City	**Metropolis, US**	**Incident #**	**10-54321**		
Zone	**MetropolisCityNorth**	**Docket/File #**	**N/A**		
Ref. Date	**01 JAN 2023**	**Case Name**	**N/A**		
Cust. Ref#	**N/A**	**Report Date**	**01 JAN 2023**	**Author**	**P.Greene**

DETAILED FORENSIC REPORT

Shooting Description

At 02:08:03 (2:08:03 AM) hours on January 01, 2023, ShotSpotter® detected a Multiple Gunshot incident in Metropolis, US. ShotSpotter recorded the event as Incident# 54321 and located it at 1234 Main St.

Position with Respect to the Coverage Area
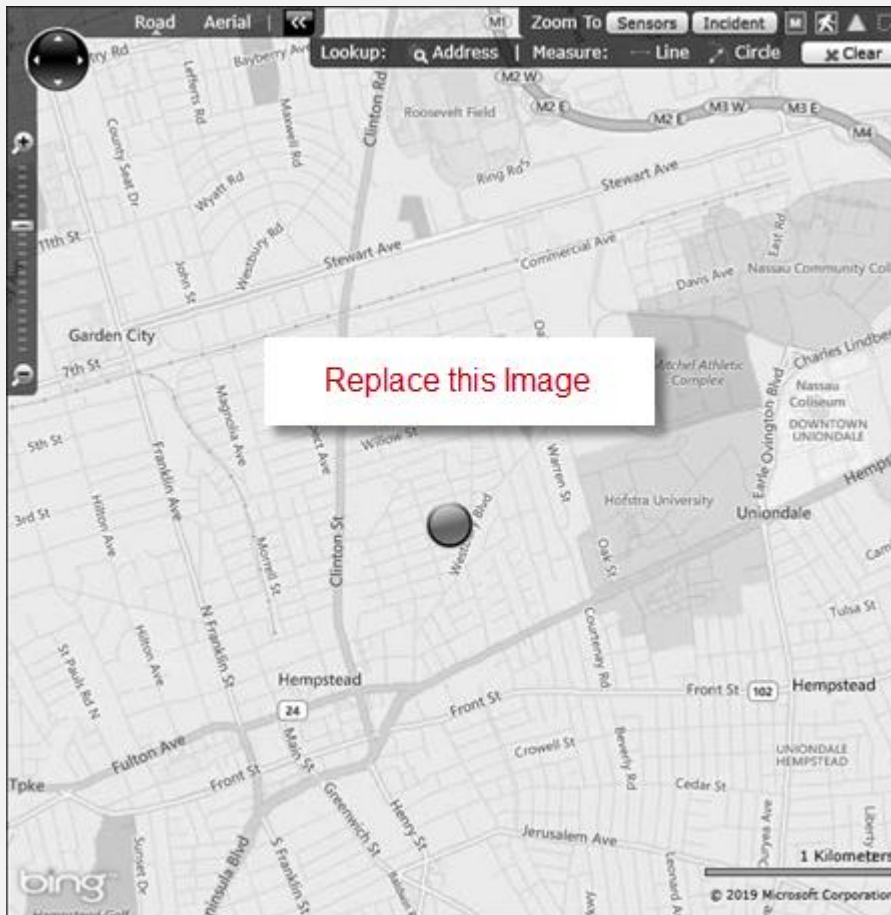
FIGURE 1.0

ShotSpotter City: displays Metropolis, US at the time of the incident. The map pin indicates the location of the shooting incident.

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About ShotSpotter

ShotSpotter was installed in Metropolis, US (MetropolisCityNorth) in 2014. This zone measures 5.78 Square Miles with ShotSpotter coverage provided by 101 sensors.

ShotSpotter has three primary components: acoustic sensors, a Location Server application, and a ShotSpotter user interface. Acoustic sensors are deployed in geographic areas that are designated by the customer. The ShotSpotter Location Server is operated by SoundThinking™, Inc. and runs on a virtual server hosted at a remote facility, the ShotSpotter user interface is run from a browser on the user's PC or from a mobile app.

The firing of a gun or detonation of an explosive device creates a loud, impulsive sound that can, under optimum environmental conditions, be detected above urban background noise up to two miles away from the firing location. Because ShotSpotter operates outdoors to detect the sounds of gunfire, its operation is understandably subject to the laws of physics and acoustic propagation.

Each acoustic sensor is triggered by impulsive sounds in its environment. The acoustic measurements of these impulsive sounds and the exact time that they were detected are transmitted to the Location Server as possible gunshots. The Location Server analyzes the data received and determines if the impulsive sound can be geographically located and classified as characteristic of gunfire. If the impulsive sound can be located and classified as possible gunfire, Location Server reports the incident to the ShotSpotter Incident Review Center where a human operator reviews the incident to classify it as gunfire or dismiss it as not gunfire. If the reviewer determines it is a gunfire incident, it is then published to the customer's user interface. The user interface provides an actionable view of the incident with an emphasis on the time and location that the shooting occurred. Gunfire incidents are typically detected, located, classified, reviewed, and published to the customer in under 60 seconds.

SoundThinking guarantees that ShotSpotter will detect and accurately geo-locate (provide latitude and longitude) 90% of detectable outdoor incidents within the coverage area, accurate to within a 25-meter (82ft) radius of the actual shooting location. SoundThinking does not guarantee 100% detection because real world, urban environments may contain intervening structures, topography, foliage, periods of increased ambient noise, and other urban acoustic noises that may either prevent the sound of a gunshot from being detected by the sensors(s) or may change or modify the audio characteristics of the sound of a gunshot so that it no longer matches the sensor(s) detection parameters.

Other factors, such as obstructed or attenuated muzzle blast, weapon discharge into or from an enclosed space, or if the weapon discharged is of .25 or smaller caliber, can all affect whether ShotSpotter can detect and accurately geo-locate a given shooting incident, and may also prevent the sensor(s) from detecting all the shots fired during an incident.

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Analysis

TABLE 1.0

Reported Incident Detail: *At 02:08:03 on January 01, 2022, ShotSpotter detected and located a Multiple Gunshot incident in Metropolis, US. Below is a table containing additional details about the incident.*

Agency:	East Palo Alto PD
Source:	MetropolisWest
Incident Id:	9751-h0TPy2ic8
Rounds:	1
Address:	opolisWest
Latitude:	Replace this Image
Longitude:	122. 924
District:	
Beat:	Beat 4
CAD ID:	
Date/Time:	10/15/2021 @ 13:30:01

City	Metropolis, US	Incident #	10-54321		
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FIGURE 2.0

Address Location: *This image displays the shooting location as calculated by ShotSpotter's automated process. The map pin indicates the location of the shooting incident as calculated by ShotSpotter in real-time and reported to the ShotSpotter operator. The street address of 1234 Main St was obtained by converting the calculated Latitude/Longitude of the incident detailed in* **Table 1.0,** *with either a database of parcel information provided by the city or county or by the satellite map provider.*

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TABLE 2.0

Timeline of Discharge of Shots and Calculated Shot Locations: *Below table shows the time of discharge, and the calculated Latitude and Longitude for each of the shots which comprise this shooting event. The times listed below are the time the system calculated the trigger was pulled based on the environmental conditions at the time of the event. These times precede the time at which the system notified the ShotSpotter Operator listed because of small radio, computational, and network delays. All times are obtained from network, system, and sensor clocks that are synchronized to GPS time, which is in turn synchronized with the atomic clock at the National Institute of Standards and Technology in Boulder, CO.*

FID/MDID	Shot	Discharge Date	Discharge Time	Interval (HH:mm:ss.fff)	Latitude	Longitude

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FIGURE 3.0

Individual Shots Fired: *This image depicts the location of each shot onto a satellite image. The latitude and longitude of each shot is calculated by post- processing an incident's audio clips and archived data. Post-processing is a "manual" re- evaluation of incident data through software tools that duplicate the real-time location algorithms that are a resident part of the ShotSpotter Location Server. Post-processing can be selectively performed on subsets of the raw data so that noises from different sources can be isolated for analysis.*

*In this image, the red dots indicate the calculated latitude and longitude locations of each of the shots as detailed in **Table 2.0**.*
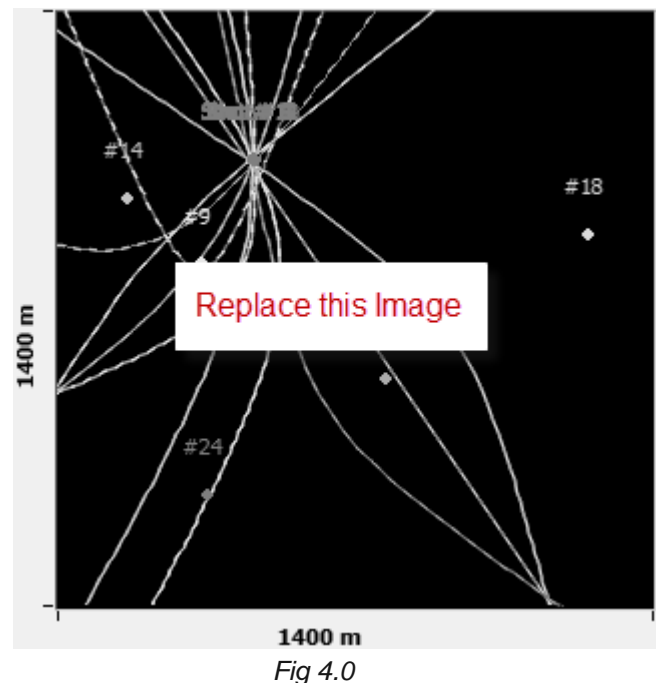
City	Metropolis, US	Incident #	10-54321		
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Multilateration

FIGURE 4.0

Multilateration Plot: *The source of an acoustic pulse (a sound that goes bang, boom, or pop) is located using a mathematical process called multilateration. Multilateration requires a minimum of three sensors that surround the source to accurately report the time that a pulse is detected. Each participating sensor will detect the same pulse at slightly different times. The Location Server calculates the time differences of detected pulses between unique pairs of sensors against the speed of sound (343 meters per second, or 768 mph) to generate a curve called a hyperbola. All the resulting hyperbolae are then plotted onto a map. The spot where the hyperbolae intersect is where ShotSpotter locates the shot. When more than three sensors participate in the detection, Location Server performs automatic calculations to find a solution that minimizes the error to the greatest extent possible. The image below is a pictorial representation of the hyperbolae calculated during the analysis of this shooting event. The map space depicts the shooting location at the intersection of the hyperbolae and the positions of the sensors used in the analysis relative to the shooting location.*

5 ShotSpotter sensors participated in automatically detecting and locating Incident# 54321. Post-process location analysis was performed using audio clips from 4 sensors.
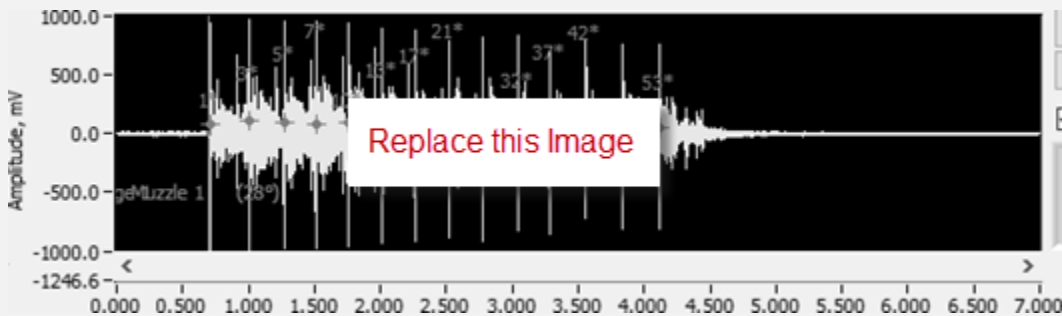

Fig 4.0

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Site-specific Acoustics

The audio waveforms depicted below, visually represent the incident audio that was recorded by, and downloaded from different sensors. Each sensor number also indicates the calculated distance from that sensor to the incident location.
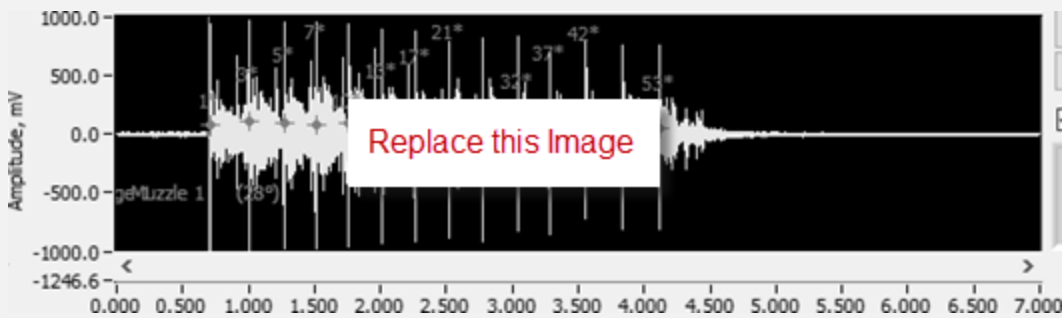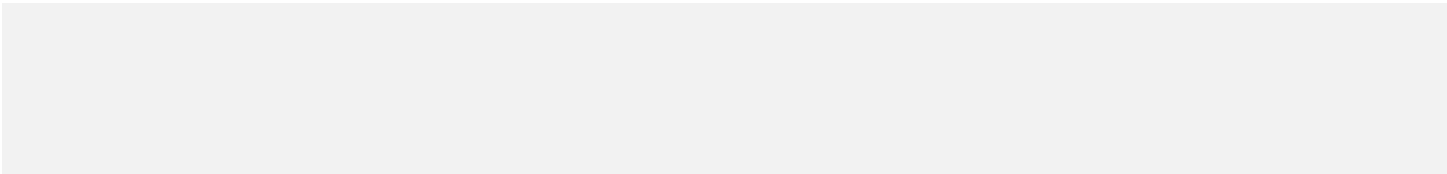

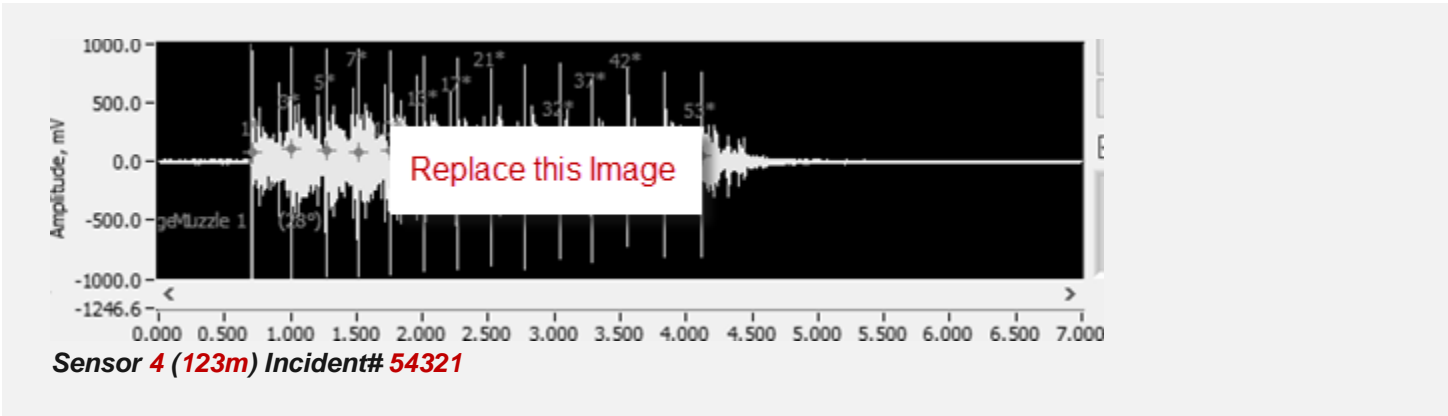*Sensor 1 (123m) Incident# 54321*

Sensor 2 (123m) Incident# 54321

Sensor 3 (123m) Incident# 54321

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Sensor 4 (123m) Incident# 54321

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Conclusion

At 02:08:03 (2:08:03 AM) hours on January 01, 2022, ShotSpotter detected a Multiple Gunshot incident in Metropolis, US. ShotSpotter recorded the event as Incident# 54321 and located it at 1234 Main St.

After review, the discharge times, and locations of 14 rounds fired were calculated and found to be within the 25m accuracy circle as described in the **About ShotSpotter** section. These results are listed in **Table 2.0** and depicted in **Figure 3.0** of this report.

Acoustical data analysis of a gunfire incident is complex and not comprehensive. The conclusions above should be corroborated with other evidentiary sources such as recovered shell casings, and witness statements.

Certification

I, Paul C Greene, declare that I am Forensic Services Manager at SoundThinking Inc., this report was prepared by me or is a true copy thereof. I have personal knowledge of the matter referred to in this report, and, if called as a witness, could and would testify thereto.

I declare that the above is true and correct.

Executed this date of_____

at _____, _____

Signature_____

Paul C Greene

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+1 (650) 887-2106 fax
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All-Purpose Certificate of Acknowledgement

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document

State of _____ / County of _____

On this date of_____,

before me_____,

Notary Public personally appeared Paul C Greene who provided to me on the basis of satisfactory evidence to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

I certify UNDER PENALTY OF PERJURY, under the laws of the State of _____ that the foregoing paragraph is true and correct. Witness my hand and official seal.

Signature_____

Notary Public

(Seal)