



Disaster and Fire Safety Commission

## ACTION CALENDAR

May 14, 2019

To: Honorable Mayor and Members of the City Council  
From: Disaster and Fire Safety Commission  
Submitted by: Gradiva Couzin, Chair, Disaster and Fire Safety Commission  
Subject: Recommendation to Install an Outdoor Public Warning System (Sirens) and Incorporate It Into a Holistic Emergency Alerting Plan

### RECOMMENDATION

We recommend that City of Berkeley immediately begin the process to purchase, install, and maintain an outdoor public warning system (sirens) as a supplement to other alert and warning technologies within our boundaries and coordinated with abutting jurisdictions and Alameda County.

This installation should be accompanied by the following:

- ongoing outreach and education so that the public will understand the meaning of the sirens and what to do when they hear a siren
- development of a holistic alert protocol, incorporating sirens as an additional option among the available suite of alerting methods
- staff training and drills on alerting procedures
- development of a testing and maintenance plan that will ensure the system is fully operational while avoiding unnecessary or excessive noise pollution in the City
- outreach to deaf and hard of hearing residents to encourage them to opt-in for alerting that meets their communication needs. This may include distributing weather radios or other in-home devices with accessibility options for people with disabilities.

This recommendation does not specify the number, type, or location of sirens; City staff should determine the most cost-effective system that achieves the goals described in this recommendation. This may include either mobile or fixed-location sirens.

### FISCAL IMPACTS OF RECOMMENDATION

Exact costs and staff time are to be determined. However, the two estimates below give a ballpark sense of the possible cost of this installation:

- Example 1: The cost of a 23-siren system in Berkeley was estimated at \$801,000 in 2004 (\$1.1 million in 2018 dollars), with an additional \$100,000 (\$132k in 2018 dollars) for public outreach and 0.5 FTE staff member time for 6 months to support the installation process.

- Example 2: A siren proposal in Sonoma County was recently estimated at \$850,000 for design and installation of 20 sirens.

### CURRENT SITUATION AND ITS EFFECTS

On March 27, 2019, at the Regular meeting of the Disaster and Fire Safety Commission, the commission passed a motion to recommend that the City immediately begin the process to purchase, install, and maintain an outdoor public warning system (sirens) as a supplement to other alert and warning technologies within our boundaries and coordinated with abutting jurisdictions and Alameda County. M/S: Flasher, Degenkolb; Vote: 8 Ayes: Degenkolb, Flasher, Simmons, Stein, Bailey, Couzin, Grimes, Dean; 0 Noes; 0 Absent; 0 Abstain.

Berkeley faces a serious threat from a wildland-urban interface (WUI) fire that has increased for many reasons, including the growth of fuel that is happening as a result of recent rains. Based on recent experiences in the 2017 North Bay fires and the 2018 Camp Fire, it is clear that a wildfire in Berkeley would spread very quickly, expanding at many miles per hour and requiring a rapid evacuation of a large number of residents. This is especially likely in the designated Hazardous Fire Zones in the hills, but an intense and fast-moving fire threatens the entire City of Berkeley, including the flats.

Significant efforts are underway to address this increasing threat, including City staff's creation of a draft Wildfire Evacuation Plan and other wildfire safety efforts.

The City of Berkeley currently has several available alerting options that it can use in a wildfire emergency (see Attachment A) but does not have a citywide system of emergency sirens.

Recent wildfires in Northern and Southern California have shown that existing alerting systems and processes have not been sufficient. These wildfires have had tragic outcomes, with a disproportionate number of deaths of seniors and people with disabilities. Some of these locations have since initiated plans to install outdoor public warning systems (sirens).

### BACKGROUND

Berkeley has considered using sirens for many years. In 2004, the City commissioned a study exploring installing emergency sirens, which included testing sirens and designing a possible layout of sirens.

In November, 2004, Bill Greulich, Emergency Services Manager at the time, recommended against installation of fixed sirens. He instead recommended exploring mobile sirens or weather radios. See Attachment B, "Alerting and warning system project update and recommendations for further action." However, in the 15 years since that discussion, neither of the suggested alternatives (mobile sirens and mass distribution of weather radios) has materialized.

Since that time, wildfires have become an increasing hazard in California due to the effects of climate change, including: increased frequency and severity of drought, tree mortality, bark beetle infestation, warmer spring and summer temperatures, and longer and more intense dry

seasons. California experienced the deadliest and most destructive wildfires in its history in 2017 and 2018.<sup>1</sup> Fires are bigger, faster, and more intense; firefighters in the 2018 Camp Fire reported that they had never seen a fire move so quickly.<sup>2</sup> The length of wildfire season has expanded to be nearly year-round.<sup>3</sup> With the continuing effects of climate change, scientists suggest that fires will continue to be a worsening threat.<sup>4</sup>

Also, in the years since the 2004 decision, smartphone technology has emerged, and while this has been an important addition to alerting options, it has not fully met the alerting needs or expectations of the public. A California Office of Emergency Services (Cal OES) Assessment Report on the Sonoma County wildfires of October 2017<sup>5</sup> concluded that public expectations for local government alert and warning services are higher than what is currently being offered. People expect to be adequately alerted, even if they have never taken any action to “opt-in” for warnings.

At this time, the City is reviewing and re-evaluating all of its emergency notification options following the 2017 and 2018 wildfires. Berkeley Fire Department has been considering the idea of installing sirens for at least a year, since January 2018.

#### ENVIRONMENTAL SUSTAINABILITY

Installing sirens will have an environmental impact due to the construction and maintenance required. They also create noise pollution that can be highly annoying for residents. Poles can be wood, concrete or steel. Sirens can be AC or battery-powered with solar-powered battery back-up as an option.

#### RATIONALE FOR RECOMMENDATION

The tragedies of the 2018 Camp Fire and the 2017 North Bay fires show the extreme danger that fast-moving wildfire events pose for both residents and responders. The objective of this Commission is to assist policy makers, responders, and residents in achieving the ultimate goal of a smooth-running, extremely fast, safe and effective evacuation with no loss of life.

Currently, Berkeley has several systems available to alert residents of an emergency. See Attachment A, “Alerting Systems Available for Berkeley Emergencies (February 2019)”.

Each of Berkeley’s currently-available alert systems will reach some but not all residents, and most of these systems are only available to people who have opted-in before an emergency, or who are actively seeking information about an emergency – not people who are simply going about their lives.

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<sup>1</sup> <http://www.fire.ca.gov/downloads/45-Day%20Report-FINAL.pdf>

<sup>2</sup> <https://www.nationalgeographic.com/environment/2018/11/how-california-fire-catastrophe-unfolded/>

<sup>3</sup> <https://www.nature.com/articles/ncomms8537>

<sup>4</sup> <https://www.theguardian.com/environment/2018/aug/07/california-wildfires-megafires-future-climate-change>

<sup>5</sup> <https://sonomacounty.ca.gov/Public-Safety/Emergency-Notification-for-Sonoma-Complex-Fires-2017/>

As an additional concern, failure rates can be high with any one system. In Sonoma County in the 2017 North Bay fires, only 51% of the 290,000 emergency alert calls reached a human or answering machine<sup>6</sup>. Camp Fire failure rates for alerts reportedly ranged from 25% to 94%.<sup>7</sup>

Due to various failures and limitations of emergency alerting, many survivors after the 2017 North Bay fires and the 2018 Camp Fire were left wondering why they did not receive any alert at all. These experiences and tragic outcomes strengthen the importance of redundancy through multiple alert methods.

A modern outdoor siren system, designed to blanket all of Berkeley in sound, would provide an additional layer of coverage where other systems may fail. Sirens can also provide redundancy if other communication channels are disabled due to power outage or cell tower disruption.

Here are several questions and answers about this siren recommendation:

**When will sirens be activated?** Currently, City staff determine what type of alerts to send out based on the level of danger, how localized the danger is, and how imminent the danger is. Sirens should be incorporated into a holistic plan for warnings and alerts so that they have the best chance of filling any gaps to alert people when there is a serious or life-threatening hazard, including wildfires, chemical spills, or other hazards.

Modern sirens allow for multiple tones, so they can be used for more than one message. In addition to wildfire and other hazard alerting, sirens could potentially be integrated with future earthquake early warning systems, which is already done in Mexico City, to provide a warning before earthquake shaking hits.<sup>8</sup>

This recommendation does not specify the exact criteria for determining when to activate a siren alert; the option of activating sirens should be incorporated into the City's alerting protocol based on the best professional judgement of City staff, and in accordance with appropriate state or federal guidelines.

Any alert or warning technology is only as good as the planning, training, and situational awareness that allows responders to use it well. We recommend that activation criteria and procedures be fully and clearly documented in writing, trained, and tested by City staff on a regular basis:

- Criteria for activating alerts
- Who is authorized to decide to activate an alert
- Content of alerts (message template), as applicable
- Technical operation of the alerting system

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<sup>6</sup> <https://abc7news.com/sonoma-county-tests-emergency-phone-calls-in-wake-of-north-bay-fires/4208459/>

<sup>7</sup> <https://www.mercurynews.com/2018/12/16/camp-fire-created-a-black-hole-of-communication/>

<sup>8</sup> <https://eos.org/features/lessons-from-mexicos-earthquake-early-warning-system>

**Will people hear them indoors?** Outdoor public warning systems are generally considered to be for alerting people who are outdoors, not indoors. However, “practical experience and the results of tests by the Federal Emergency Management Agency (FEMA) and others have shown that siren sounds are quite effective for alerting large populations—including those indoors”<sup>9</sup>

According to a 2006 FEMA technical bulletin, despite the limitations in sound getting inside buildings, “an outdoor [public alert system] can reasonably be expected to alert *some* people inside buildings” and “a properly designed outdoor [public alert system] may also awaken sleeping members of the public in residential areas.”<sup>10</sup> This bulletin reports that the likelihood of a person being awakened from sleep by an outdoor siren ranges from 17% - 52%, depending on the person’s age and the loudness of the sirens.

Consistent with this research, past events also show that sirens are often heard indoors. For example, in the deadly 2011 Joplin, MO tornado, sirens “could generally be heard indoors” although unfortunately many residents did not take action based on the sirens<sup>11</sup>. Recent siren malfunctions in 2017 and 2018 (in Dallas and Memphis) resulted in a large number of complaints about people being awakened or kept awake by the sirens.<sup>12</sup> And many West Berkeley residents can attest to being awakened from sleep by Bayer plant sirens.

Clearly, the City can’t rely on sirens to alert everyone who is indoors, especially if people are asleep. Sirens may only reach half or a quarter of this population; because of this, sirens should be just one layer in multiple alerting methods that are used. The most effective emergency alerting combines multiple methods, both outdoor and indoor.<sup>13</sup>

We recommend that the selection of tones and frequencies be made to maximize the chance of the siren being audible indoors, as described here: “lower frequency components should be included for better coverage, including components between 225 Hz and 355 Hz for transmission through windows (Mahn 2013).”<sup>14</sup>

**Will they be confusing?** An ongoing public information campaign is an important part of any outdoor public warning system, so that people know what action to take when they hear a siren. Additionally, siren testing should be designed to help the public be aware of sirens and their meaning. Testing should take place at the same time of day and week (e.g. at noon on Tuesdays) to avoid any confusion, and silent testing should be used when possible.

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<sup>9</sup> <https://asa.scitation.org/doi/10.1121/1.2024832>

<sup>10</sup> [https://www.midstatecomm.com/PDF/FEMA\\_guide.pdf](https://www.midstatecomm.com/PDF/FEMA_guide.pdf)

<sup>11</sup> <https://www.nist.gov/sites/default/files/documents/2017/05/09/NCSTACmtgDec2013KuligowskiJoplin.pdf>

<sup>12</sup> <http://www.wmcactionnews5.com/2018/11/01/tornado-sirens-falsely-sound-nd-straight-morning/>,

<https://www.nytimes.com/2017/04/08/us/dallas-emergency-sirens-hacking.html>

<sup>13</sup> [https://www.researchgate.net/profile/John\\_Sorensen7/publication/327226171\\_Rogers\\_and\\_Sorensen\\_1988\\_Diffusion\\_of\\_Emerg\\_Warn/links/5b816d40299bf1d5a7270825/Rogers-and-Sorensen-1988-Diffusion-of-Emerg-Warn.pdf](https://www.researchgate.net/profile/John_Sorensen7/publication/327226171_Rogers_and_Sorensen_1988_Diffusion_of_Emerg_Warn/links/5b816d40299bf1d5a7270825/Rogers-and-Sorensen-1988-Diffusion-of-Emerg-Warn.pdf)

<sup>14</sup> <https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1950.pdf>

Here are examples of siren testing programs in locations near Berkeley:

- San Francisco, which has had a siren system in place for many years, tests their system every Tuesday at noon using a single tone for 15 seconds. In an actual emergency, the sound will cycle repeatedly for 5 minutes.<sup>15</sup>
- Oakland and UC Berkeley test on the first Wednesday of every month at the same time, using a slow wail for 90 seconds. This is explained to the public as not only testing the system, but “enhancing public awareness” so that if something different from the usual day, time, or tone is heard, the public should turn on radios, computers, phones or TV for more information. Three different tones are used in case of an actual emergency: A 3-minute slight wail means shelter in place, a slow wail means a tsunami, and a fast wail means a fire.<sup>16</sup>
- Richmond, which is on the Contra Costa County system, tests on the first Wednesday of every month at 11:00 am for less than 3 minutes, and every Wednesday at 11:00 am using a barely audible sound (known as a “growl test”)<sup>17</sup>. There are also two systems in place controlled by the Chevron Refinery.

The typical action that people should take when they hear an emergency siren is to seek more information through other channels, which may include the radio or internet, in order to learn what they need to do next. It’s very important that people get a consistent message from all of these channels, so planning for that output should be included in the holistic alerting plan.

Here are two examples of this process not working well:

- In the 2011 Joplin, MO tornado, sirens prompted people to look for more information, but they got conflicting information from different sources, which led to public confusion and is considered a major contributor to why people didn’t take action and get to safety.<sup>18</sup>
- Another example of poorly-managed public information for outdoor public warnings is the Bayer plant in West Berkeley. Bayer alarms occasionally go off and are concerning to neighbors, but there is minimal information available online, and Bayer doesn’t answer a support line after hours.

City of Berkeley would need to do a better job and provide extensive support and education, not only when the system is installed but also on an ongoing basis afterwards, and every time the sirens are activated.

**Are they accessible and ADA compliant?** A negative feature of sirens is that, like other audible alerts, they are not accessible to people who are deaf or hard of hearing.

Berkeley’s emergency alerting must use a combination of notification methods that can reach all residents. The public outreach campaign should include a very extensive program to reach all

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<sup>15</sup> <https://sfdem.org/tuesday-noon-siren>

<sup>16</sup> <http://www2.oaklandnet.com/oakca1/groups/fire/documents/webcontent/oak063278.pdf>

<sup>17</sup> <https://www.ci.richmond.ca.us/331/Community-Warning-System>

<sup>18</sup> <https://www.nist.gov/sites/default/files/documents/2017/05/09/NCSTACmtgDec2013KuligowskiJoplin.pdf>

disabled residents and encourage them to opt-in for alerting that meets their communication needs. This may include distributing weather radios or other in-home devices with strobe light or vibration options as an alternative to siren alerting for people who are deaf or hard of hearing.

We believe that despite this limitation, sirens could help deaf and hard of hearing residents. In emergencies, many people learn about the danger from a neighbor, not directly from official alerts. This is described in the 2018 Camp Fire:

*“Some learned about the looming wildfire from neighbors knocking on their doors. Or frantic cellphone calls from friends. Others just looked out their windows and saw the smoke and flames, or heard the chaos of neighbors hustling up children and pets and scrambling to get out.*

*Matthew White was sound asleep when the fire began raging around his home in Paradise, Calif., the morning of Nov. 8. But somehow he heard his cellphone ring.*

*It was a friend of his shouting on the other end of the line: “Get the hell up and get the hell out! Paradise is on fire!” “<sup>19</sup>*

The way this helps is analogous to the concept of “herd immunity” or “community immunity” that helps explain how vaccines make communities safer: blanketing the area with a siren will allow a larger percentage of people to get informed and to inform neighbors, and this will improve the level of protection for all, including vulnerable neighbors who may not hear the sirens.

**Will they work in a power outage?** Outdoor warning sirens can have backup batteries, which can be recharged using solar panels to ensure that they will work during a power outage. They can be controlled by a radio signal from a safe location.<sup>20</sup> Sirens may burn down in a fire, but they will at least be able to provide warning until the fire reaches their location.

**What other communities in California have sirens?** Many communities near Berkeley have sirens, including the City of Oakland and UC Berkeley as well as Contra Costa County, as noted above. Oakland’s sirens were installed as a result of the 1991 Tunnel fire. Lake County installed sirens following the deadly Valley Fire in 2015. Sonoma County is considering installing sirens following the deadly North Bay fires of 2017. Mill Valley is exploring the use of mobile sirens. Berkeley now has the opportunity to install sirens before, rather than after, a disaster occurs.

**Will people take them seriously?** The decision-making process for people to decide to take action in an emergency is complicated and varies from person to person. *Studies show that people look for confirmation from more than one source before they take action.*<sup>21</sup> Sirens can reinforce other messages about imminent danger.

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<sup>19</sup> <https://www.nytimes.com/2018/11/21/us/paradise-fires-emergency-alerts.html>

<sup>20</sup> [https://www.dhs.gov/sites/default/files/publications/Outdoor-Sirens-MSR\\_0315-508.pdf](https://www.dhs.gov/sites/default/files/publications/Outdoor-Sirens-MSR_0315-508.pdf)

<sup>21</sup> <https://www.osti.gov/servlets/purl/6137387>

Although conventional wisdom may worry about a “cry wolf” or “warning fatigue” effect from too many warnings, research about these effects is mixed.<sup>22</sup> Ensuring the credibility of the sirens and avoiding a “cry wolf” effect should be considered when choosing a siren system and testing plan.

**Can’t the city go door-to-door instead?** If there is a fire moving at the scale and speed of recent California wildfires, responders will not have enough time to alert a large portion of the population by going door-to-door. The City will be balancing its resources between fighting the fire, clearing the roads, and knocking on doors. According to Berkeley’s draft Evacuation Plan:

*“Community members should not expect door-to-door notifications or assistance from emergency responders during evacuation.”*

**What is the best siren system?** This recommendation does not specify a specific siren brand or system. A 2015 FEMA survey of available siren systems<sup>23</sup> shows that there are many features that can be varied in different systems, including:

- Price
- Number and location of sirens
- Static or mobile sirens
- Materials (concrete, wood, or metal poles)
- Type of sounds (wailing, beeping, voice)
- Power backup
- Methods of activation (in-person, radio, wired, wireless)
- Testing options (low-volume and silent testing)

We recommend that Berkeley select a system that provides the most cost-effective solution to meet the goals described in this recommendation: providing reliable coverage for the maximum number of Berkeley households possible, while offering enough flexibility of controls so that sirens can be effectively integrated into a complete alerting protocol.

#### ALTERNATIVE ACTIONS CONSIDERED

Several interrelated recommendations were made to City Council in 2017 and 2018 addressing fire safety and community disaster preparedness. These recommendations included many possible actions covering a broad range of preparedness and hazard mitigation activities. Progress is already being made on some of these priorities.

Sirens should be part of a suite of emergency alerting options; other options could also be enhanced in addition to this one:

- Berkeley could forgo installing sirens, and focus on improving existing protocols to get the maximum effectiveness from the existing suite of alerting tools, particularly Wireless

<sup>22</sup> <https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1950.pdf>

<sup>23</sup> [https://www.dhs.gov/sites/default/files/publications/Outdoor-Sirens-MSR\\_0315-508.pdf](https://www.dhs.gov/sites/default/files/publications/Outdoor-Sirens-MSR_0315-508.pdf)



Emergency Alerts (WEA, also used for Amber Alerts). A new set of guidelines for WEA and Emergency Alert System (EAS) alerting is expected from Cal OES in July 2019, and Berkeley will be required to comply with those guidelines within six months. We look forward to Berkeley's continued improvement of these protocols.

- Mass distribution of NOAA weather radios has been discussed as an alternative to sirens. However, the cost to distribute weather radios to every household in Berkeley would reach \$1+ million, and each radio would need to be programmed to receive appropriate alerts. It would also be challenging to ensure proper maintenance and testing of the radios over time. However, a limited distribution to residents who are deaf and hard of hearing should be considered as an accessible supplement to sirens.
- Relying on police and fire vehicle apparatus (bullhorns or sirens) is another option. However, these have a limited audible range<sup>24</sup> and would not be able to alert large portions of the city at once. There may also be physical obstacles that could limit the ability of vehicles to reach all the areas that need alerting. It should not be forgotten that such systems may have a substantial role to play in an early warning system specifically designed to evacuate seniors and people with disabilities.

#### CITY MANAGER

The City Manager refers to the budget process.

#### CONTACT PERSON

Keith May, Assistant Fire Chief, Berkeley Fire Department, 510-981-5508

#### Attachments:

- 1: Attachment A: Alerting Systems Available for Berkeley
- 2: Attachment B: Memorandum: Alerting and Warning System Project Update, November 2004

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<sup>24</sup> <https://www.fireapparatusmagazine.com/articles/print/volume-22/issue-4/features/siren-limitation-training.html>