

MissionCriticalPartners
Because the Mission Matters

Siren Feasibility Report

Final Report

PREPARED JULY 2020
FOR THE CITY OF MALIBU, CALIFORNIA

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Executive Summary

Mission Critical Partners, LLC (MCP) was retained by the City of Malibu, California, to investigate the feasibility of providing a siren alerting and warning system. The intent of the system is to provide mass alerting and warning in the event of natural and manmade disasters including wildfires, terrorist events, and severe weather.

MCP would like to thank Malibu public safety employees for providing outstanding support throughout the feasibility study.

A siren alerting system is an outdoor warning system (OWS) designed to alert/warn the public of an event or possible event, depending on how it is utilized. While there may be instances where someone will hear a siren indoors, depending on the construction of the building, location, and distance from the siren, siren systems are for outdoor alerting. Indoor notification is not guaranteed. Sirens are just one tool used in a public safety alerting strategy and complement the use of other alerting tools.

Sirens can be tone-only or both tone and voice. Voice systems, while helpful to relay messages, also are difficult to implement in a large area with multiple sirens. The location and distance from systems and other natural and manmade obstructions, as well as atmospheric conditions, will affect the intelligibility of the outdoor message. Voice and tone components of a siren system can be integrated into indoor public address (PA) systems with additional equipment and configuration to enhance the system.

Siren systems are used to alert the public of an imminent threat. With tone systems, the activation of the sirens alerts the public to the threat; the public then should seek other information on the threat. A voice/tone system will provide the alert with a message regarding the threat and what to do. Modeled voice coverage intelligibility and coverage area will differ depending on atmospheric conditions.

MCP worked with the Malibu public safety group to identify the City-owned properties that could support a siren. Once the properties were identified, sound propagation studies were performed to provide maximum coverage within Malibu's city limits. The models then were adjusted to provide maximum coverage within the city limits but reducing the possible sound coverage into neighboring jurisdictions. It is not possible to provide maximum coverage without some sound entering neighboring jurisdictions.

MCP estimates between 20 to 33 sirens are necessary to provide appropriate coverage in key identified areas. Final siren placements will be critical to ensure coverage during Santa Ana winds. Coverage can be obtained using a minimum of 20 sirens, but due to terrain, accessibility, and landowner permissions additional sirens may be needed. A detailed engineering design, to include final siren locations, will be necessary to determine the actual siren count and provide the predicted coverage.

The estimated installation cost of the siren system is $1.2 million to $1.9 million. These estimates were established on a base siren installation. Local code and enhanced installation costs due to final locations have not been considered. A detailed engineering design also will be required for final costing.

1 Background

The City of Malibu (City) sought a planning study for an outdoor warning system (OWS), specifically sirens, and the identification and design of multiple siren sites to ensure that the sirens are audible in all areas of Malibu (the city) when the system is activated.

Of particular concern to the City is the effects of Santa Ana winds. The National Weather Service defines Santa Ana winds as "… a weather condition in which strong, hot, dust-bearing winds descend to the Pacific Coast around Los Angeles from inland desert regions."[1] Known for the dry, hot weather that they bring in autumn, the winds often bring the lowest relative humidity of the year to coastal Southern California. The low humidity, combined with the warm, compressional-heated air mass, plus high wind speeds, create critical fire weather conditions.

Malibu relies primarily on communications tools that require electricity during a disaster. These methods include web-based alerts, reverse 911-style alerts, and Wireless Emergency Alerts (WEA). Areas of the city regularly experience power outages during adverse, especially windy, weather conditions. The local utility provider utilizes a Public Safety Power Shut-off (PSPS) program during Red Flag[2] weather conditions. Because of the PSPS program, residents of Malibu could possibly be without power during periods of heightened fire danger, resulting in an increased risk of not receiving important communications, including evacuation orders, via phone, internet, or radio.

Environmental events like these must be fully understood when planning and designing an OWS, so the system can clearly and effectively communicate alerts to residents and visitors. The OWS must be designed to rely on solar power and have enough battery-backup capacity to send critical alerts, when required, at night or days when the sun may be blocked by smoke or clouds.

The City contracted with Mission Critical Partners, LLC (MCP) to develop a comprehensive and actionable OWS plan to enhance its ability to disseminate emergency alerts, especially in wildfire situations that pose a threat to life and property.

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[1] "Santa Ana Wind." Glossary. National Weather Service. https://w1.weather.gov/glossary/index.php?word=santa+ana+wind

[2] Red Flag is "a fire weather program which highlights the onset of critical weather conditions conducive to extensive wildfire occurrences." Reference: "Red Flag." Glossary. National Weather Service. https://w1.weather.gov/glossary/index.php?word=red+flag

2 Methodology

2.1 Project Kickoff Meeting

MCP conducted a project kickoff meeting in January 2020 with the City that established mutual acquaintance, clarified roles, and confirmed the desired outcomes and deliverables. MCP took this as an opportunity to gain a mutual understanding of the City's future vision of its proposed OWS.

2.2 On-Site Information Gathering

MCP spent time on-site gathering information to fully understand what is required of the system both operationally and technically. During the on-site interview, MCP reviewed each element of an OWS and documented expectations and requirements of the system. A key focus of the meetings was site discussion. The City provided site information in geographic information system (GIS) format.

MCP's analysis began with City-provided sites as a priority, but also kept in mind all site options available. While the City supports the placement of sirens in public right-of-ways, arbitrary 'pins' where dropped as a last resort to demonstrate the number of sites needed for this initial feasibility and budgetary exercise.

2.3 Sound Propagation Analysis

MCP conducted a sound propagation analysis. The sound study ensures that sirens are distributed optimally throughout the city by identifying coverage. Using collected data, MCP produced sound propagation maps using siren planning software to determine the levels of coverage achieved from proposed sites. The coverage models take into consideration varying geographical topology and environmental factors such as foliage and building density.

The study considered various environmental factors including:

- Ambient temperature
- Ambient humidity
- Wind speed
- Wind direction
- Building height
- Terrain

Environmental factors that will be present during Red Flag weather were important when modeling coverage, including understanding the effects of the Santa Ana winds. In addition, much of Malibu has deep canyons and steep hills, which pose a challenge for proper coverage.

The analysis resulted in recommendations for the most efficient siren distribution across the city, including:

- A sound coverage area for each proposed siren site, considering environmental data
- Identification of any areas of the city in which sirens will be ineffective due to geography or other characteristics

2.4 OWS Planning Study

MCP compiled the data collected into this report, which provides a baseline assessment and includes the following:

- Design options available
- Estimated cost for each option
- Estimated ongoing maintenance costs following project completion
- Maps showing range of each proposed siren
- Descriptions of recommended siren models, including visuals and detailed lists of technical features
- Limitations on the effectiveness of an OWS in Malibu

3 Findings

3.1 Sites

The City provided six properties, identified on the map below, that could be used as potential sites for sirens.



- Trancas Park
  - Latitude and Longitude (Lat-Long) Coordinates: 34.038916, -118.845391
  - This 35-acre park has been identified as a possible siren site based on its status as a City-owned property, proximity to residential areas, and relatively flat geography. While the northern end of the park houses playground equipment, the southern end is primarily an open field. In particular, the

southwest corner may be viable due to its lack of impacts on residents' ocean views and Environmentally Sensitive Habitat Areas (ESHA).

- Heathercliff Road and Pacific Coast Highway (PCH)
  - Lat-Long Coordinates: 34.022118, -118.806681
  - This 18-acre undeveloped lot has been identified as a possible siren site based on its status as a City-owned property, proximity to residential and commercial areas, relatively flat geography, and lack of impact on current land uses.

- Bluffs Park
  - Lat-Long Coordinates: 34.033339, -118.702064
  - This 10-acre park has been identified as a possible siren site based on its status as a City-owned property, proximity to residential areas, and its current use as an alternate location for the City's Emergency Operations Center (EOC). The relevant residential neighborhoods are at a lower elevation than the park itself.

- 23575 Civic Center Way
  - Lat-Long Coordinates: 34.036233, -118.691314
  - This 9-acre undeveloped lot has been identified as a possible siren site based on its status as a City-owned property, proximity to residential and commercial areas, relatively flat geography, and lack of impact on current land uses.

- Malibu City Hall
  - Lat-Long Coordinates: 34.039369, -118.692974
  - City Hall has been identified as a possible siren site based on its status as a City-owned property, proximity to residential areas, and status as a government building.

- Las Flores Park
  - Lat-Long Coordinates: 34.040054, -118.637656
  - This 6.7-acre park has been identified as a possible siren site based on its status as a City-owned property, proximity to residential areas, and relatively flat geography. Additionally, it is in a fire-prone region of the city that was devastated by wildfire in 1993.

This site information was useful in the southern/coastal areas. For the north, arbitrary sites were dropped in to assess the number of sites that would be needed to gauge the scope of this budgetary effort.

3.2 Current State of Alert and Notification

Malibu does not currently have an OWS, although the Los Angeles County Sheriff's Department has public address (PA) systems on all vehicles.

If the decision is made to evacuate, shelter-in-place, or take other protective action, the City disseminates this information through multiple channels. The City may use one or all the following means of communication to issue an emergency notice to take protective action:

- Wireless Emergency Alerts (WEA)
- Emergency Telephone Notification System (ETNS)
- PA system and vehicle sirens
- City website for alerts[3]
- Malibu City Television (TV)
- Call in telephone number

The various alert and warning systems employed by the City are designed to provide timely and up to date information during an emergency. Many of the systems used to communicate emergency information are already being used to inform the public of day-to-day City business.

Wireless Emergency Alerts

WEA is part of Integrated Public Alert and Warning System (IPAWS). IPAWS is the nation's alert and warning infrastructure, overseen by the Federal Emergency Management Agency (FEMA). "IPAWS provides public safety officials with an effective way to alert and warn the public about serious emergencies using the Emergency Alert System (EAS), Wireless Emergency Alerts (WEA), the National Oceanic and Atmospheric Administration (NOAA) Weather Radio, and other public alerting systems from a single interface."[4]

The City only has direct access to WEA alerts, which it can issue through their ETNS.

WEA are emergency messages sent by authorized government alerting authorities through the major mobile carriers. WEA are targeted to a defined geographical area. This capability allows for both the residents of a given jurisdiction and persons visiting the jurisdiction to be notified. WEA are presented differently than a typical text alert in order to differentiate it from regular notifications. They offer a unique alert tone and vibration accompanied by a brief push notification displayed uniquely on the end user's mobile device. The public does not need to register for this service. WEA is an opt-out system. Mobile device users will receive the WEA notification unless they choose to deactivate the service on their mobile device.

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[3] https://www.malibucity.org/alerts
[4] FEMA. Integrated Public Alert & Warning System. https://www.fema.gov/integrated-public-alert-warning-system

NOAA Weather Radio

While the City does not utilize this technology, it does work closely with the National Weather Service (NWS) and NOAA to receive ongoing updates during weather-related incidents, such as rainstorms or fire watches.

Emergency Telephone Notification System

Malibu currently uses Everbridge as its official emergency notification system, which is only used for communication of urgent information. Everbridge can be used to contact City residents, businesses, and employees. Everbridge sends emergency alert notifications via voice messages, short message service (SMS)/text messages, and email messages during times of emergencies and disasters.

PA System and Vehicle Sirens

The Los Angeles County Sheriff's Department and the Los Angeles County Fire Department can issue warnings using sirens and loudspeakers on their vehicles. Examples where this may be appropriate include:

- Widespread evacuation
- Hazardous materials incident
- Civil disturbance
- Crowd control

This method is effective in reaching most people, except those with hearing impairments. This method should be used in addition to other mass notification systems including WEA and Everbridge, as appropriate.

Alert Center

The Alert Center, a component of the City's website Notify Me system, can provide alerts to residents and others (e.g., visitors, businesses) that wish to self-register into the system. This system is used for more day-to-day information such as beach, public health, traffic, utility, and weather information.

City Sirens

The City intends to install sirens (similar to tornado sirens) throughout the area. The sirens may be used to issue evacuation orders or shelter-in-place warnings, and more. These sirens will have the capability to project far and wide with the intent of notifying the whole community if necessary.

This assessment focuses on this form of alert and notification.

Other Emergency Information Systems

Malibu uses several other systems including a hot line that residents can call for the latest information.

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Following the initial emergency notification, the City would utilize the means below to relay important messages to the public.

- Social media
  - Twitter
  - Facebook
  - Instagram
- Media releases and E-blasts
- City website Alert Center
- Malibu TV 3
- Electronic changeable message signs (CMS)

4 Assessment

4.1 Technology Overview

During times of emergency, communications is key to saving lives. There are several ways to communicate with the public during these situations—one very effective method is outdoor warning sirens. OWSs can advise people that a hazard exists and, depending on the jurisdiction, what action needs to be taken. Although outdoor warning sirens serve the same primary purpose of alerting people about natural and manmade hazards, they can vary widely in terms of design, functionality, features, and performance.

4.1.1 Principle of Sound

Sound is a form of mechanical energy oscillations of pressure through the air above and below the surrounding air pressure. Three components of sound that can be distinguished by humans are loudness[5], pitch[6], and tone[7]. Sound travels at a speed of about 1,000 feet per second through the air, but wind, turbulence, humidity, and temperature can cause variations in the speed of sound.

Loudness is determined by the magnitude of sound in decibels (dB) relative to the carrier (dBc). The frequency, or pitch, components of a sound are expressed in terms of hertz (Hz). The average human hearing range is usually defined between 20 and 20,000 Hz. Lower frequencies travel farther in the air than higher frequencies, because higher frequencies attenuate more rapidly with distance.

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[5] The attribute of a sound that determines the magnitude of the auditory sensation produced and that primarily depends on the amplitude of the sound wave involved. https://www.merriam-webster.com/dictionary/loudness
[6] The property of a sound and especially a musical tone that is determined by the frequency of the waves producing it; highness or lowness of sound. https://www.merriam-webster.com/dictionary/pitch
[7] Vocal or musical sound of a specific quality. https://www.merriam-webster.com/dictionary/tone

Sound decreases in magnitude (loudness) and in dBc at greater distances from its source. This decrease is called attenuation. Factors that affect the rate of attenuation include sound frequency, terrain, prevailing winds, temperature, atmospheric stability, and humidity.

4.1.2 Outdoor Sound Propagation

As sound moves outdoors from an OWS to a potential listener, there are factors that influence the propagation of sound.

- Divergence: As sound radiates away from a source, its intensity decreases with distance because the energy of its original sound pressure is spread over a larger and larger area.

- Sound Absorption: Terrain and atmosphere have the most effect on outdoor sound absorption.
  - Refraction: Refraction of outdoor sound by temperature and wind velocity gradients is very complex. The atmospheric nonuniformity of the temperature and wind in the atmosphere produces a bending or refraction of sound waves.
  - Ground Absorption: Sound propagation paths near the ground can experience additional attenuation. Acoustically "soft" surfaces such as topsoil covered with grass can cause significant attenuation. Inversely, acoustically "hard" or reflective surfaces such as asphalt, ice water, or concrete provides significantly less attenuation.

- Obstructions: Sound can be blocked by barriers, vegetation, and buildings. Factors such as outdoor conditions, building construction materials, and open or closed windows can determine the level to which persons inside a building will be able to hear outside sound. The table below depicts sound loss for various types of construction.

Table 1: Sound Loss Indoors[8]

Building or Construction Type	Sound Loss (dB)	
	Open Window	Closed Window
Residences – light frame, single-pane windows	12	20
Residences – light frame, dual-pane or storm windows	12	25
Schools	12	25
Churches	20	30
Hospitals/Convalescent Homes	17	25

[8] Reproduced from FEMA, Outdoor Warning Systems, Technical Bulletin (Version 2.0), January 12, 2006. Pg 8.

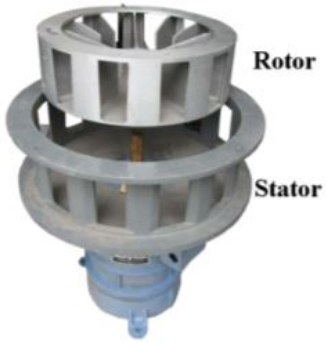
Building or Construction Type	Sound Loss (dB)	
	Open Window	Closed Window
Offices	20	30
Theaters	17	25
Hotels/Motels	17	25
Masonry wall construction – single-pane windows	12	25
Masonry wall construction – dual-pane windows	12	35
Sealed glass wall – ¼-inch glass thickness more than 50 percent of exterior wall area	-	28
20 lb/ft^2 solid wall – no windows, no cracks, no openings	-	30
50 lb/ft^2 solid wall – no windows, no cracks, no openings	-	38

The effects of all the above-mentioned factors on sound attenuation outdoors is both intricate and unpredictable.

4.1.3 Siren Sound Generation

Outdoor warning sirens can be classified either as pneumatic or electronic.

- Pneumatic
  - Pneumatic sirens generate tones through the interaction of two principal components: a rotor and a stator. Machined into both the rotor and stator are alternating equidistant vanes, which generate tones as the rotor spins and draws air into the siren. The incoming airflow is pushed out in bursts through the stator each time its holes align with the holes of the rotor. Sound waves are produced by the process of blocking and unblocking airflow at regular intervals. The frequency of the air bursts determines the pitch of the siren.



- Electronic
  - Circuitry components such as oscillators, transistors, modulators, and speaker drivers (e.g., woofers and tweeters) generate, amplify, and produce sound waves and vary their frequency and

duration. The electronic-based system projects sound through speakers that are mounted as a horn assembly. These synthesized sounds can include customized tones or emulate the standard warning signals of pneumatic sirens, such as wail and high-low, and broadcast both live and pre-recorded voice announcements.

4.1.4 Siren Sound Propagation/Coverage

Typically, there are three types of coverage patterns: directional, rotating, and omni-directional.

- Directional: A highly focused cone of sound is sent out in the direction the device is pointing.
- Rotating: To expand the breadth of their sound coverage areas, some directional sirens have built-in mechanisms that enable them to rotate 360 degrees around a vertical mounting unit such as a pole
- Omni-directional: These devices produce sound in all directions horizontally from the source



Figure 1: DSA Directional Speaker Array (Federal Signal)



Figure 2: WPS4000 Series Rotating Siren (Whelen)



Figure 3: WPS2900 Series Omni-directional Siren (Whelen)

4.1.5 Siren Performance Measurements

The performance of outdoor warning sirens can be assessed in various ways. Common measurements are noted below:

- Sound output: the sound pressure level in decibels at a specified distance, usually 100 feet
- Effective range: the distance at which a siren can maintain a specified sound pressure level; typically, 60 to 70 dB
- Sound radius or sound circle: the estimated range of omni-directional and rotating sirens

- Beam width or sound emission arc: the breadth of a directional siren's horizontal output measured in degrees
- Intelligibility: the extent that voice announcements can be understood by the listener (applies only to sirens capable of voice announcements)

4.1.6 Siren System Features

4.1.6.1 Tone versus Voice

There is the capability of producing various tones for an outdoor siren warning system—each tone conveying a distinct message to the listener. This of course requires significant investment in public education to ensure procedures for each tone (situation) is fully understood. An effective educational campaign ensures the message of these tones is understood regardless of language, dialect, and cultural origins.

In areas with a large transient population (e.g., high volumes of seasonal workers, tourists, campers, etc.), who may not understand the meanings of the various tones, it is important to have a system in place that instructs the listener via voice as to the required procedure during the emergency situation. Depending on the demographic of the area, this may require the use of different languages. This voice option also is useful when complex instructions are required.

The best know siren sound is the alert tone used by NOAA for severe weather, which is heard on television and radio. Most of the older generation know what it means, having been accustomed to the weekly tests. How the younger generations watch television and listen to music is different and many younger people are not exposed to the weekly or monthly tests. Foreign nationals also may not be familiar with the sounds.

It is quite likely that people will hear the sirens and then inquire as to the meaning. Again, an initial outreach program and continuing education will be necessary if multiple tones are selected to represent different situations.

The number of tones used should be kept to a minimum.

4.1.6.2 Strobes

For persons who are hearing impaired or reside in areas located beyond the outdoor siren's audibility or intelligibility range, a visual alert is a viable option to provide additional alerting. Strobes are mechanisms to provide complementary warning capabilities to outdoor siren systems to meet Americans with Disabilities Act (ADA) requirements. The strobes are only effective, however, with line of sight to the siren. If one cannot see the siren, the strobe will be ineffective. Sound coverage area is much larger than the distance a strobe can be detected.

4.1.6.3 Control System

In the event of an emergency, the central control center must communicate with the siren for activation. In addition to activation, operations, monitoring, and testing rely on siren communications. This communication can be one-way or two-way.

- One-way: While the central control tower can activate the warning sirens, the sirens cannot reciprocate. An advantage of this option is the low startup cost; however, the disadvantage of this type of system is the manpower needed to inspect and test the sirens.

- Two-way: This option allows the siren to report back to the central control center. Advantages of this option include status reporting, real-time monitoring for tamper detection, and battery status updates. While these capabilities come at a higher cost, they may be justified in lower maintenance and operational costs over the system's lifetime.

4.1.6.4 Inter-connecting network

Most outdoor warning sirens require some sort of activation and control system to regulate its operation. Sophisticated activation products have digital control units, ensuring the siren also can be operated from a computer using a wired Ethernet connection or with various wireless technologies including cellular, satellite, and radio. Features of these digital systems include the following:

- Cloud-based access from any computer or mobile device, which allows the user to access their system from any computer connected to the internet
- User-friendly applications for iOS and Android, including a web-based console with a mobile responsive graphical user interface (GUI)
- Weather activation
- Map-based activation

4.1.6.5 Power Sources

Outdoor warning sirens can be powered in a variety of ways; however, larger models designed to provide mass notification capabilities typically operate on alternating current (AC) power, with rechargeable batteries or generator for backup power. The advancements in renewable energy technologies, including wind and solar, have been leveraged by some siren manufacturers.

4.1.6.6 Installations

There are three types of installations for the poles: direct buried, pier, and ballasted.

- Direct Buried: This installation is used with wood or fiberglass poles. Typically, a pole is 50 feet long. Eight to ten feet is buried in the ground, leaving 40 to 42 feet exposed. The diameter of the hole is approximately 15 inches.

- Pier: This installation is used for a steel or concrete pole. While the pole is buried to the same depth as a direct bury, more soil is disturbed as the pole diameter is larger.
- Ballasted: This installation is for a galvanized steel mount and is non-penetrating. As there is no digging required, the soil is not disturbed. The base is approximately 11 feet square and requires stone as a ballast.

Once the poles are installed, the equipment can be installed. Generally, the amplifiers and strobe light, if applicable, are mounted near the top of the pole. If solar panels are used, they will be mounted on top of the amplifiers. The equipment cabinets and batteries are mounted towards the lower half of the pole. Some owners prefer to mount the equipment at a height reachable by personnel standing on the ground and others prefer to mount it higher to avoid potential tampering or theft.

4.1.7 Market Research

There are several outdoor warning siren manufacturers, listed in the table below. Appendix C, Product Information, contains specification sheets from some popular outdoor siren manufacturers. Additional information on the sirens included in this report can be obtained from the vendors listed alphabetically in this table.

Table 2: Siren Manufacturers

Vendor	Phone	Website/Email
Acoustic Technology Inc (ATI)	(617) 567-4969	https://www.atisystems.com/about/ info@atisystem.com
American Signal Corporation	(414) 358-8000	www.americansignal.com sales@americansignal.com
Eaton	(800) 631-2148	www.cooperindustries.com
Edwards Signaling	(800) 655-4497	www.edwards-signals.com
Federal Signal Corporation	(800) 548-7229	www.fedsig.com/warning-mass-notification-systems customersupport@fedsig.com
Sentry Siren, Inc.	(866) 427-4736	www.sentrysiren.com mail@sentrysiren.com
Whelen Engineering Company, Inc.	(860) 526-9504	www.whelen.com iowsales@whelen.com

4.2 Alert and Notification Operational Overview

Alerting the public is one of the major functions of government in an emergency. To effectively perform these functions there are several things to consider. The first is understanding the components of effective

public alerting. Alert, warning, and notification are different actions, but all are important to protect the public.



An alert is giving notice to the public to get their attention that an event has occurred. This is often difficult in the constant noise of today's environment. The alert is often a short sound, action, or message. For a radio listener, the alert would be the EAS tones and headline that precedes an EAS message.

A warning is used to prepare the public for a potential risk. Warnings often include actions the public can take to mitigate the impact of the risk.

A notification has more information and usually has instructions for the public to try to protect them from the event. For a radio listener, this would be the description and instructions in the EAS message.

4.2.1 Operationalizing Alerting

MCP reviewed the Malibu website and it was clear that the use of these systems has been planned in the past and used. The use of a dedicated alert webpage for information that is easy to reach works well and the hot line information is readily available to the public.

Effectively alerting the public relies on several factors and is built on actions by the alerting authority. Some of the things that can provide this are the following:

- Plans: Pre-established plans outline what systems will be used by whom. These should include primary and alternate systems as well as systems used by other agencies.
- Policies and Procedures: Clear policy and procedure delineate who, when, how, and why various communications will take place.
- Pre-defined and Pre-approved Messaging Templates: Pre-defined messages should be developed in conjunction with a public information professional.

- Training: Recurring training on the use of the systems will improve users' skills. It is important to have multiple people trained on all systems.

- Exercise: Use of these systems on a regular basis will increase effectiveness. This is a constant process with plans trained, exercised, and refined regularly. This process also helps to keep information fresh in the minds of the users.

4.2.1.1 Plans

The City of Malibu Emergency Operations Plan states that one of the emergency management goals is to "provide effective life safety measures, reduce property loss, and protect the environment." All other plans must support these goals. To supplement this plan, the City also is in the process of developing an Alert and Warning Plan that will be consistent with the State's Alert and Warning Guidelines, issued in 2019. The Alert and Warning Plan will include guidelines for training, exercises, testing, and policies on emergency and non-emergency use of all systems, including the OWS once it is implemented.

4.3 Siren Coverage Predictions

MCP conducted a feasability sound propagation/coverage analysis. This study identified the number of possible sirens needed to cover the city, as Phase II would provide a more detailed design with siren locations. The siren count may change based on final site selections during the detailed design phase.

Coverage maps were created based on a model simulation developed in SoundPLAN® software. The model used to generate the sound pressure maps for Malibu divided the geographic regions by assigning a higher absorption factor to the hills and a higher reflective value to the flat land area to the south. Additionally, the sound pressure models took multiple environmental factors into consideration including:

- Temperature
- Humidity
- Barometric pressure
- Wind speed
- Wind direction
- Building height
- Terrain fluctuations

Meteorological assumptions used in the model are listed in the table below.

Temperature	77º F
Humidity	50% Calm 11% Santa Ana Winds
Winds	Calm and 40 mph Santa Ana winds
Barometric Pressure	29.92 inHg[9]
Siren Height	45 ft

The coverage maps developed utilized potential sites provided by the City, as noted in Section 3.1, Sites.

MCP modeled three scenarios, with four primary variations between the scenarios.

- Number of sites (or site density) – Different site counts were modeled to not only depict coverage for the north and city-wide regions, but different site count scenarios were created to show a minimal and optimal site count design for the overall city-wide solution.

- Siren power (or loudness) – Scenarios were modeled using either high-power sirens or a mix of high-power and low-power sirens to prevent excessive sound outside the city limits.

- Effects of high winds – Environmental factors that will be present during Red Flag weather events were of importance when modeling coverage, especially understanding the effects of the Santa Ana winds. Both phases were modeled under a no wind condition (calm day) and a Santa Ana winds condition to assist in visualizing the effects on siren coverage during a wildfire.

- Indoor coverage – At the request of the City, potential indoor coverage was modeled for each scenario. This is essentially a subtraction of 25 dB to allow for building signal loss. The value for *'Residences – light frame, dual-pane or storm windows'* from Table 1 was used.

The table below summarizes the three scenarios (nine total maps).

[9] Inch of mercury

Table 3: Coverage Modeling Scenarios

	# of Sites	High or Low Power or Mix	Santa Ana Winds	Indoor
Scenario #1	6	High	x	x
Scenario #2	20	Mix	x	x
Scenario #3	33	Low	x	x

Appendix A, Siren Coverage Maps, contains the maps for the above scenarios. Each map illustrates three thresholds: yellow, green, and reddish-brown; each threshold represents sound pressure in a dB value or loudness. Yellow represents the strongest at 80 dB or greater, while reddish-brown is the weakest at 60 to 70 dB. The green threshold is 70 to 80 dB.



Noise level in dB (decibels)

Most vendors design systems to have a minimal threshold of 60 to 70 dB. Per FEMA guidelines, effective siren systems should be designed to be at least 10 dB louder than ambient levels. MCP took various measurements throughout the city and found ambient levels range from 40 to 60 dB. Being conservative, MCP used a minimal threshold of 70 dB in the coverage modeling, which is illustrated by the green shading.

To help provide a frame of reference for typical dB levels, the table below contains some common sounds and their dB ratings.

Table 4: Sound Levels (dB) and Relative Loudness of Typical Noise Sources[10]

dB	Outdoor Noise Levels
120	Military jet aircraft take-off from aircraft carrier with afterburner at 50 ft. – 130 dB
110	Turbo-fan aircraft at takeoff power at 200 ft. – 118 dB
100	Boeing 707 or DC-8 aircraft at one nautical mile (6,080 ft) before landing – 106 dB Jet Flyover at 1,000 ft. – 103 dB Bell J-2A helicopter at 100 ft. – 100 dB
90	Boeing 737 or DC-9 aircraft at one nautical mile (6,080 ft) before landing – 97 dB Motorcycle at 25 feet – 90 dB
80	Car wash at 20 ft. – 89 dB Propeller plane flyover at 1,000 ft. – 88 dB Diesel train 45 m.p.h. at 100 ft. – 83 dB
70	Passenger car 65 m.p.h. at 25 ft. – 77 dB Freeway at 50 ft. from pavement edge 10 a.m. – 76 dB
60	Air conditioning unit at 100 ft. – 60 dB
40	Bird calls – 44 dB

4.4 Inter-connecting Network

For control and monitoring of the siren system, a network will be needed to connect the sirens and provide connectivity back to the control point(s). There are various options available to the City, from wireless to wireline and City-owned or leased; options include the following:

- Radio
- Cellular
- Fiber/wireline
- Satellite

Most vendors offer products/solutions to facilitate each type of network, and it is the City's decision as to which best meets its needs. There are advantages and disadvantages of each to consider.

[10] Reproduced from FEMA, Outdoor Warning Systems, Technical Bulletin (Version 2.0), January 12, 2006. Pg 8.

Table 5: Network Solutions Advantages and Disadvantages

	Advantages	Disadvantages
Radio	• City would own/control • Return on investment (ROI) short term • Reliable; redundancies built-in	• Higher capital expense up front
Cellular	• Quick deployment • Minimal capital up-front	• Least reliable; first to drop during a power outage • City does not own/control
Fiber / wireline	• Can be advantageous if already in place • City would own/control	• Usually not available at all locations • Expensive to deploy • Bandwidth offered is not required for this application
Satellite	• Quick deployment • Minimal capital up front	• Most expensive on-going expense • City does not own/control

Typically, most siren systems utilize a dedicated radio system for its connectivity and communications. These systems are simple and straight-forward. The main advantage of a radio system is that the City would own it and control it, even the frequency used; the City would need to secure a channel from the Federal Communications Commission (FCC). Radio technology using radio frequencies in the very high frequency (VHF) and ultra high frequency (UHF) ranges are common communication channel choices.

MCP created a coverage study, shown below, in the VHF band to assure it would cover all the siren locations.



Figure 4: Digital VHF Coverage Study

5 Options

Based on the information gathered and the assessment of that data, MCP assembled the following options available to the City.

5.1 Option #1 – 6 Sites, High Power Sirens

In this option, the initial six sites that the City provided were analyzed. High-powered sirens were modeled to show the maximum coverage possible. Please refer to Scenario #1 coverage maps in Appendix A. Note the coverage overlap between Malibu City Hall, Civic Center Way, and Bluffs Park.

This system design is recommended for effective tone alert coverage in the areas shown but is not recommended for live PA or pre-recorded voice announcements.

The budgetary cost breakdown for this option is below. Prices reflect a fully installed, turnkey system.

Table 6: Option #1 Cost Estimate

		Quantity	Unit Cost	Extended Cost
Siren Sites	Siren	6	$16,000	$96,000
	Local controller	6	$11,000	$66,000
	Solar power kit	6	$3,000	$18,000
	Batteries (4 each siren)	24	$375	$9,000
	Radio / Satellite (local)	6	$3,500	$21,000
	40 ft wood pole and installation	6	$14,000	$84,000
	Central controller	1	$8,000	$8,000
	PC, software (included)	1	$0	$0
	Radio system	1	$100,000	$100,000
	Optimization, configuration, and training	1	$12,000	$12,000
	Freight	1	$12,000	$12,000
			TOTAL BUDGETARY	$426,000

The budgetary cost above assumes a wooden pole. If the City desires a steel pole, an additional $10,000 per siren would need to be added, plus the cost of the pier foundation. These foundations typically are installed by a City-preferred local contractor. It is estimated that these foundations cost $3,000 to $5,000 each.

Additional assumptions:

- Electric will be available at each site as the primary power source
- For power redundancy, all sirens have solar power and battery backup designed for a minimum of 30 minutes altering time.
- Does NOT include costs for site acquisition; assumption is that sites are City-owned and available
- Does NOT include costs for California Environmental Quality Act (CEQA) adherence, legal, and FCC licensing
- Radio system includes repeaters, antenna system, mounting, and wiring to siren central controller for two locations (one on roof of City Hall and the other to be determined)
- Annual maintenance is approximately 7 percent of the capital cost of the system
- Internet connectivity will be available at controller for vendor support and cloud application

5.2 Option #2 – 20 Sites, Mix of High and Low Power Sirens

In this option, five of the six sites that the City provided are used. Due to the proximity of Malibu City Hall and Civic Center Way, coverage overlap is excessive; as they are essentially the same location, one site was dropped. To expand this option, additional arbitrary sites were added to provide coverage across the rest of the city.

To meet the City's desire to have voice capability in the Zuma Beach, Point Dume, and Civic Center areas, low-powered sirens were considered, while higher powered sirens were used in the remaining areas to maximize coverage and minimize site count. Please refer to Scenario #2 coverage maps in Appendix A.

This hybrid system design provides for voice capability in the areas required and effective tone-only coverage in the remaining areas of the city.

The budgetary cost breakdown for this option is below. Prices reflect a fully installed, turnkey system.

Table 7: Option #2 Cost Estimate

		Quantity	Unit Cost	Extended Cost
Siren Sites	Siren	20	$16,000	$320,000
	Local controller	20	$11,000	$220,000
	Solar power kit	20	$3,000	$60,000
	Batteries (4 each siren)	80	$375	$30,000
	Radio / Satellite (local)	20	$3,500	$70,000
	40 ft wood pole and installation	20	$14,000	$280,000
	Central controller	1	$8,000	$8,000
	PC, software (included)	1	$0	$0
	Radio system	1	$100,000	$100,000
	Optimization, configuration, and training	1	$40,000	$40,000
	Freight	1	$40,000	$40,000
			TOTAL BUDGETARY	$1,168,000

The budgetary cost above assumes a wooden pole. If the City desires a steel pole, an additional $10,000 per siren would need to be added, plus the cost of the pier foundation. These foundations typically are installed by a City-preferred local contractor. It is estimated that these foundations cost $3,000 to $5,000 each.

Additional assumptions:

- Electric will be available at each site as the primary power source
- For power redundancy, all sirens have solar power and battery backup designed for a minimum of 30 minutes altering time.
- Does NOT include costs for site acquisition
- Does NOT include costs for CEQA adherence, legal, and FCC licensing
- Radio system includes repeaters, antenna system, mounting, and wiring to siren central controller for two locations (one on roof of City Hall and the other to be determined)
- Annual maintenance is approximately 7 percent of the capital cost of the system
- Internet connectivity will be available at controller for vendor support and cloud application

5.3 Option #3 – 33 Sites, Low Power Sirens

This option provides a contrast to the other options. This option indicates what would be required if there was a city-wide requirement of both tone and voice OWS capability. Please refer to Scenario #3 coverage maps in Appendix A. This is the highest site count option.

The budgetary cost breakdown for this option is below. Prices reflect a fully installed, turnkey system.

Table 8: Option #3 Cost Estimate

		Quantity	Unit Cost	Extended Cost
Siren Sites	Siren	33	$16,000	$528,000
	Local controller	33	$11,000	$363,000
	Solar power kit	33	$3,000	$99,000
	Batteries (4 each siren)	132	$375	$49,500
	Radio / Satellite (local)	33	$3,500	$115,500
	40 ft wood pole and installation	33	$14,000	$462,000
	Central controller	1	$8,000	$8,000
	PC, software (included)	1	$0	$0
	Radio system	1	$100,000	$100,000
	Optimization, configuration, and training	1	$66,000	$66,000
	Freight	1	$66,000	$66,000
			TOTAL BUDGETARY	$1,857,000

The budgetary cost above assumes a wooden pole. If the City desires a steel pole, an additional $10,000 per siren would need to be added, plus the cost of the pier foundation. These foundations typically are installed by a City preferred local contractor. It is estimated that these foundations cost $3,000 to $5,000 each.

Additional assumptions:

- Electric will be available at each site as the primary power source
- For power redundancy, all sirens have solar power and battery backup designed for a minimum of 30 minutes altering time.
- Does NOT include costs for site acquisition
- Does NOT include costs for CEQA adherence, legal, and FCC licensing
- Radio system includes repeaters, antenna system, mounting, and wiring to siren central controller for two locations (one on roof of City Hall and the other to be determined)
- Annual maintenance is approximately 7 percent of the capital cost of the system
- Internet connectivity will be available at controller for vendor support and cloud application

6 Conclusions and Recommendations

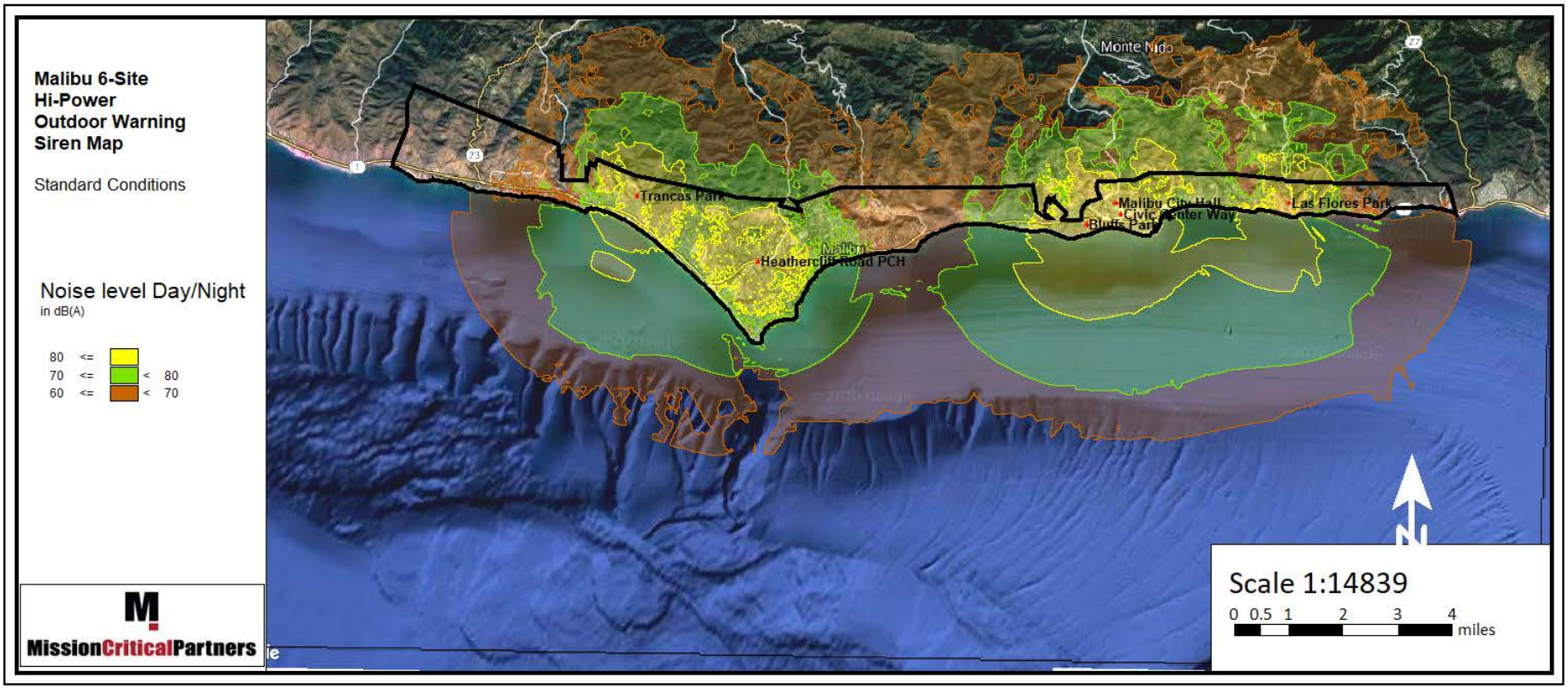
MCP believes that the proposed hybrid high/low power 20-site system is a better design and recommends that solution to the City of Malibu. This solution not only satisfies the voice requirement in the Zuma Beach, Point Dume, and Civic Center areas, but also provides tone alerting coverage across the city.

As discussed, achieving good intelligible voice across the city is difficult, but a design with more low powered sirens lends to a more intelligible message. If the City chooses to use voice messages, MCP recommends sending those messages out one siren at a time, instead of simulcasting it over all sirens at the same time; this minimizes the effects of echoes and distortion. For tone alerting, MCP recommends keeping the number of tones used to a minimum. This makes community outreach and training easier and minimizes confusion in the community by having numerous tones indicating different uses/alerts.

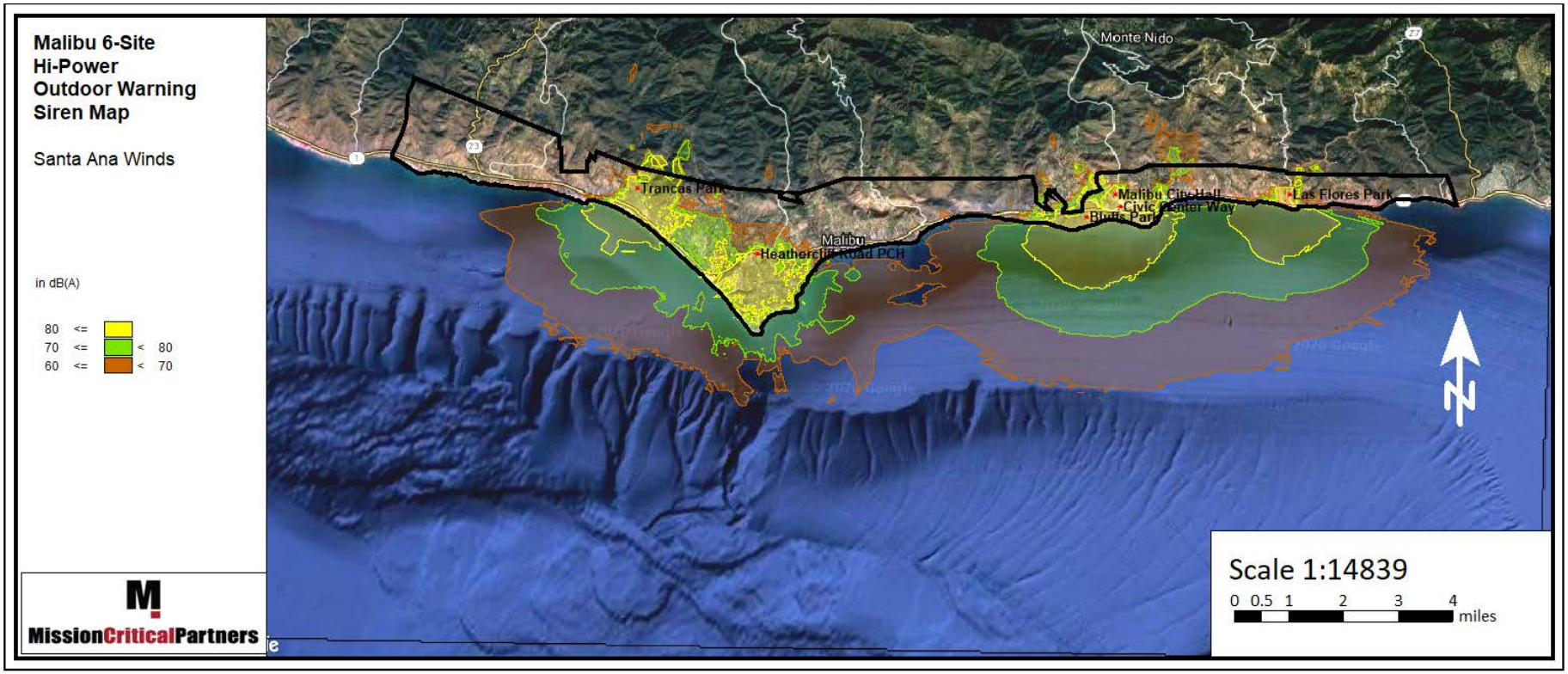
Appendix A – Siren Coverage Maps

Coverage maps for the three scenarios can be found on the pages that follow.

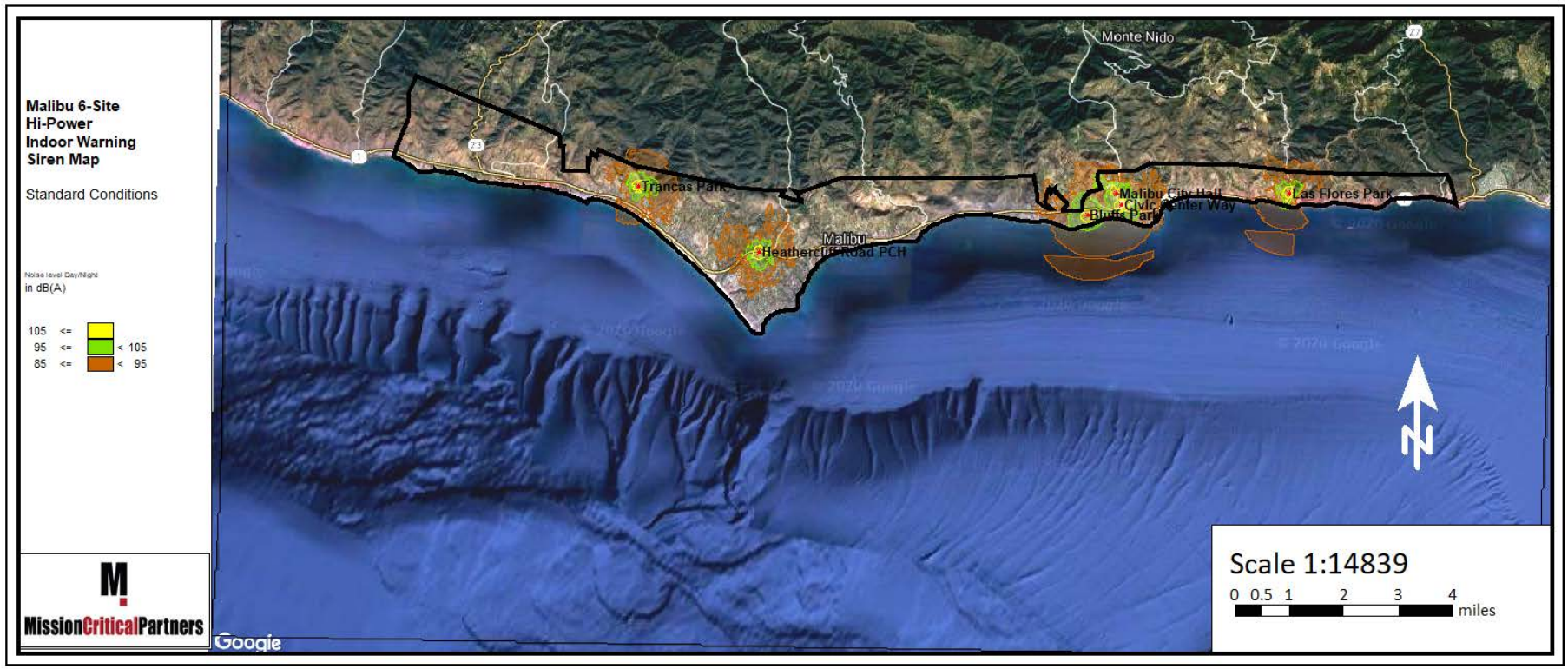
Scenario #1A – 6-site, high-power sirens



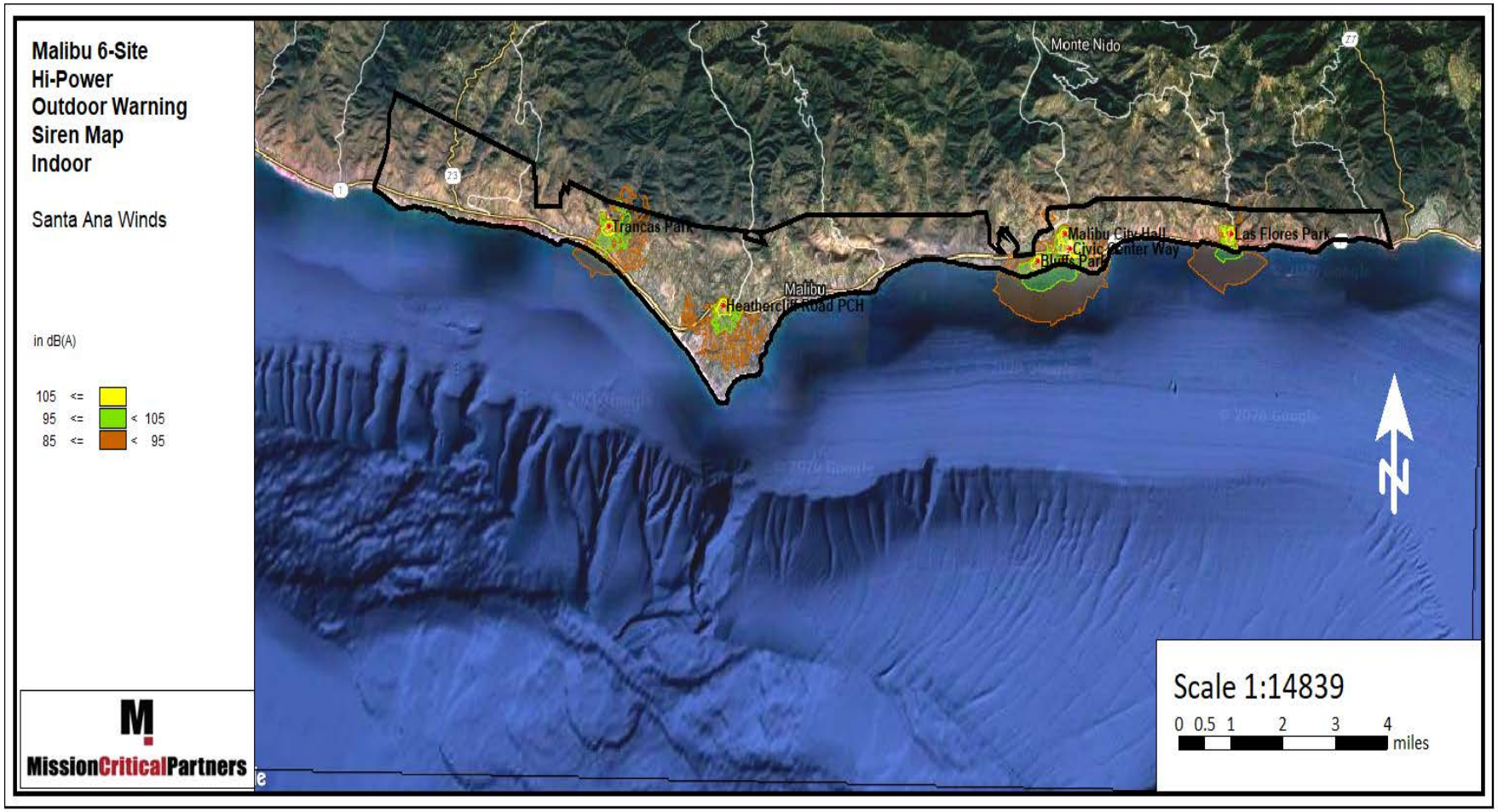
Scenario #1B – 6-site, high-power sirens, affects of Santa Ana winds



Scenario #1C – 6-site, high-power sirens, indoor coverage (25 dB)



Scenario #1D – 6-site, high-power sirens, indoor coverage (25 dB), affect Santa Ana Winds



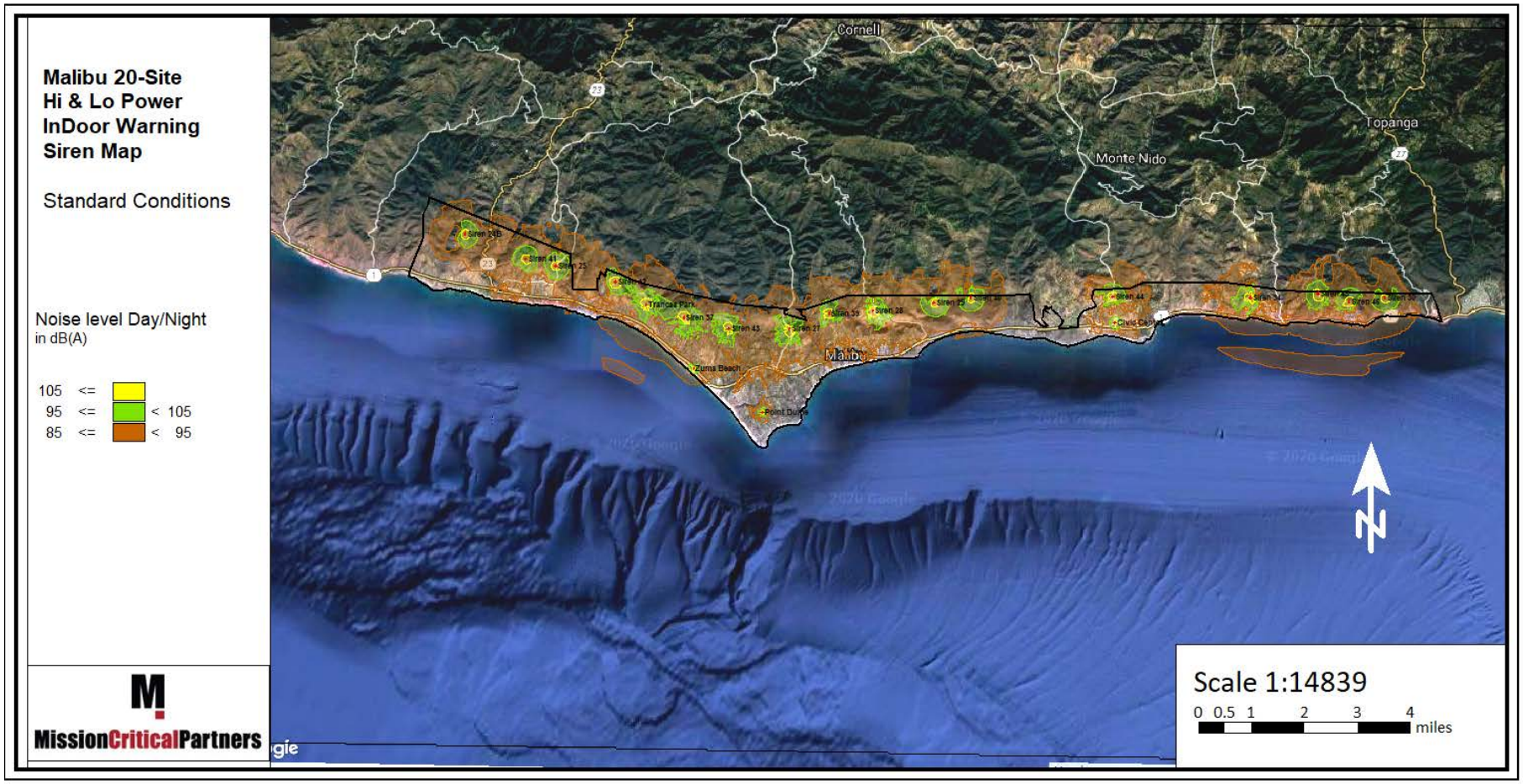
Scenario #2A – 20-site, high- and low-power siren mix



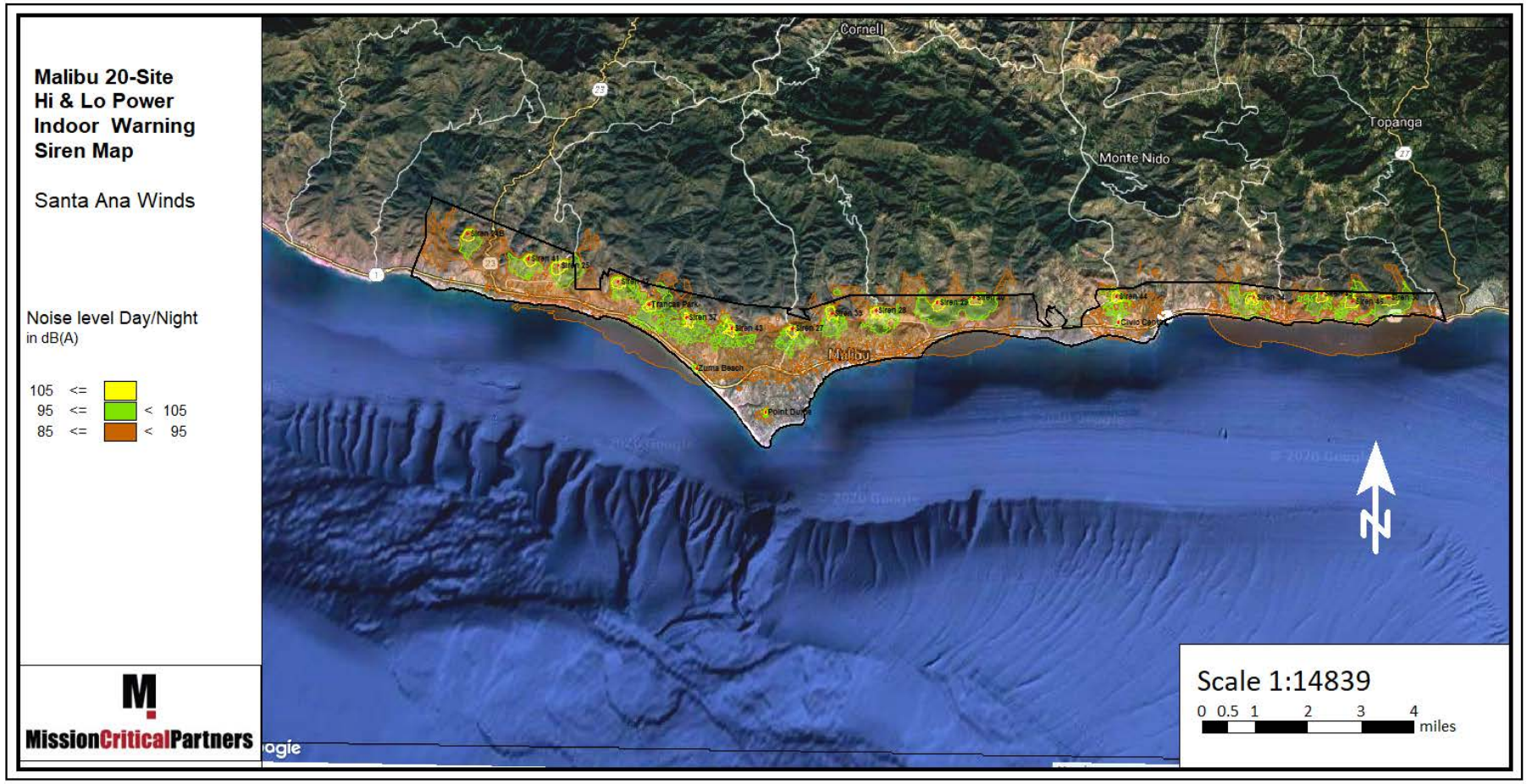
Scenario #2B – 20-site, high- and low-power siren mix, affects of Santa Ana winds



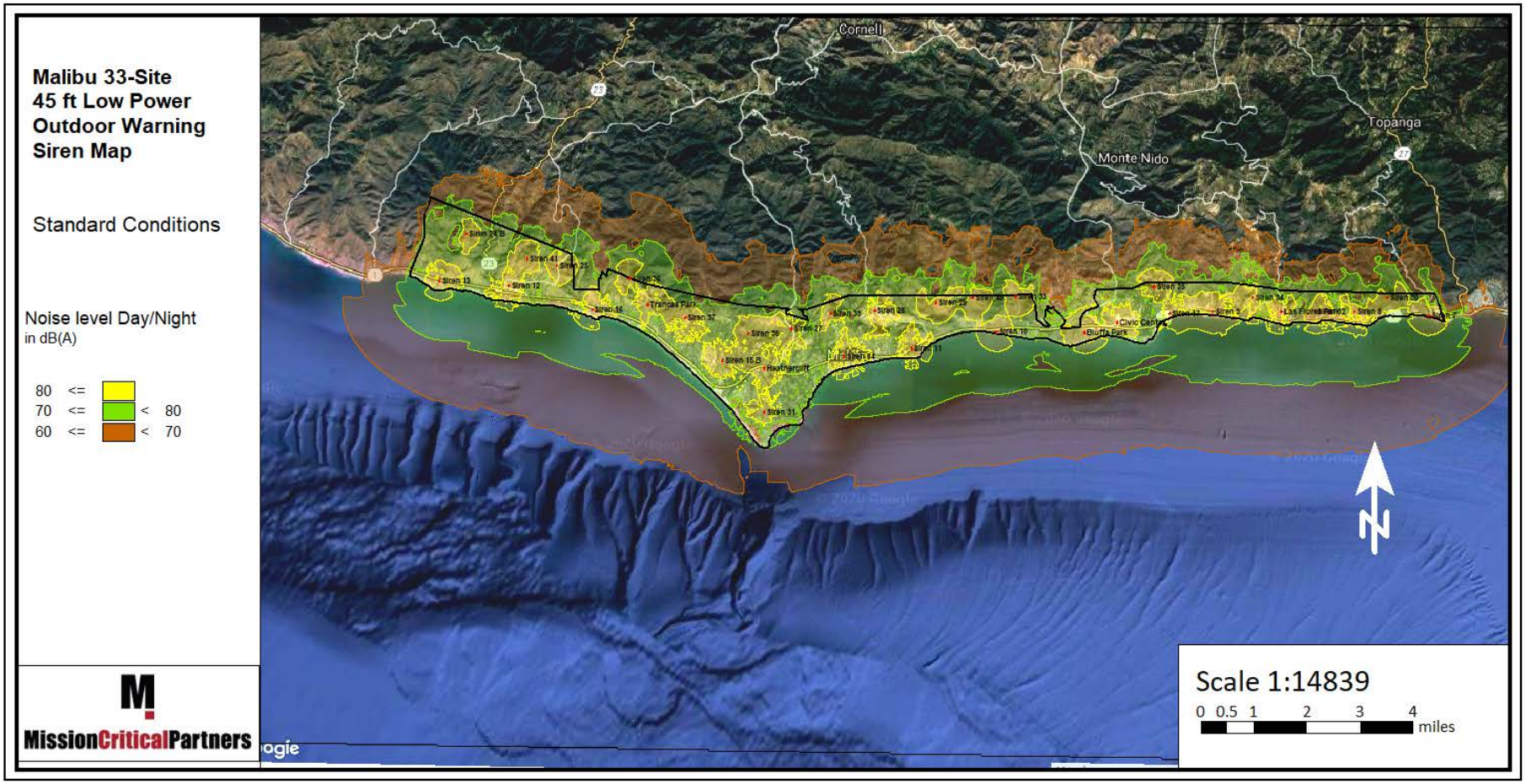
Scenario #2C – 20-site, high- and low-power siren mix, indoor coverage (25 dB)



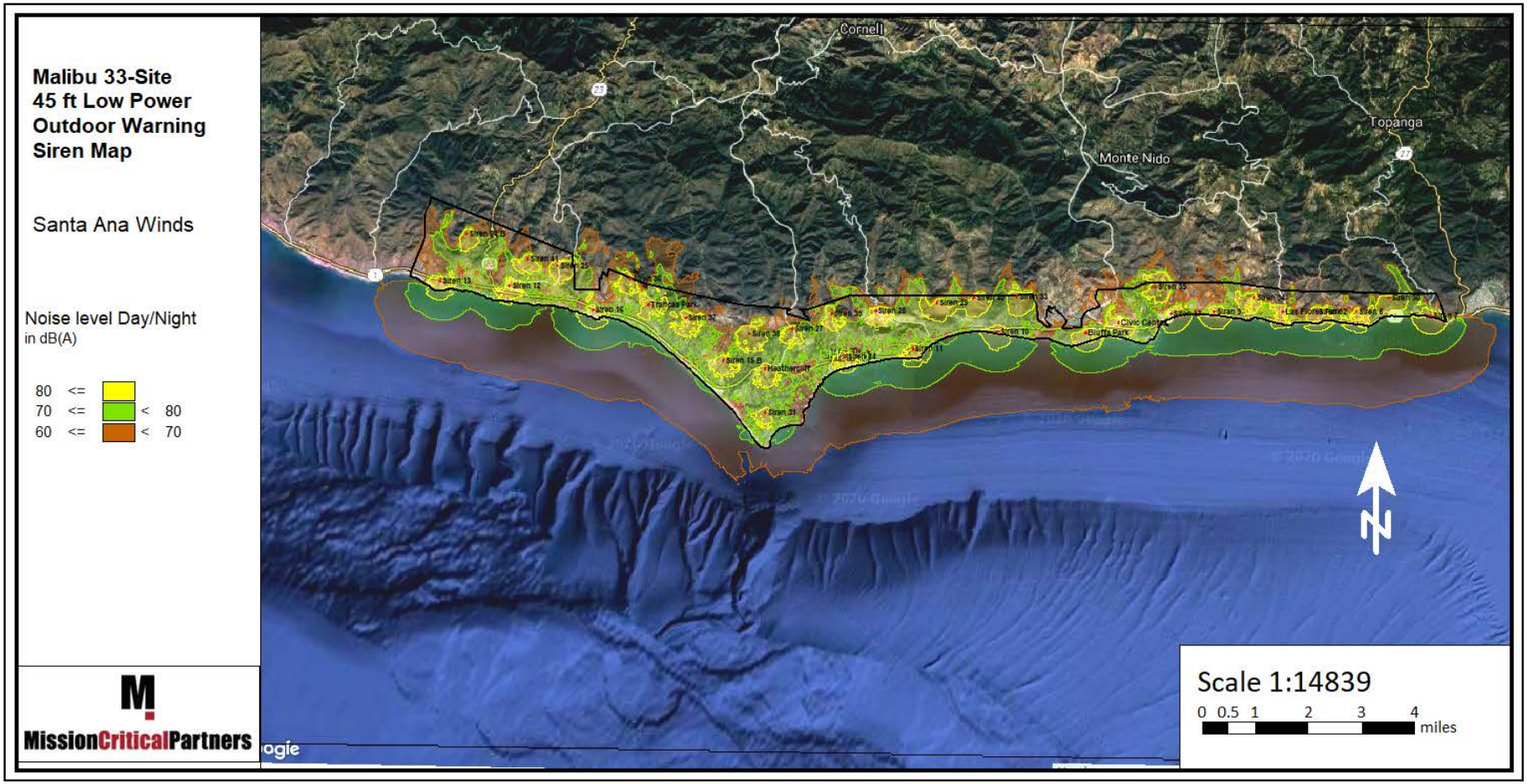
Scenario #2D – 20-site, high- and low-power siren mix, indoor coverage (25 dB), affects Santa Ana Winds



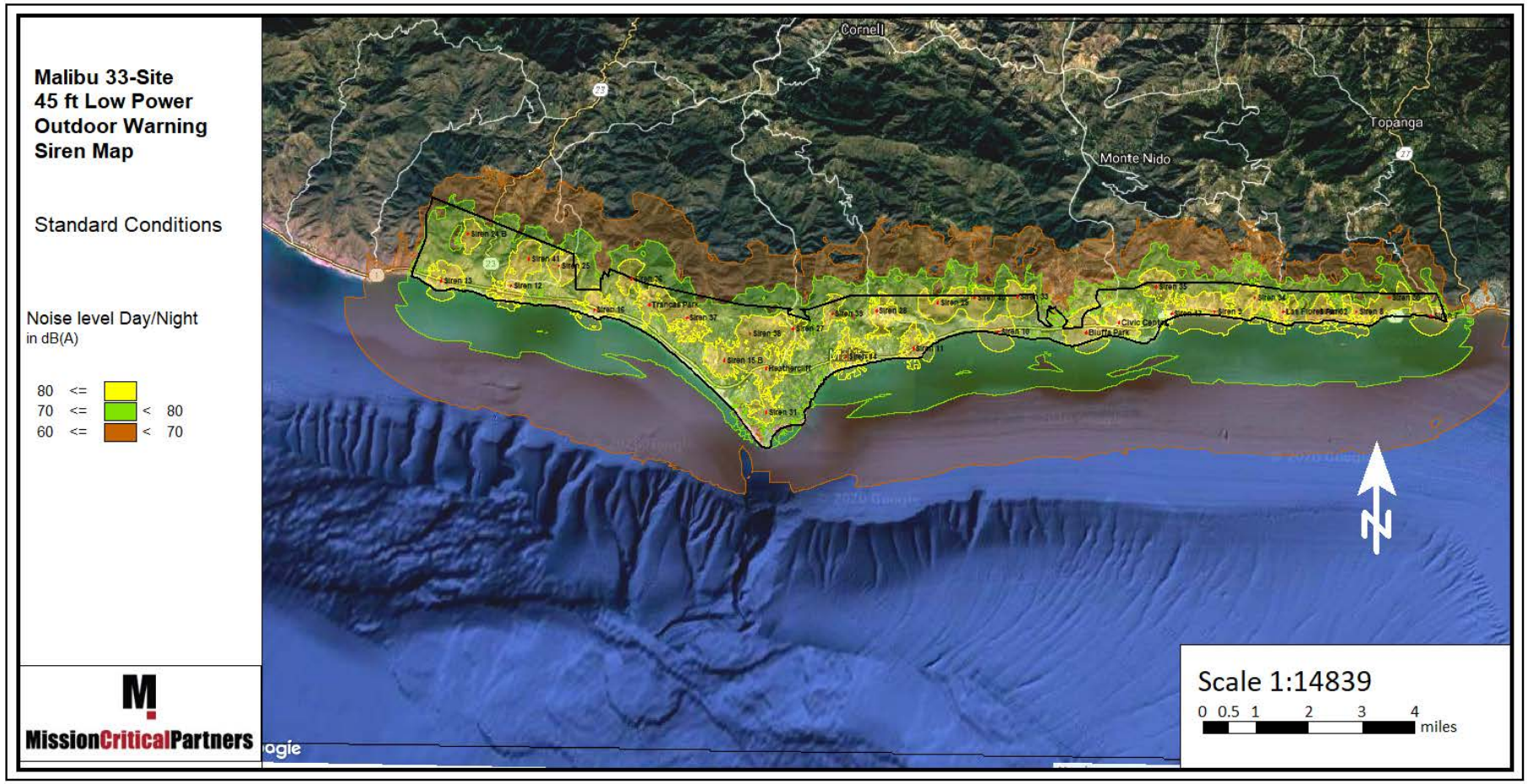
Scenario #3A – 33-site, low-power sirens



Scenario #3B – 33-site, low-power sirens, affects of Santa Ana winds



Scenario #3C – 33-site, low-power sirens, indoor coverage (25 dB)



Scenario #3D – 33-site, low-power sirens, indoor coverage (25 dB), affects Santa Ana winds



Appendix B – Alerting Technologies

Technology	Alert (A), Notification (N), or Both (A/N)	Intended User/Audience	Time Frame	Description
Sirens	A	Outdoor and open space public	Immediate	▪ One-way system for alerting the public of emergencies ▪ Limited information available ▪ Must be followed up with where to get detailed information ▪ Visitors may not know what messages may mean
Public Address (PA)	A/N	Indoor and outdoor open space public	Immediate	▪ One-way system for alerting the public of emergencies ▪ Limited information available ▪ Must be followed up with where to get detailed information ▪ Visitors may not know what messages may mean
Tone Alert Radios (TARs)	A/N	Indoor public	Immediate	▪ One-way system that can be used to alert the public ▪ Provides some additional information of actions required ▪ Limited to fixed sites that have these devices
Emergency Telephone Notification Systems (ETNS)	N	Landline or pre-registered wireless phones	Near-term	▪ One-way system that can be used to notify users of actions needed ▪ Systems are often best effort and have some latency based on the system and usage at the time of use ▪ Transmission of Teletypewriter (TTY) signals required for equal access

Technology	Alert (A), Notification (N), or Both (A/N)	Intended User/Audience	Time Frame	Description
Legacy EAS	A/N	Commercial media watching public	Near-term	▪ One-way system for alerting the public ▪ Provides a limited amount of information ▪ Constrained by available types of messages the system allows ▪ Local messages are not required to be broadcast by the media outlets
IPAWS		Various—see below	Immediate	▪ Acts as a gateway to several other alerting methods ▪ Allows users to create a single message that is disseminated via multiple methods
IPAWS–EAS	A/N	Commercial media watching public	Near-term	▪ One-way system for inputting messages to other systems ▪ Used for alerting the public and providing a limited amount of information ▪ Constrained by available types of messages the system allows.
IPAWS–WEA	A	Wireless phone public	Immediate	▪ One-way system for alerting the public ▪ Provides a limited amount of information ▪ Constrained by the available types of messages the system allows ▪ Uses cellular radio broadcast of a short text to wireless phones and, as such, may reach visitors more easily ▪ Not all phones receive these messages ▪ The public can disable this from their phones

Technology	Alert (A), Notification (N), or Both (A/N)	Intended User/Audience	Time Frame	Description
IPAWS–NWEM[11]	A/N	Weather radio users	Immediate	▪ One-way system for alerting the public ▪ Allows more detailed information ▪ Constrained by available transmitters in the area ▪ Public must tune to these stations ▪ Added benefit of using weather radio county codes for notifications
IPAWS–All-Hazards Information Feed	N	Private service users	Near-term	▪ Used by several commercial systems ▪ Include popular mapping and search engines and commercial alerting services
Highway traffic radios	A	Traveling public	Near-term	▪ One-way system for alerting the public ▪ Allows more detailed information ▪ Constrained by available transmitters in the area ▪ Public must tune to these stations
Alert translation services	A/N	Non-English Speaking/Deaf and Hard of Hearing Public	Near-term	▪ One-way system usually accepts the IPAWS feed ▪ Translates to ASL or other languages and then posted to a public website or sent via ETNS
Roadside message boards	A	Traveling Public	Near-term	▪ One-way system for alerting the public ▪ Provides a limited amount of information ▪ Constrained by size of the sign and ability of a driver to read the sign

[11] As of February 2020, the link to NWEM from IPAWS was not available to local authorities, but work continues. It is in the best interest of the local authorities to monitor this process to gain this capability when it becomes available in the future.

Technology	Alert (A), Notification (N), or Both (A/N)	Intended User/Audience	Time Frame	Description
Route alerting	A/N	Public in fixed locations along the route	Near-term	▪ Generally, a one-way system for alerting the public along a route ▪ Takes time and resources to cover relatively small areas ▪ Sound (e.g., sirens) may not penetrate modern buildings
Drone route alerting	A/N	Outdoor and open space public	Delayed	▪ One-way system for alerting the outdoor public ▪ Similar difficulties as sirens with penetrating into buildings ▪ Time needed to get into service ▪ Limited alerting time due to battery life ▪ FAA rules limit use ▪ Not useable in the event of wildfire as it prevents fire-fighting activities
Cable system interrupt	A/N	Cable viewers	Immediate	▪ One-way system for alerting the public ▪ Allows more detailed information ▪ Constrained by the available access ▪ Being replaced by other more-focused systems as cable system areas expand
Social Media	N	Internet Connected Public	Delayed	▪ Used to provide information to the public and sample public reactions ▪ Can help reduce rumors ▪ Can be used in some cases as a method to get reports from the public
Press Release	N	Media	Delayed	▪ One-way system that allows for more information to be sent to the media ▪ Information is sent, but that does not mean it will be relayed to the public

Technology	Alert (A), Notification (N), or Both (A/N)	Intended User/Audience	Time Frame	Description
Press Conference	N	Media	Delayed	▪ Two-way system that allows the media to give feedback and expand their understanding of the situation ▪ Not all information may get to the public

Appendix C – Product Information

Product information can be found on the pages that follow.

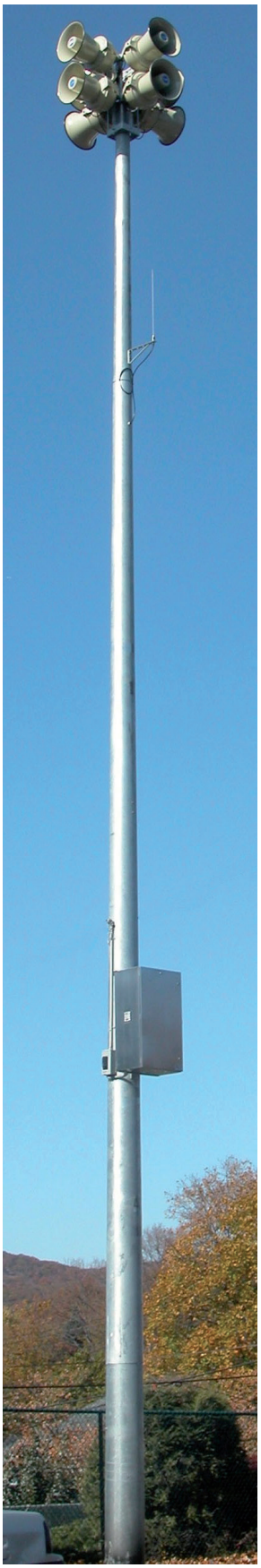
ATI Systems
ACOUSTIC TECHNOLOGY, INC.

HPSS

High Powered Speaker Station

Our most powerful siren, the High Powered Speaker Station (HPSS) provides exceptional voice clarity for outdoor mass notification applications where intelligibility of pre-recorded voice messages and live Public Address (PA) is critically important. The HPSS provides up to 3200 watts of continuous audio output. It is also capable of driving strobe lights and LED message signs for visual alerting in areas with high ambient noise levels.

The unit is monitored, controlled, and activated by an ATI central control unit, such as the REACT5000 or REACT4000, or can operate standalone using the Local Operating Console (LOC) option.* Our HPSSs can support multiple simultaneous communication paths to ATI control units to provide the most robust, reliable notification system available*. All HPSSs have battery backup systems since AC power is often lost during an emergency. In addition, ATI offers a high wind solar panel option to charge the batteries where AC is not available or practical. *



ATI's HPSS32

Key Features

- Excellent acoustic performance and voice intelligibility
- Up to eight 400W speaker horns and steel speaker mounting bracket included, for roof or pole-mount installation
- Configurable audio coverage patterns ranging from 360° omnidirectional to unidirectional
- NEMA 4X Stainless steel enclosure with ventilated battery compartment, door intrusion switch and enclosure mounting bracket
- Unique, compact and highly efficient Class D amplifiers with 1600/3200 watts of continuous audio output power integrated on a high-performance controller board
- Conformal-coated printed circuit boards for operating in harsh environments
- UL464 listed option available upon request*
- Message encryption and security coding to prevent unauthorized system activations
- Local and remote testing and reporting including "silent" testing
- Temperature-compensated battery charger and power On/Off circuit breakers
- Very low standby power requirements and 60 minutes of continuous activation
- Flexible and redundant communication methods including IP, Ethernet, twisted pair/telephone cable, fiber optic, cellular and satellite*
- Built-in tone generator providing 10 standard, pre-configured tones; up to 255 pre-recorded voice messages and 100 hours of recording time
- Automatic gain control for consistent output volume

HPSS SPECIFICATIONS

Physical Attributes

	HPSS16	HPSS32	400W Speaker
Length	40”		19”
Width	23”		21”
Depth	15”		24.34”
Weight (without radio/batteries)	118 lbs	126 lbs	45 lbs

Environmental Characteristics

Operating Temperature	-40 to +80°C
Humidity	0 to 95%, non-condensing

Electrical/Power Characteristics

	HPSS16		HPSS32	
Supply voltage	120VAC 60Hz	240VAC 50Hz	120VAC 60 Hz	240VAC 50Hz
Supply current, max	5A	3A	5A	3A
Standby current	550mA, typical §			
Standby time without AC	> 3 days §			
Max activation time	60 minutes (steady tone, full power) §			
Radio power supply	12V DC, 12A maximum*			

Communication I/O

Communication to ATI units	IP (Ethernet), (UHF/VHF) radio, fiber, satellite, DSL, and cellular modem*
RS485/RS232 port	1, maximum (either RS485 or RS232)*
Signaling inputs	8, maximum* (configurable)
Signaling outputs	8, maximum* (configurable)
Audio out (for PA or FACP)	configurable 300/600 ohm balanced or unbalanced

Pre-recorded Messages/Tone Characteristics

Number of alert tones	10 pre-configured alert tones
Number of recorded messages	255, maximum
Recording time, maximum	100 hours (depends on recording content)

Amplifier Characteristics

	HPSS16	HPSS32
Number of 400W speakers	up to 4	up to 8
Output voltage	25V	
Max power (audio/strobe)	1600 W RMS	3200 W RMS
Audio Bandwidth	250 Hz - 5 kHz	
Output regulation	< 1dB, no load to full load	
Amplifier efficiency	90%	

All information and specifications are subject to change without notice, and may contain typographical or other errors.
§ Assuming 2 - 105AH batteries, with radio communication
**Additional hardware/firmware may be required.*

Acoustic Technology, Inc.
30 Jeffries Street, Boston, MA 02128
Tel: 617-567-4969 ext. 1041 Fax: 617-569-2964

www.atisystem.com
info@atisystem.com
61116R2

FEDERAL SIGNAL



Shown with optional QuadraFlare lights

Model MOD Series

Modulator
High Powered Omni Speaker

Federal Signal's Modulator High Powered Speaker Array offers the same proven technology as the original Modulator with the exception of a smaller compact chassis. Modulator provides a flat frequency response up to 2000Hz producing intense warning signals and digital voice messaging over a large area. The Modulator design enables the siren to produce a high sound level and intelligible voice communications.

The innovative omni-directional electronic Modulator speaker array consists of modules that utilize four 100 watt drivers. It also provides clear voice communication and offers warning signals which are produced by Federal Signal's UltraVoice™ electronic controller and amplifier system. Custom tones and professionally recorded voice messages for the UltraVoice controller are available and can be purchased upon request.

The Modulator High Powered Speaker Array combined with the UltraVoice controller is ideal for community/municipal, industrial and military applications where immediate instruction is necessary.

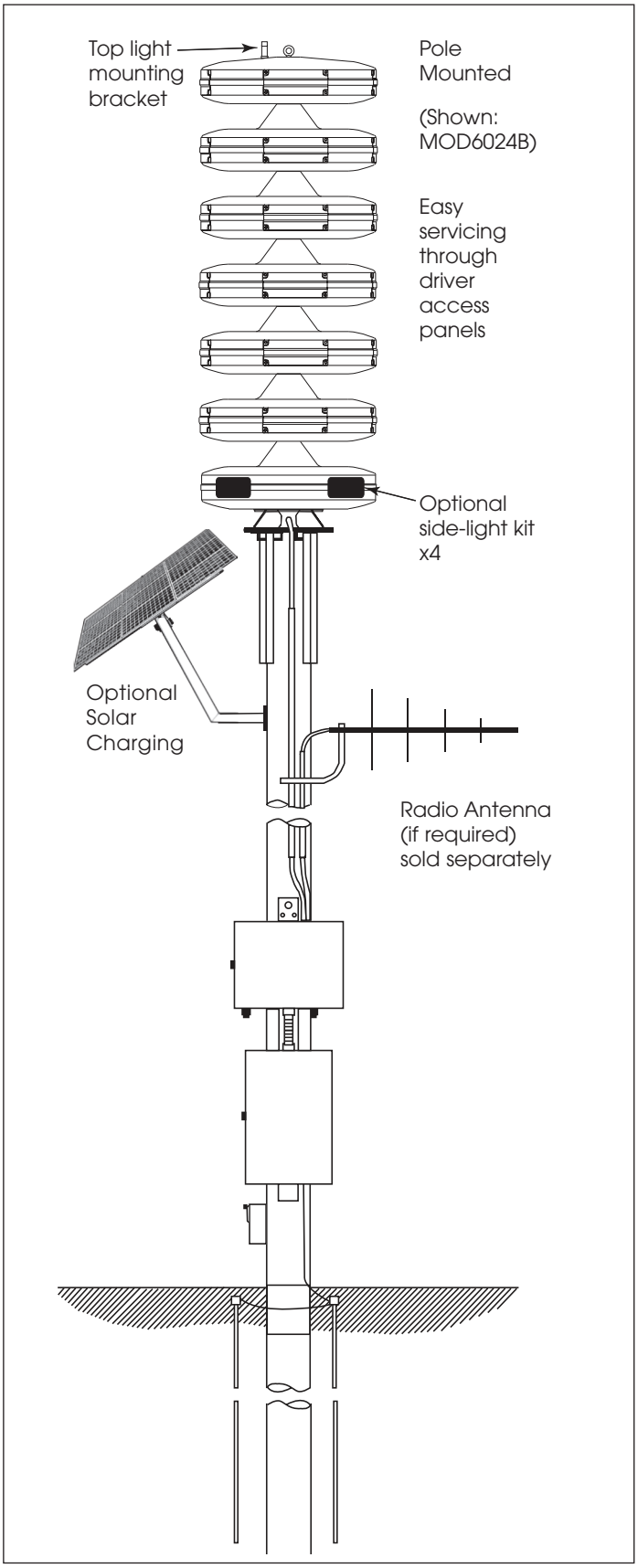
The Modulator and UltraVoice controller can be networked via radio, IP, landline, cellular and/or satellite communications. Powering is available in AC, DC, or solar. The system typically operates from batteries which are charged from either AC or Solar. Federal Signal can also provide customized solutions to fit your special applications.

FEATURES

- Light-weight, compact design
- Utilizes Federal Signal Ultravoice™ for control and amplification
- Excellent frequency response for clear voice reproduction
- 360° coverage without sound variation in horizontal planes
- Easy servicing through convenient access panels
- Anechoic chamber-certified

MODEL	ACTIVE MODULES	TOTAL WATT	DECIBELS @ 100'[1]	EFFECTIVE RANGE @ 70 dBc	HEIGHT IN	HEIGHT MM	NET WEIGHT LBS	NET WEIGHT KG	SHIPPING WT LBS	SHIPPING WT KG
MOD1004B	1	400	106 dBc	1,200'	28"	71	125	56.8	264	120
MOD2008B	2	800	112 dBc	1,800'	43"	109.2	190	86.4	294	133.6
MOD3012B	3	1200	115 dBc	2,200'	57"	144.7	255	115.9	444	201.8
MOD4016B	4	1600	118 dBc	2,800'	72"	182.8	320	145.5	544	247.3
MOD5020B	5	2000	120 dBc	3,100'	86"	218.4	385	175	744	338.2
MOD6024B	6	2400	121 dBc	3,400'	101"	256.5	450	204.5	960	436.4
MOD8032B	8	3200	124 dBc	4,200'	130"	330.2	580	263.6	1392	632.7

Modulator® High Powered Omni Speaker (MOD)



SPECIFICATIONS

Frequency Response:	200-2000Hz
Color	Off-White
Paint Type	TGIC-polyester powder coat
Modulator Horn Type	Hyperbolic flare
Horizontal Coverage	360° +/- 1 dB(C)
Diameter	35"/88.9cm
Wind Loading @ 110mph wind velocity[1]:	
MOD1004B	251 lbs
MOD2008B	377 lbs
MOD3012B	503 lbs
MOD4016B	629 lbs
MOD5020B	755 lbs
MOD6024B	881 lbs
MOD8032B	1133 lbs

[1] Wind loading is the calculated force of wind at 110mph (shoreline), exposure D (flat, unobstructed coastal areas) on frontal area 4.64 ft. per American National Standards Institute A58.1"Minimum design loads for buildings and other structures."

HOW TO ORDER

Contact our Federal Signal Sales Engineers to design a system that meets your specific requirements.

Specify speaker array model number – each speaker array model must be ordered with a specific corresponding UV and Amplifier.

Speaker	Controller[1]
MOD1004B	UV + 1 UV400
MOD2008B	UV + 2 UV400
MOD3012B	UV + 3 UV400
MOD4016B	UV + 4 UV400
MOD5020B	UV + 5 UV400
MOD6024B	UV + 6 UV400
MOD8032B	UV + 8 UV400

[1] Controllers available in Radio, IP, and Landline.

Note: 40 feet of cable is supplied with siren. Extension cable in 10 foot increments is also available. Mounting the UV controller further than 100 feet is not recommended (further mounting may decrease power output).

ACCESSORIES

Description	Part Number
Flashing light for top of MOD	**191XL-024***
Red Quadraflare 4 light kit	**MOD-QF-KIT**
Blue Quadraflare 4 light kit	**MOD-QF-KIT-B**

* Indicates color: (A) Amber, (B) Blue, (C) Clear, (G) Green or (R) Red

REPLACEMENT PART

Description	Part Number
Driver, 100 watt	**K8570063A**

UltraVoice is a registered trademark of Federal Signal Corporation.

WPS2901 One Cell

Mass Notification Warning Product

Whelen's Mass Notification WPS2900 Series omni-directional voice product delivers clear, powerful voice communication.

SYSTEM FEATURES

- **WPS2901** – One omni-directional speaker cell assembled in a vertical column
- Two compartment (Type II) natural finish aluminum or stainless steel cabinet
- Speaker cell includes one high efficiency 400 watt speaker driver
- 50' (15.24m) cable included
- Pole top mounting bracket included
- Public address and pre-recorded voice message capability
- Local or remote controls available
- Battery powered
- One power amplifier
- AC temperature compensated "tri-mode" 10 amp battery charger
- Electronic controller
- Tone Generator Timer
- Local control push-buttons
- Battery switch
- **RDVM1G –** digital voice 1-28 message capable
- **SI TEST®**
- **SLIDEOUT™** battery tray
- Lightning arrestor
- Six standard warning tones – Wail, Whoop, Alert, Attack, Hi-Lo, Airhorn

SYSTEM OPTIONS

- **Solar option** – 2 each 80 watt panels, with brackets and solar regulator
- **Batteries** – 2 each Delco S2000 or Interstate Workaholic 31-MHD Batteries. Check Whelen's web site, www.whelen.com, for other recommended batteries
- **Microphone** – for use at the cabinet (locally) or at the control point (remotely)
- **VisuAlert™** – Omni-Directional visual warning Model **VALERT*** for 2900 Series
- **L31H*F4** – Top mount high dome beacon for 2900 Series, 24 VDC

ACTIVATION CONTROLS

Our VHF and UHF radio narrow-band control packages feature Whelen protocol COMM/STAT™ and include the following:

- Radio
- Radio interface
- Tone or digital squelch
- 3-5 dB gain omni-directional antenna with bracket
- 35' (10.67m) of RG58 antenna cable
- Polyphaser
- **SI TEST**
- Low battery alarm (two-way only)



Other features are dependent upon one or two-way controls. Whelen equipment can be interfaced with many different types of two-way radio communications products and systems, from ACE, MOSCAD and FSK.

The following is available as standard options. **BOLD BLUE** in callout indicates the Whelen Model:

ONE-WAY CONTROLS

- **AUXIN** – Auxilliary board for contact closure activation
- **D2030LL** – 10 digit DTMF Landline
- **D2030NV** – 10 digit DTMF VHF High-Band Narrow-Band/138-174 MHz
- **D2030NU** – 10 digit DTMF UHF Narrow-Band /450-470 MHz
- **WPSTT** – Two-tone sequential option (one-way radio package must be ordered from above options)

TWO-WAY CONTROLS

- **AUXCS** – Two-way contact closure activation and status board
- **C2030LL** – Two-way landline activation
- **C2030NV** – 10 digit DTMF VHF High-Band Narrow-Band/138-174 MHz
- **C2030NU** – 10 digit DTMF UHF Narrow-Band /450-470 MHz

OPTIONS

- **STATUS** – Cabinet window LED status indicator
- **PGINT** – Paging interface
- **INTRUWPS** – Intrusion Alarm



Type II Electronic Cabinet



UL LISTED

WPS2901 One Cell

Specifications

Component	Height Inches (CM)	Width Inches (CM)	Depth Inches (CM)	Weight Lbs. (kg)
WPS2901 Speaker	18.8 (47.75)	33.40 (84.84)	–	119 (53.98)
Electronics Cabinet Type II (Aluminum)*	60.50 (153.67)	33.20 (84.33)	12 (30.50)	132 (59.90)
Pole Top Bracket	30.5 (77.47) (with top plate)	12.0 (30.50) x 13.5 (34.30)	See Drawing	71 (32.20)

Batteries add 115 lbs. (52.16 kg) *Stainless cabinet option adds 58 lbs. (26.31 kg).
Pallets, boxes and skids add weight. Check with Whelen if a freight quote is needed.

Electrical

- **Battery Charger Input:** 120VAC, 60Hz, 7A fuse (240VAC 50/60 Hz available)
- **Battery Charger Output:** 28VDC, 10A (nominal)
- **Batteries:** (2) 12V, 115AH lead calcium
- **Standby Current:** 82mA, 24VDC
- **Operating Current:** 23A, 24VDC
- **Power Amplifier Output Power: Tone:** 400 watts, **Voice:** 500 watts

Environmental

- **Operating Temperature:** -35°C to +60°C
- **Storage Temperature:** -65°C to +125°C
- **Humidity, Non Condensing:** 0 to 95%

Ordering Information

BASIC SYSTEM INCLUDES THE FOLLOWING

- **WPS2901** – Speaker assembly with 50' (15.24m) cable & electronics cabinet with all the standard components including voice board for 1-28 pre-recorded messages and Pole Top Bracket

OPTIONS

- **AUXIN** (one-way) / **AUXCS** (two-way) – Auxiliary boards for contact closure activation
- **D2030LL / D2030NV / D2030NU** – One-way controls
- **C2030LL / C2030NV / C2030NU** – Two-way controls
- **WPSTT** – Two-tone sequential
- **STATUS** – Cabinet window LED status indicator
- **PGINT** – Paging interface
- **INTRUWPS** – Intrusion alarm (two-way only)
- **MSGPROG** – Custom pre-recorded messages
- **MSGPROGL** – Whelen library messages
- **WPSNCMIC** – Microphone for public address use at the cabinet
- **WPSBATT** – One pair of Whelen approved batteries
- **RTM** – Roof top mount
- **SBC280** – Solar option

OPTIONAL LIGHTING ACCESSORIES

- **VALERT*** – VisuAlert™ lighting accessory
- **L31H*F4** – L31 LED, 24VDC
- **LCWPS** – LED controller with mounting plate, hardware and harnessing for L31 & L32
- **LEDCTRL** – LED controller only

* Specify color **A**=Amber, **B**=Blue, **R**=Red, **C**=White/Clear

Acoustic Performance

Wattage: 400 watts
Estimated 70dB Range: 1,500 ft / 458 m

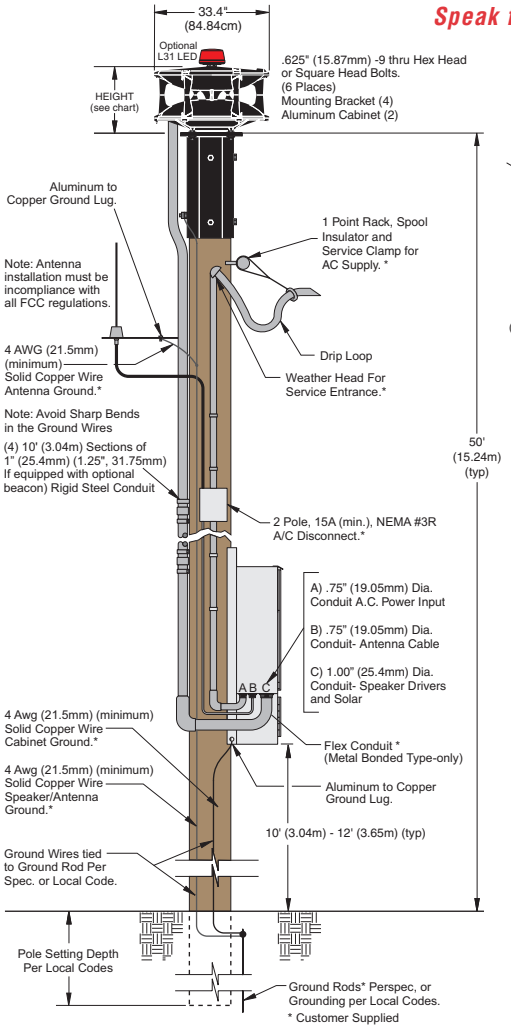
Weather, terrain and other structures may impact the range. Each siren within the system may have a decreased or increased range depending on conditions beyond our control.

MASS NOTIFICATION PRODUCTS
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Chester, Connecticut 06412-0684
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800-637-4736
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design improvements without notification.
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"Our Mass Notification Products Speak for Themselves"™



⚠ **WARNING:** This product may contain chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, visit whelen.com/regulatory.

Appendix D – Additional Resources for Emergency Alerting and Communication

Additional resources are provided below.

Public Safety Communications, Ten Keys to Improving Emergency Alerts, Warnings, & Notifications. April 2019
https://www.dhs.gov/sites/default/files/publications/ten_keys_to_improving_emergency_alerts_warnings_notifications.pdf

Public Safety Communications, Essentials of Alerts, Warnings, & Notifications. May 2019
https://www.natoa.org/documents/CISA%20Essentials%20of%20AWNs.pdf

Guide to Implementing the Integrated Public Alert and Warning System (IPAWS). Version 2, February 2019
https://www.cseppportal.net/Training%20Documents/IPAWS_Implementation%20Guide_Final_FEB2019_Version%202.pdf