is minimal distortion of the warning message. However a drawback may be its reliance on electronic systems that tend to fail during disasters as well such as cell phone tower overload and power outages. In Arizona, two of the counties that responded

are considering the purchase of “reverse 911”software. None of the rural communities presently have it.

Route alert systems

Route alert systems, such as those used by law enforcement with public address systems, also have limitations similar to radio broadcasts in that the message may not penetrate households. Distortion of the message is reduced if a scripted message is used by public safety officers. According to Liddell and Perry (2004) warning channels,

“...vary in the degree in which they affect the decision stages of risk identification, risk assessment, protective action search, protective action assessment … and implementation. Specifically, the conditions that promote message comprehension (high specificity, low distortion, and high feedback from warning recipient) are likely to promote the protective action decision process” (pg 79).

The message should begin with a description of the threat (Lindell & Perry, 2004) and what protective action should be taken. The message should be forceful.

Jurisdictional/Legal Issues:

Effective wildland-urban interface evacuation planning can be more problematic when organizational boundaries are crossed, particularly those lines of authority between federal, state and local jurisdiction. As seen in the Southern California firestorm of 2003 and in interviews with emergency managers, knowing who has jurisdiction and authority for decision making and bringing those leaders together becomes essential. Use of liaison officers on Incident Management teams in Arizona that have a strong local law enforcement link has proven helpful in linking teams with local emergency services branches and getting a sense of expectations of the team (Interview Dan Oltrogge September 2004). As seen in the survey results, emergency

managers were not clear on who has authority to order a mandatory evacuation, much less whether a county has jurisdictional authority to do so, since Arizona has no state statute authority to order residents from their home.

Sheltering in Place vs. Evacuation

New thoughts are being approached as to whether evacuation is a must do option. More and more community leaders are looking at the concept of sheltering in place when it is safe to do so. Often, the call for evacuation is so rapid that the chances of implementing even the most well thought out plans may not work. Coconino County Emergency Services Coordinator Jim Driscoll (interview August 5, 2004) stated that when you have 24 hours, things go smoothly because you have time to implement plans and notification. During the Rodeo-Chedeski fire in Arizona in 2002 the EOC had only eight minutes to evacuate one sub-division. It was chaos. In the Cedar Fire in San Diego, which began in the evening, the fire was burning so fast (2-3 acres per second) that residents had very little warning. Fourteen people died fleeing from their homes. No one that sheltered in place perished. (Kim 2004)

Are citizens able to effectively contribute toward the protection of their own properties? In looking at the Australian model, wildfire authorities do not evacuate residents that live in the urban interface zone so long as they meet certain criteria: (1) their homes must meet defensible space requirements such as fire resistant roofing, (2) removal of vegetation around the home and with in 10 meters of the residents, and lastly the family or remaining members must be physically able to defend their homes (Harrap 2004). Researchers have looked at the three phases of fire as it approaches the urban interface zone: ember attack, radiated heat and direct flame impingement. Of these, ember attack can pose the greatest threat to a house not fully prepared, since its presence last the longest, often coming ahead of the fire front and in windy

conditions, lasting long after the front has moved. Australian fire officials argue that the presence of residents to combat ember attack will ensure the survival of the home. “It’s far more efficient to have added resources of the homeowner who, given the proper information and advise can undertake the vitally important role of extinguishing the embers that potentially threaten the integrity of a structure” (pg.1)

Dan Oakes, Fire Marshall, in an Article on sheltering in place entitled Fight or Flight stated “… we prioritize multiple access/egress routes as part of a cookie-cutter approach to fire protection planning in interface areas and thereby educate, influence and ultimately deceive the public, legislative bodies and myriad other stakeholders. By our actions, we communicate to them that their future fire safety is not a product of their survival in the homes we approved, or should have approved for them, but rather their evacuation infrastructure and planning.” (2000)

Dan Oltrogge, Incident Commander for the Southwest Incident Management team felt that sheltering in place would require extensive schooling of residents about what to expect from the fire and how to prepare and defend their homes. Last minute panic and evacuation could be disastrous (Interview September 2004).

In conclusion, the basis of effective warning systems is understanding and predicting the behavior of customers. The challenge of emergency managers is to re-shape public perception, attitudes and beliefs about hazards and risk by instilling a sense of individual responsibility for emergency preparedness. The key is making hazard planning a bottom-up/top down process that involves all levels of the community. (Sorenson 1987)

Recommendations

Evacuation planning is a process not a product (Quarantelli, 1977). Throughout Arizona, rural counties that are facing increasing risk of catastrophic wildland urban interface fire are active in developing and planning for such an event. The fires over the last several years, Rodeo –Chedeski, Indian Fire and have illustrated the need for increased planning and mitigation tools to help communities better prepare. The MAST model of community planning should be evaluated for adoption throughout counties in Arizona.

Second, communities need to have a highly sophisticated crisis communication plan that is practiced and drilled along with other evacuation and emergency operations drills. Pre-designated teams need to be identified along with locations and technology to support the team. These teams can stand alone or incorporated into a joint information center depending on the magnitude and complexity of the event.

Third, quantitative evacuation traffic transportation modeling should be conducted to evaluate the effectiveness and deployment of evacuation routes. This is especially important in rural neighborhood with limited egress routes. Grand Canyon would benefit from such a study to determine the impact and evacuation times during the busy tourists season. What are the impacts on heavy traffic days, or people traveling by train that may become stranded at the park?

Fourth, the need to evacuate should not be the sole immediate solution to an advancing fire. As has been seen in Australia and discussed by a number of fire and disaster experts, sheltering in place may save the most lives. The key to its success is well educated citizens and communities that have incorporated defensible space mitigation strategies. Grand Canyon

National Park needs to assess the potential for sheltering in place both community residents and stranded visitors. Mitigation planning for this needs to be incorporated into the evacuation plan.

Lastly, any evacuation planning for the wildland urban interface community should be viewed as consequence management. Prevention and reduction of catastrophic fires holds the key to risk reduction planning. More emphasis on defensible space vegetative management, ensuring building structures meet urban interface building codes, retrofitting historic structures to improve their defensibility will all contribute to minimize the need for massive evacuations, reduction in property loss, reduction in long term displacement of community members and most importantly lives saved.

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Appendix A

Survey Questions and Results

Question #1
Does your county have written policies or procedures pertaining to disaster evacuation planning?

Response Choices	*Number of respondents*	*Percentage %*
YES	12	100%

Question **#2**
If you answered yes to the above question, how often does your county review the plan?

Response Choices	*Number of respondents*	*Percentage %*
Annual	8	75%
Every 2 years	4	25 %
Every 3 years	0	
Has not been reviewed in last 4 years	0	
Does Not Apply	0	

Question #3
How often does your county conduct an exercise drill(either table-top or real time drill)?

Response Choices	*Number of respondents*	*Percentage %*
Annual	12	100%
Every 2 years	0	
Every 3 years	0	
Have not conducted exercise drill	0	

Question #4
In the event of an evacuation die to wildland fire, who would order a mandatory evacuation?

Response Choices	*Number of respondents*	*Percentage %*
Incident Commander	4	25%
Elected Official	0	
Law Enforcement	4	25%
Emergency Manager for Jurisdiction	0	
No authority to mandatory evacuation	8	50%

Question #5
What forms of emergency notification would be utilized for an evacuation? Answer all that apply.

Response Choices	*Number of respondents*	*Percentage %*
Siren	4	25%
Reverse 911	12	100%
NOAA Weather Radio	12	100%
Emergency Alert System (TV, radio)	12	100%
Door to Door	12	100%

Question #6
How has your county educated community groups and citizens to follow procedures in the event of a disaster and evacuation? Answer all the apply.

Response Choices	*Number of respondents*	*Percentage %*
Brochures or pamphlet	12	100%
Home mailings	6	50%
Newspaper articles	12	100%
Public Meetings	12	100%
Websites	6	50%

Question #7
How would you notify residents of re-entry or long term displacement in the aftermath of an evacuation order? Answer all that apply.

Response Choices	*Number of respondents*	*Percentage %*
Call back list	0	
Public Service Announcements via TV or Radio	12	100%
Red Cross	12	100%
Community Meetings	12	100%
Website	3	20%

Question #8
What types of information do you include in evacuation instruction for an wildfire evacuation?

Response Choices	*Number of respondents*	*Percentage %*
Utility Shutoff	12	100%
Taking of valuables	12	100%
Signal of Departure	12	100%
Evacuation Routes	8	75%
Collection Center Locations	12	100%

Question #9
Does your disaster/evacuation plan include planning for re-entry procedures?

Response Choices	*Number of respondents*	*Percentage %*
YES	10	80%
NO	2	20%
No Sure	0	

Question #10
In your wildland interface evacuation planning efforts, have you considered planning to "shelter in place" in neighborhoods that are "defensible"

Response Choices	*Number of respondents*	*Percentage %*
YES	8	75%
NO	4	25%
Not sure	0	

Question #11
Has your county experienced a wildland fire evacuation or prepared for a possible evacuation within the last five years?

Response Choices	*Number of respondents*	*Percentage %*
YES	8	75%
NO	4	25%

Question #12
How much time (in hours) did you have to implement an evacuation?

Response Choices	*Number of respondents*	*Percentage %*
1-4 hours	4	25%
5-12 hours	0	
12-24 hours	0	
> than 24 hours	2	20%

Question # 13
How useful were your written plans?

Response Choices	*Number of respondents*	*Percentage %*
Poor	0	
Fair	0	
Good	4	25%

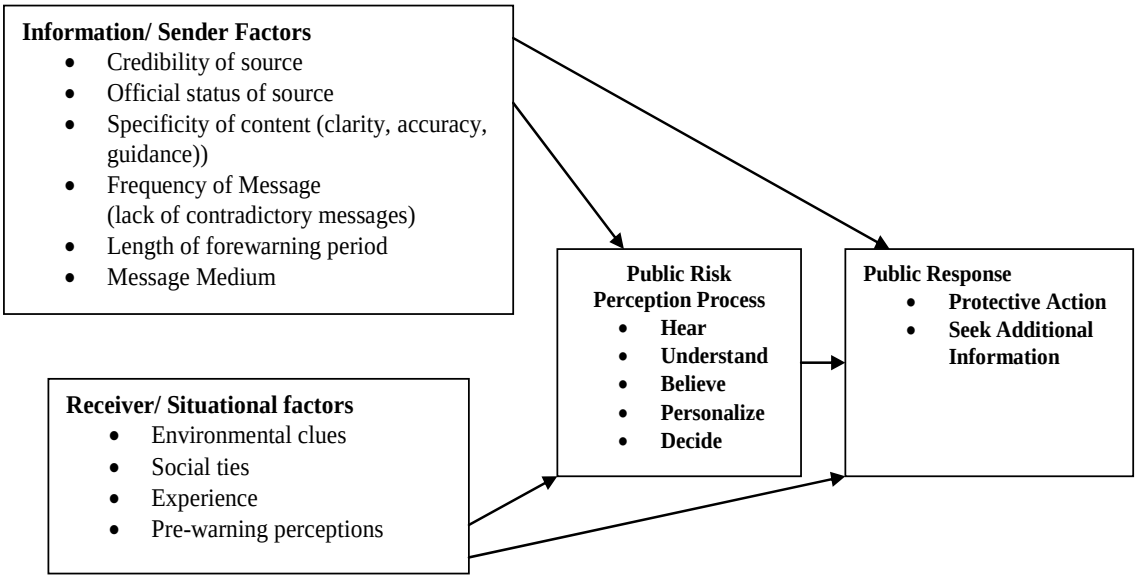
Very Good	4	25%
Excellent	0	

Question #14
Did preplanning impact the outcome of the evacuation?

Response Choices	*Number of respondents*	*Percentage %*
YES	8	100%
NO	0	
Unsure	0	

Appendix B

A Model of the Theory of Public Risk Communication



(Fitzpatrick and Mileti, 1994)

Appendix C

Specific tasks for Crisis Communication and Evacuation Planning
Hazard: Wildland Urban Interface Fire

Strategic Analysis

- Conduct community wildland-urban interface fire vulnerability analysis
- Analyze community makeup and content
- Identify community's perception of the risk
- Set goals for risk communication program

Operational Analysis

- Identify the available risk communication sources in the community
- Identify the available risk communication channels in the community
- Identify specific audience segments
- Conduct simulations on evacuation route and traffic flow modeling

Resource mobilization

- Obtain the support of senior appointed and elected officials
- Enlist participation of other government agencies as partners and stakeholders
- Enlist the participation pf nongovernmental, nonprofit and private sector organizations
- Work with mass media, local news channels, etc...
- Work with neighborhood associations and service organizations

Program Development

- Staff, train and exercise a crisis communication team annually with emergency operations, incident management teams and EOC
- Establish procedures for communicating effectively in an escalating crisis and emergency response
- Plan use of all informal and formal communication networks including telephone trees and internet in order to assure redundancy in the system
- Establish procedures for controlling message distortion and rumors

Program Implementation

- Build source credibility by increasing expertise and trustworthiness
- Use a variety of channels to disseminate hazard information
- Conduct community outreach meetings
- Provide community education materials for defensible homes
- Provide community education materials for protective actions to be taken during a wildland fire
- Evaluate performance of team.

APPENDIX D

Grand Canyon

National Park Service
U.S. Department of the Interior

Grand Canyon National Park
Arizona

Basic Evacuation Procedures

for Grand Canyon residents

June 2004

Why evacuate?

An evacuation of Grand Canyon National Park would be necessary in the following situations:

- A wildland fire is threatening the developed or residential areas
- A flammable gas leak or other hazardous materials incident were to occur in a populated area
- A natural disaster
- The safety of the people in the park is threatened in any way

When do you need to evacuate?

The signal for all residents to evacuate will be a continuous sounding of the fire sirens for **5 minutes** or longer. This signal may be repeated. The prolonged siren activation will be followed by radio announcements on KAFF 930 AM and 92.9 FM. Information contained in the announcements will include:

- Securing of residences
- Evacuation routes
- Evacuation collection centers to be used

Other means of notification would include emergency vehicle public address systems, as well as door-to-door contact.

Evacuation routes

All evacuation routes will be clearly marked at the time with signs and/or personnel assigned to direct traffic. It is critical that you follow the designated evacuation routes.

Evacuation Collection Centers

For the **South Rim**, Evacuation Collection Centers will be established in **Williams and/or Flagstaff** by the American Red Cross in conjunction with Coconino County Emergency Services. These Centers will be used for registration, information and assistance. Locations are not pre-established and therefore would be announced during the evacuation process.

Inner Canyon Collection Centers include Indian Gardens and Phantom Ranch. **North Rim** Collection Centers include Jacob Lake and Cliff Dwellers Lodges, and the Fredonia School.

SAFETY ZONES–*a Safety Zone is a large open area to use if you cannot safely evacuate the park*

During an evacuation where leaving the park is not possible, evacuees would be directed to these Safety Zones:

1. South Rim – Canyon Village Marketplace Parking Area
2. Desert View – Watchtower Parking Area
3. North Rim – North Rim Ballfield
4. Inner Canyon – Indian Gardens and Phantom Ranch (assuming no threat to the Inner Canyon area)

Registration and accountability

You are not required to remain at an Evacuation Collection Center. However, it is imperative that you register there so information concerning your whereabouts is available for local officials and relatives. ***Every family should establish evacuation plans for times when members may be separated. A relative or friend should be established as an emergency contact where all family members would call to exchange information*** **and reconnect.**

Essentials to take for immediate evacuation

- Important papers (if immediately available)
- Medications
- Dentures and prescription glasses
- Personal toilet articles and sanitary needs
- Sleeping bags or blankets
- Baby food and diapers
- Checkbook, credit cards, cash
- Driver's license and other identification

Actions to take for immediate evacuation

- Disconnect all appliances except the refrigerator and freezer
- Close and lock all doors and windows
- Leave the exterior and porch lights on
- ***Tie a white or light-colored pillowcase, towel, or similar item to the front door handle to indicate the residence has been evacuated***

Additional items to take if time permits

- Flashlight and extra batteries
- Portable battery-powered radio
- Change of clothing for each person
- Food – nonperishable, ready-to-eat
- Recreational items – games, cards, etc.
- Irreplaceable items and personal mementos
- Valuables

Additional actions to take if time permits

- Secure outdoor possessions and equipment
- Secure or hide valuables
- Turn off the gas before leaving-be sure you know how to do this well in advance

Disabled and special needs residents

Individuals who need aid in the event of an evacuation are encouraged to plan ahead with neighbors, friends, and relatives. Be sure to register with the E911 Location Identification Database at Grand Canyon National Park Communications Center by calling (928) 638-7805.

If help is not readily available at the time of an evacuation order, call the Communications Center emergency line at (928) 638-2477, or locally dial 911 for assistance.

Evacuation of pets

Planning for care of pets should be included with a family's evacuation plans. You may not be home when the evacuation order comes. It is strongly encouraged that pet owners arrange in advance for a trusted friend or neighbor to move your pets out and meet at a prearranged location. Be sure to take the necessary supplies to care for your pet for an extended period of time while at the Evacuation Collection Center. Pets will need to be kept under physical control at all times.

Returning home

Once you have evacuated, you may not return home until authorized to do so by the local officials.

Current incident information will be available through the local AM and FM radio stations, the officials at the Evacuation Collection Centers, or by calling (928) 638-7888.

For more information, go to the park website at www.nps.gov/grca/evacuation.

APPENDIX E

GRCA- SOUTH RIM EVACUATION TASK LIST

- ***DECLARATION OF PARK CLOSURE*** by the Superintendent. Initiate South Rim Area evacuation through subordinate personnel. Notify NPS Dispatch *[GC Regional Communication Center & Williams Fire Dispatch]* of the closure/evacuation declaration.

- Initiate through NPS Dispatch:
  FIRST – Radio Alert Tone and general broadcast of evacuation notice/announcement.
  SECOND – Activate General Alarm Sirens for a minimum of five minutes. *[If appropriate]*

- Initiate PRIORITY **evacuation notifications** through NPS Dispatch to:
  1. **Xanterra Parks & Resorts.** (Direct contact with General Mgr. or Dir on Duty)
  2. **Coconino County Sheriff's Office.**
  3. **Arizona Department of Public Safety** (DPS)
     - Request out-of-Park roadblocks and activate electronic messaging equipment
       SUGGESTED LOCATIONS:
       - ***Valle*** *– Highway 64 & 180 junction*
       - ***Williams*** *– Highway 64 & I-40 junction*
       - ***Flagstaff*** *– Highway 180 at junction with Snow Bowl Road*
       - ***Cameron*** *– Highway 64 and 89 junction*
  4. **Coconino County Emergency Services/American Red Cross.**
     - Request Evacuation Centers be set up and Park informed of locations.
  5. **Paul Revere Transportation.**

- NPS Dispatch to complete additional evacuation notifications, with assistance from Public Affairs and Concessions personnel if available. ***(listed in Appendix A, Evacuation Management Plan)***

- Contact **South Entrance and Desert View Entrance Stations** and initiate controlled access at these locations using on-duty and callback personnel. Assign minimum of one Law Enforcement unit to the Entrance Stations.

- SIMULTANEOUS ACTIONS -

- Establish and designate Command Staff positions:
  - Incident Commander
  - Operations Chief
  - Logistics Chief
  - Safety Officer
  - Information Officer
  - Xanterra Liaison, Paul Revere Liaison, Other Liaison as appropriate

- Incident Commander designates **Incident Command Post (ICP)**. Radio Alert Tone and broadcast ICP location. All visitor protection and other incident personnel directed to report to the ICP for check-in and assignment, unless specifically directed otherwise. Possible ICP locations include:
  - Park Headquaters
  - Firebase/Helibase
  - NPS Maintenance Office Building

- Determine the following information and disseminate as widely as possible.
  1. **Evacuation timeframe**
  2. **Evacuation routes currently available**
  3. **Evacuation Center locations**

- Establish/designate Groups and Group Supervisors, as required for type of incident;
  - Evacuation Group
  - EMS/SAR Group
  - Structural Fire Group (if not already established and is required)
  - Wildland Fire Group (if not already established and is required)

- Establish/designate Units, Unit Leaders, and assign personnel, as required for type of incident:
    - Law Enforcement Unit
    - Transportation Unit
    - Inner Canyon Unit
    - Traffic Control Unit

- Initiate incident **personnel accountability system** (PAS) to maintain accountability.
    - Positive Radio Communication Is Required.

- Establish and appropriately staff **traffic control** locations:
    1. **Center Road & South Entrance Road intersection**
    2. **South Entrance Road and Desert View (East Rim) Road intersection.**
    3. **Others locations as needed and available personnel permit**

Evacuation Patrol

- **Initiate Village-wide vehicle and foot notification patrols.** Assign areas to be covered based on greatest to least threatened. Use vehicle patrol PA (public address) systems to broadcast evacuation announcement and essential information, and foot patrols to cover areas impractical for vehicle contact. Track and record each area covered.
    1. **Residential areas**
    2. **Commercial, Business and Public Use Village Areas (accessible by vehicle)**
    3. **West Rim Drive**
    4. **Supai Village, Kennel, Waste Water Treatment Plant Area**
    5. **Yaki Point Area**
    6. **Canyon View Information Plaza (CVIP)**
    7. **Rim Trail (foot patrol):**
        - Yaki Point to Mather Point.
        - Mather Point to Yavapai Observation Station.
        - Yavapai Observation Station to Verkamps/El Tovar area.
        - Trailheads.

USE HASTY & EFFICIENT TECHNIQUES FOR RAPID ANNOUNCEMENTS AND

EVACUATION SCRIPT:

1. *"Attention- This is an ___ (immediate evacuation or advisory)."*
2. *"You have ____ minutes to leave the park."*
3. *"Please exit the park via_____."*
4. *"An evacuation center has been established at _____."*

- Contact and verify that **Grand Canyon Clinic, Grand Canyon Railway, Kaibab Learning Center, and Grand Canyon School** have initiated their individual evacuation plans. Determine any additional needs and provide assistance. Verify that **all Concessioners** have initiated their individual evacuation plans

- Maintain normal **shuttle bus operations** as long as both safe and practical. Increase the shuttle bus operations if both buses and drivers are available, with first emphasis on areas of greatest threat. Maintain tracking, status, and accountability of bus operation.

- Determine appropriate locations and establish Corridor/Inner Canyon **trail blocks/patrols**

- Initiate or verify **chlorine cylinder removal** from the NPS Waste Water Treatment Plant and the Water Storage Tank area (Yavapai/Trailer Village).

- Determine security needs and assign assets

- Assess notification patrol operations. Continue, repeat or redirect as appropriate. Assess evacuation status and release any incident personnel no longer required.

- Initiate long term support operations to personnel and visitors required to remain in the Inner Canyon areas. Determine and provide necessary long-term resource support for the incident personnel, including food, water, housing and other essential supply needs (individual residences may not be available based on type of incident and threat level.