

Memorandum

To: Tom Day

CC: None

Date: 12/15/2010

Re: Warning Systems

I have completed the research you requested on possible warning system options for the residents in and around Eagle Spring Lake. My findings are below:

General Information

Your initial request was for information regarding an outdoor warning siren system for the lake. I have taken the liberty of expanding my research to include other possible warning systems and combinations to give you the best possible feedback.

There are basically two types of outdoor warning systems in use today. These are electro-mechanical and electronic systems. Both have advantages and disadvantages in our application.

Electro-mechanical Sirens and Systems

Electro-mechanical systems are essentially large motor powered units that can normally produce up to three siren tones. These are the classic "Air Raid" sirens that have been used for decades. Modern models are DC powered off of battery systems that are charged with standard 120 volt AC current. This allows the siren to operate for a period of time in the event of a power failure and uses a hardwired electric system that is relatively cheap and easy to install.

Electro mechanical systems radiate sound using either directional or omni-directional sound paths. Rotating siren systems are the least expensive and they use a smaller motor to produce a very concentrated sound beam that is rotated around approximately every 15 to 20 seconds. Omni-directional systems produce sound in a full 360 degree pattern at all times, but require larger and more expensive sound generating equipment.

For a person up close to the siren mounting, there is little difference in sound reception and the direct and reflected sound patterns produce good to excellent warning results. However, the further away a listener is from the siren mounting point the distinction between the two systems becomes obvious.

For the rotating sirens, the listener will hear what sounds like an approaching and passing train whistle. The sound will be loudest every 15 to 20 seconds as the listener enters the direct path of the siren and then the sound will taper off to virtual silence. Basically what this means is that the listener will hear the siren for approximately every 15 to 20 seconds of every minute.

For an omni-directional system the sound output remains virtually constant so that the listener will receive a sound pattern for the full signal duration, normally between 3 and 5 minutes.

Electro-mechanical systems produce three basic signals. The first is mandated by federal regulation is the Attack Warning signal. This is a Civil Defense signal that is an up and down wavering tone. For rotating siren systems, this signal may be confused with the Alert signal as the siren rotates around and a form of up and down tonal pattern that is created as a result of the directional basis of the siren signal.

The Alert signal is the signal commonly used for severe weather warnings. This is a steady tone for 3 to 5 minutes.

A third tone is an interrupted steady tone (AKA Beeping tone) that is commonly used for fire sirens.

Electro mechanical systems are noted for their durability. Life spans of 30 or more years for a annually serviced system is not unusual. Normal annual service includes circuit checks, battery terminal cleaning and contact adjustments. Approximately every four years the units will require battery replacement (normally 4 deep cycle marine batteries) and every 10 years lubrication of the top mount equipment and painting is suggested.

Electronic Sirens and Systems

Electronic systems are essentially large speaker systems that can also provide some public address capabilities. These systems are battery operated and use either 120 volt charging systems or solar arrays to keep the batteries up to performance power.

Electronic units are manufactured in three basic configurations. These are rotating, omni-directional and directional systems. The rotating and omni-directional electronic systems function in the same manner as their electro-mechanical counterparts. Directional electronic arrays focus the sound into a 90 or 180 degree sound pattern which in some instances is more cost effective and has some

advantages when it comes to public address messaging (discussed later on in this report).

Electronic systems produce all the tones of electro-mechanical systems and more. Up to 8 tonal patterns can be included in an electronic system. However, with the exception of military use, few if any these tones are every used in public warning systems.

Electronic systems also have the advantage of being used as public address systems. The public address function is most useful at close to medium ranges as the further out the voice sound travels, the more distorted it will become.

Voice operation on rotating electronic systems is somewhat problematic. Unless the siren has a stop motor function on the device rotator, messages of any length fade in and out as the sound pattern rotates around. If the siren has a stop function on the rotator, ideally the message must be repeated up to 6 times to assure legible distribution.

Omni-directional electronic systems attempt to distribute sound messages in a 360 degree pattern. Variability in sound reflection with a tonal pattern is generally not a concern, but in voice communications it is a distinct problem. As sound is reflected back and bounced around, a 360 degree system is more subject to distortion and the voice instructions are likely to become unintelligible at any real distance from the unit.

Directional systems are designed like stadium speaker systems and produce good quality voice sound patterns or longer but narrower paths. Directional systems may be multi-plexed to operate as independent directional systems to keep sound quality up, but this requires repetition of the message as you would have in a rotating system with a stop rotor function.

Electronic systems do not have the longevity of electro-mechanical units. Their electronic circuits are more subject to damage from lightning strikes and like all electronics they degrade over a period of time. Good electronic units have a lifespan of around 15 years with yearly maintenance. Yearly maintenance consists of cleaning battery connections, checking voltages and speaker resistance, and cleaning solar panels, if present. Every four years the batteries should be replaced and depending on the unit this will involve replacement of deep cycle marine batteries or hybrid nickel metal hydride cells at a cost of between \$400.00 to \$650.00.

System Limitations

A properly designed outdoor warning system will produce an alerting tone of 70 dBc over the coverage area. This will produce a signal that is distinguishable over most

ambient noise to be distinguished by a listener *outdoors*. Outdoor warning systems are just that, warning systems designed to alert people out of doors of a situation. While people near the siren installation site may be able hear the siren indoors, signal reliability is not assured. Furthermore, people who may be sleeping in a house with ambient noise present, such as air conditioners, are not likely to receive enough of a signal to rouse them from a normal sleep pattern. Furthermore, being able to distinguish voice messages indoors becomes even more problematic. *It is not cost effective or generally feasible to design a siren system to reliably warn people inside structures of impending danger.*

Suggestion(s)

In reviewing the options available to the Eagle Spring Lake Management District, if an outdoor warning system is desired, it is my suggestion that the district select a directional electronic system.

In reviewing the basic engineering data, the best location for the installation of such a system is at the DNR Boat Launch on a 50 foot heavy grade utility pole. To eliminate the need for extensive service underground wiring and the necessity to pay for monthly electric meter charges, I would further suggest that the system be installed with a solar array which is very practical due to its southern facing.

A directional array would provide good outdoor tonal warning coverage for the entire lake and abutting shore land. Likewise the expense of providing warning coverage to areas not under the Lake Management District's concern, most specifically north and east of the proposed mounting site is eliminated. With such a system, the Lake District would be paying for alerting primarily lake residents. Of course, should the Township wish to contribute funds to the project, additional speaker arrays could be mounted on the pole for expanded coverage and some cost sharing arrangement be developed.

A directional system would also allow for voice messaging to the lake residents or occupants of the lake itself. The coverage of the directional system would be good to excellent for all areas with the exception of Mary's Bay which would have fair coverage. A messaging system could be dispatched from the base of the unit itself, from some dispatch point, and even from the water patrol boat.

Severe weather alerting could be triggered either through the use of National Weather Service Radio or from the Waukesha County 911 dispatch center.

The estimated budgetary cost of installing a directional system at the DNR Boat Launch as described above would be approximately \$23,000.00. Yearly maintenance of the system is estimated to cost about \$125.00 with charges every four years to replace the batteries estimated at approximately \$525.00. Because of large variability in costs and other factors, I have not been able to ascertain the insurance costs for the unit.

Options

There are other options available to the Lake Management District to keep its residents informed in the event of an emergency. The National Weather Service and local authorities have greatly improved the Weather Radio System in the last few years. SAME (Specific Area Message Encoding) features are now included on the majority of over the counter weather alert radios. This means that the radio may be programmed to activate only for those messages that affect the local region. This greatly reduces the frustration found with early systems that alerted for any message in a six county area that may or may not impact any single given listener.

A basic mid-range weather alert radio comes with a number of options including battery back ups and the capability of being expanded to include alerting options for hearing impaired. Hearing impaired alerting options include everything from flashing lights to vibrating units that can be placed under the pillow of user to wake them from a sleep.

In addition to providing an alert of some occurrence, the voice capability of the weather alert radio can give specific protection suggestions and can be used for other types of emergencies, such as potential terrorist attacks or child abduction emergencies.

There are significant cost savings if weather alert radios are purchased in quantity. For example, if the district were to purchase 100 units of a common mid-range programmable receiver with advance options, the cost per unit would drop from \$50.00 to around \$35.00.

This would mean that the Lake District could provide 100 residents with weather alert radios that would provide reliable *indoors* warning, day or night, for as little as \$3,500.00. And I have located several volunteer groups that would be potentially willing to program and distribute the radios free of charge.

The key drawback to this option is that it will not provide warning to residents outside of their house or people on the lake.

Obviously there is a third option which is to combine an outdoor warning system with a weather alert radio system for maximum ideal coverage.

Funding Options

Unfortunately, it does not appear that there is any significant funding available either from the federal or state government to offset any of these options. At best, the Lake District could apply for Hazard Mitigation Funding with the Wisconsin Division of Emergency Management, but at last check the waiting list for funding was over 10 years.

Final Comments

I am available to discuss my findings in greater detail and to provide further service to you if the Lake Management decides to proceed with any parts of this project.