Town of Ludlow
Engineering Needs Assessment Report
February 23, 2018

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1 Executive Summary

The Town of Ludlow Massachusetts and the Radio Communications Advisory Committee engaged ACD Telecom to perform an evaluation of the current communications systems and sites where the equipment is located. This inspection was to consist of evaluating the physical condition of sites and state of the current infrastructure equipment. The purpose of this evaluation was to determine the feasibility of the existing sites and communications equipment to support future enhancements, expansion, and modernization.

The Town of Ludlow's sites and equipment were found to be deficient and substandard, especially for public safety communications system in many ways. In their current condition, the sites are unable to support future technology enhancements or new systems.

As planning for system(s) upgrades or replacement proceeds, it will be essential to plan and budget appropriately to provide for facilities and supporting physical infrastructure that meets the needs of a Public Safety Critical Infrastructure communications system.

Any communications system is comprised of many smaller individual parts. Each of these parts plays its own key role in delivering the reliable communications that Public Safety first responders need on a daily basis. The overall system is only as reliable and robust as the weakest link. Every step should be taken to remove weaknesses in the system(s) through careful planning.

2 Scope of inspections

The scope of this inspection was to investigate the existing radio sites condition and inspect their current configuration, layout, and suitability as critical infrastructure against public safety radio standards (ANSI, TIA and EIA).

Main Areas of Site Inspection

- Above surface evaluation of grounding techniques and components
  - Equipment grounding
  - Shelter/Cabinet grounding
  - Coax grounding and lightning protection in building
  - Auxiliary support systems grounding
  - Compound grounding (fence, gates, generators, ice bridge)
  - Tower grounding
- Generator and UPS power systems existence and general condition
- Shelter/Cabinet cleanliness, space, weather and insect/rodent protection, security and climate control
- Tower structural condition, FAA/FCC compliance, security, coax and antenna condition along with installation practices
- Antenna system condition and performance

Limits of this Inspection

- Sub-terrain grounding system and techniques were not evaluated
- Structural inspection of tower was not performed by a structural engineer. The inspection was limited to obvious problems such as rust or similar conditions
- Tower inspection was conducted from the ground through visual observation and pictures

3 General findings

Sites were evaluated based on contemporary industry standards. Below is a breakdown of what was found.

3.1 Shelter Climate Control

- There were mixed findings ranging from well controlled to no HVAC present at all. There was no consistent equipment or methods between the sites.
- At several locations, shelter and cabinet temperatures were witnessed to be excessive.
- At the Minechoag Fire Tower site, the Fire Department and WMLEC radio equipment are located in the rear generator room of the shelter. This portion of the shelter was never intended to support communications equipment. There is no HVAC system present in this area of the shelter. This is directly opposite of an industry accepted practice and requirement for a public safety system. In addition to the lack of any HVAC to remove the BTUs created by the communications equipment, the generator creates a significant heat source when in operation. A sustained commercial power failure at this location will likely lead to equipment overheating and a complete shutdown of the fire repeater.
- The Senior Housing facility site has the Ludlow Police Department (LPD) radio equipment located in a janitorial closest with inadequate ventilation and HVAC. At the time of inspection, the repeater exhibited signs of excess heat and fan noise.
- The pole mounted receive only sites at Hill Terrace and Alden Street have sealed cabinets with no way to properly exchange the heat created by the equipment or remove the heat introduced by the ambient weather conditions and sun exposure.
- The Hampden County Jail site has only a small portable cooling unit located in the equipment room. At the time of inspection, the room was in excess of 85°F. The Sheriff's Department representative that met with us on site, advised that room temperatures in excess of 100°F are not out of the ordinary and that alarms and equipment outages from high temperature occur regularly.
- Equipment temperatures at the main LPD headquarters is generally well regulated by the building's main HVAC system.

3.2 Equipment Installation and Mounting

- Equipment installation practices range from good to very poor.
- Most equipment is rack or cabinet mounted and secured adequately within the cabinets.
- Equipment cabinets at LPD headquarters are sitting loose on shelves in the sally port area. This increases the chances of equipment being damaged if a cabinet is moved or bumped. I believe the cabinets being unsecured are a result of the limited space available to access and service the equipment. To reach certain components for inspection, service, or repair, requires the cabinets to be rotated or slid from their location. Racks and cabinets should be rigid mounted with adequate clearance on all sides to perform proper repair and maintenance on the equipment.
- Equipment at LPD headquarters, specifically the sally port, are exposed to excess environmental factors such as dust and humidity. Large garage doors and vehicles entering during inclement weather brings excessive moisture exposure to the equipment.
- Antenna lines are not tagged or identified in any manner. The proper identification of an individual antenna requires tracing the line from start to finish.
- Spare and out of service equipment is intermixed with live equipment at the sally port location in LPD headquarters.
- Labeling on equipment was found to be outdated and inaccurate at several locations. Frequency and function labels were not installed or updated on equipment as it was cycled from spares to live service.

3.3 Generators and Transfer Switches

- The Police headquarters and Minechoag Fire tower sites have reliable backup power. The remainder of the sites have little or no emergency power.
- Fuel tank capacities are adequate at LPD and Minechoag sites.

3.4 Grounding

- Grounding practices are extremely poor and leaves the critical infrastructure equipment exposed to lightening and surge risks. Again, this is contrary to any kind of industry accepted communications system for a public safety communications system
- Remedial action should be taken immediately to properly protect the current radio equipment at all sites.
- Police Headquarters:

    - There is no grounding present on the voter rack in the basement closet area.
    - There is no grounding present on any equipment or transmission lines in the sally port area.
    - There is no tower ground buss bar on the exterior of the building or base of the tower. Antenna line grounding on the tower is clamped to a diagonal support.
- Minechoag Fire Tower:
    - Only one point of earth ground was located on the entire site. On one tower leg, there is a single line to earth ground. Due to the footer of the tower leg, you cannot see where this lead enters the surface. Resistance from this single point ground is likely to greatly exceed recommended performance thresholds.
    - The generator fuel tank is not bonded or grounded.
    - There is no tower ground buss. There is evidence of possible copper theft. Antenna line grounds are hanging free at the base of the tower.
    - The shelter buss at the entry point does not have a conductor to earth ground. It is instead tied back to the grounding conductors inside the shelter. This system is essentially only providing bonding and no grounding.
- Senior Housing:
    - No grounding of any kind is present on lines, antennas, or the equipment cabinet.
    - The tripod antenna mount on the roof has a ground conductor clamped to it and tied back into the lightening rod on the smoke stack. This can provide a path to ground if the antenna mount was struck. However, it can also introduce surge when the lightening rod at a much higher elevation is struck.
- Hampden County Jail:
    - Rack mounted equipment is grounded to room buss. The buss has a conductor exiting the floor of the room to an unknown ground source.
    - Room grounding is present but not to the current standards.
    - ACD Telecom did not inspect grounding of the lines and antennas on the roof of the facility.
- Alden Street:
    - There is a ground rod driven at the base of the utility pole. Internal equipment and lines are connected to the ground rod. This system is simple but adequate for a receive-only site with pole mounted cabinet.

- Hill Terrace:
    - There is a ground rod driven at the base of the utility pole. Internal equipment and lines are connected to the ground rod. This system is simple but adequate for a receive-only site with pole mounted cabinet.

3.5 Security

- Police Headquarters:
    - Site security is excellent because of the facilities' primary role.
    - The cages in the sally port should be locked so that only trained communications technicians have access to the equipment.
    - Barb wire should be installed on the tower compound fencing to prevent unauthorized access.
- Minechoag Fire Tower:
    - Site Security is good. Access driveway is gated and locked, compound with barb wire is gated and locked.
- Hill Terrace:
    - Due to the nature and location of the site, no perimeter security is present.
    - The cabinet has a cut lock on the rear door.
- Alden Street:
    - Due to the nature and location of the site, no perimeter security is present.
    - The cabinet door is locked, and the cabinet is elevated high enough that a ladder is needed to gain access.
- Senior Housing:
    - The building is a limited access, semi-secure facility.
    - The interior room where the equipment is located is a janitorial closet. Non-public safety staff from the facility have regular access and activities in this room.
- The Hampden County Jail site is very secure.

3.6 Site Conditions

- LPD headquarters has the equipment located in areas of the building with mixed usage. This introduces exposure to additional environmental concerns such as dust and humidity. General staff have access to communications equipment.
- Minechoag Fire Tower site conditions are poor. Evidence of rodents were found throughout the facility. A large tree is left inside the fenced compound with limbs hanging directly over the shelter.
- Senior Housing:

    - This site's conditions are terrible. The janitorial closet where the radio cabinet is located is hot, humid, unsecure, ungrounded, and has potential liquids exposure to equipment. There is a sink located within 3 feet of the radio cabinet. The storage shelves present in the room with liquids and chemicals creates a very real risk of liquid spill and splash to the cabinet.
- The Hampden County Jail site is extremely hot inside the equipment room with only a small portable HVAC unit to attempt to cool the room.
- The pole mounted receive sites at Alden Street and Hill Terrace have no ability to support additional new equipment or be reconfigured for future usage.

3.7 Towers

- Police headquarters is a very light duty Pirod U-Series tower with sleeve clamped leg joints. The light duty nature of this structure and revisions to the TIA-222 tower standard make it unlikely that this structure will adequately support any additional antennas. A current structural analysis is recommended to ensure the tower is still within safe structural load limits.
- To the best of our knowledge, there has never been a structural analysis performed on the Minechoag Fire Tower. A structure of this type and age was not originally intended to support the wind and ice load of communications antennas. Additional research showed that in 1967 the original 7'x7' observation cab was upgraded to a 10'x10' observation cab. This increase added substantial load to the tower. ACD Telecom's best estimate is that the structure will fail a full structural analysis under the TIA-222 standard. The tower is painted, and the paint condition appears to be in generally good shape.

3.8 UPS Systems

- Rack mounted UPS units are present at Police headquarters.
- Hill Terrace has a battery backup present. While on site, this unit was tested and is currently operational.
- There is a battery backup present at the Minechoag Fire Tower site but it was not tested.
- UPS power is not present at other locations.

4 Discrepancy Report

4.1 Major Concerns

There were several items found that would qualify as major concerns.

1. Grounding at many of the sites is missing, incomplete, or inadequate. Proper equipment grounding is essential to protecting public safety critical infrastructure equipment of this nature. Grounding practices and installations need to be overhauled to protect the current equipment, and before any new equipment can be installed at any of the current Ludlow communication sites.
2. Proper HVAC climate control to regulate equipment temperature and humidity must be introduced to all areas that house public safety critical infrastructure equipment. In addition, redundancy in these systems should be added. Typical public safety sites incorporate redundant HVAC systems operating on a lead/lag controller.
3. Environmental exposure of equipment needs to be assessed and mitigated.
    a. Open wire mesh lockers for access denial in the sally port does not protect the equipment from water and dust exposure.
    b. Multi-use rooms such as the janitorial closet at the Senior Center exposes the equipment to a very high degree of risk.
    c. Outdoor pole mounted cabinets cannot properly offset or remove heat from external ambient conditions.
4. Backup power of any type is missing from several site locations. Only two locations have backup generators to support the equipment during a sustained commercial power failure.
    By its nature, a public safety critical infrastructure communications system, sees its highest usage and demand during times of crisis such as storms and power outages. Every effort should be taken to ensure a minimum of 48 hours of onsite backup emergency power is available.

4.2 Other Concerns

The primary focus of these site visits was to establish the readiness of Ludlow's current sites and infrastructure to support the installation of new radio system equipment that will enhance performance and interoperability throughout the Town of Ludlow. It was identified that there is inadequate shelter space to support any additional equipment at this time. Future work to identify and purchase modern communications system(s) will

need to include scope of work and associated costs for physical infrastructure to support the system(s).

A significant investment in supporting infrastructure will be required to allow any new communications equipment to be installed and function as a reliable means of communication by first responders.

Antenna line tagging is missing. Antenna lines should be tagged for easy identification by technicians. Tag materials need to be weather resistant and permanent in nature. Proper tagging and/or color coding should be done on each transmission line at several places; such as the equipment termination, shelter exit port (inside and outside), tower base, and antenna base. Large color-coded bands are recommended for use at the antenna base to be visible from the ground with binoculars.

5 Existing Radio System Overview

5.1 Inventory

As part of ACD Telecom's site inspection process, a physical inventory is performed. The make, model and serial number of equipment is typically recorded. During the Town of Ludlow visits, the large majority of equipment serial number information was not accessible. As a result, a physical rack by rack inventory was completed on equipment associated with the Ludlow radio system(s) but a large portion of the information was unable to be obtained. Every effort was made to document all equipment in as much detail as possible. Some equipment was not labeled, or labels were not visible due to the rack configuration. Service was not disrupted, and no equipment was disturbed in attempting to gather this information.

The information gathered during this inventory audit is contained in section 6, Site Data sheets.

5.2 Subsystems

5.2.1 Police UHF Conventional

The Ludlow Police Department (LPD) operates on several independent conventional analog UHF channels. These channels were at one time a multichannel trunked system. Performance issues with the trunked system resulted in the change back to single conventional repeaters.

The main dispatch channel is repeated from the Minechoag Fire Tower location with a second standby backup repeater located at LPD headquarters. Switching between these two repeaters requires manual intervention. In addition to the main and backup transmitter sites, there are 4 receive only sites to improve talk back performance on the main dispatch channel. A voter located in the lower level of the LPD headquarters votes the received audio from the multiple receive sites.

Located at the police headquarters are three standalone repeaters used for SRT, Major Incident, and Detail channels. Coverage of these channels is limited and does not encompass the entire Town of Ludlow political boundary. These repeaters are also connected to the consoles through tone remote.

In addition to the Ludlow channels, the Police Department uses the WMLEC-1 UHF channel to interoperate with surrounding jurisdictions when the need arises. The WMLEC channels also allow the Police and Fire to interoperate when needed.

5.2.2 Fire VHF Conventional

The Ludlow Fire Department operates on a series of conventional analog VHF high band channels. The main dispatch channel is repeated from the Minechoag Fire Tower location. Several simplex VHF channels supplement their operations. To overcome the limited coverage foot print of the Fire Tower repeater, the fire Department has installed cross band vehicular repeaters. These repeaters utilize a UHF channel as the input back to the apparatus and then the mobile radio will repeat back on the primary VHF channel. This cross band vehicle repeater set up requires a separate UHF portable radio to be used when operating in areas that a regular VHF portable radio cannot reach back to the repeater at the Minechoag Fire Tower.

In addition to the Ludlow Fire Department VHF channels, the Fire Department uses the WMLEC-2 VHF channel to interoperate with surrounding jurisdictions when the need arises. The WMLEC channel also allows the Fire and Police to interoperate when needed.

5.2.3 Ludlow Public Works

The Public Works department operates a single VHF high band repeater located at the Minechoag Fire Tower location.

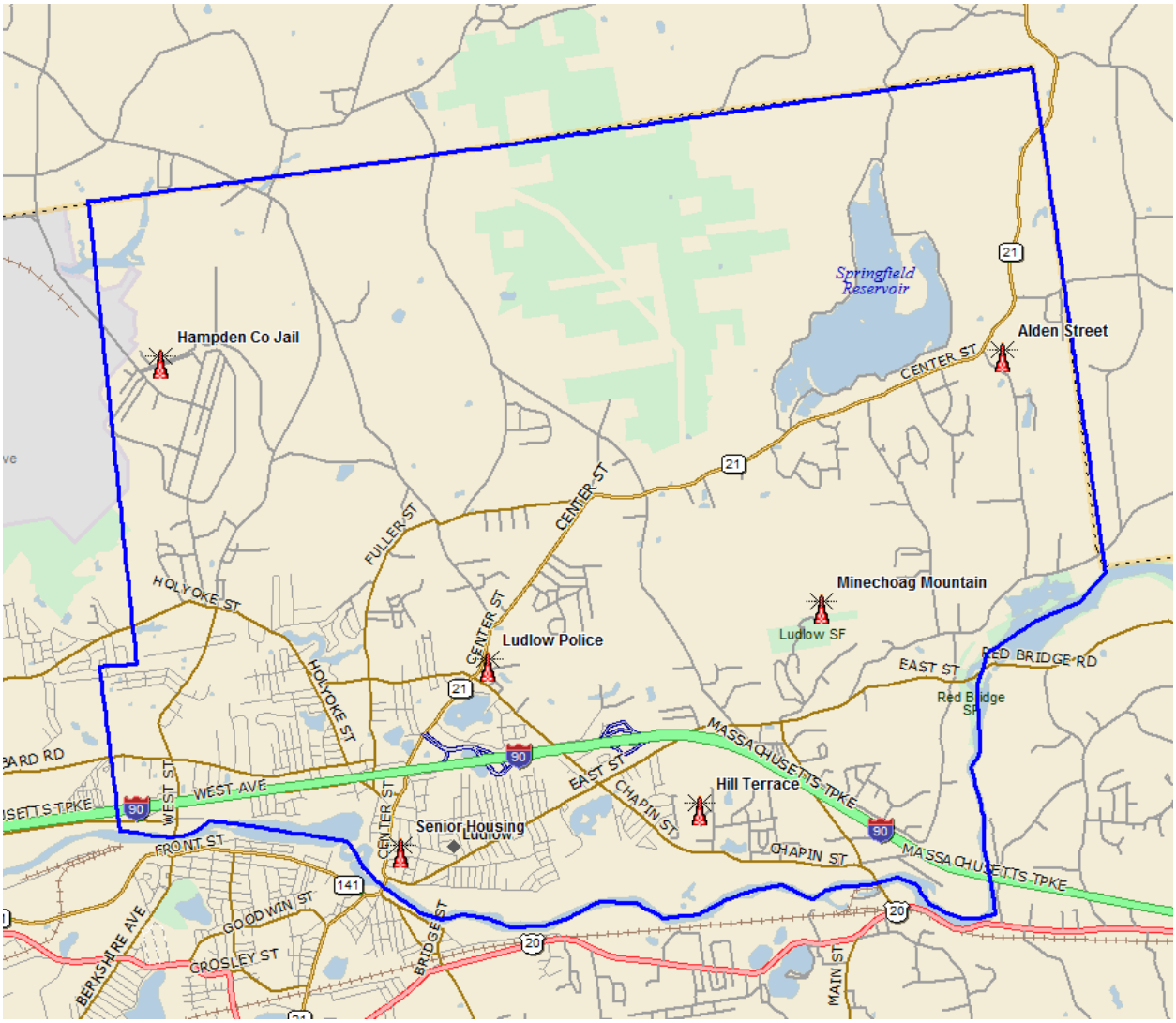
5.2.4 Ludlow Schools

The school district operates a single VHF high band channel with the repeater located at the LPD headquarters. Since the repeater is located along side of the LPD equipment, a tone remote control interface allows the police dispatchers to have access to this channel at the consoles.

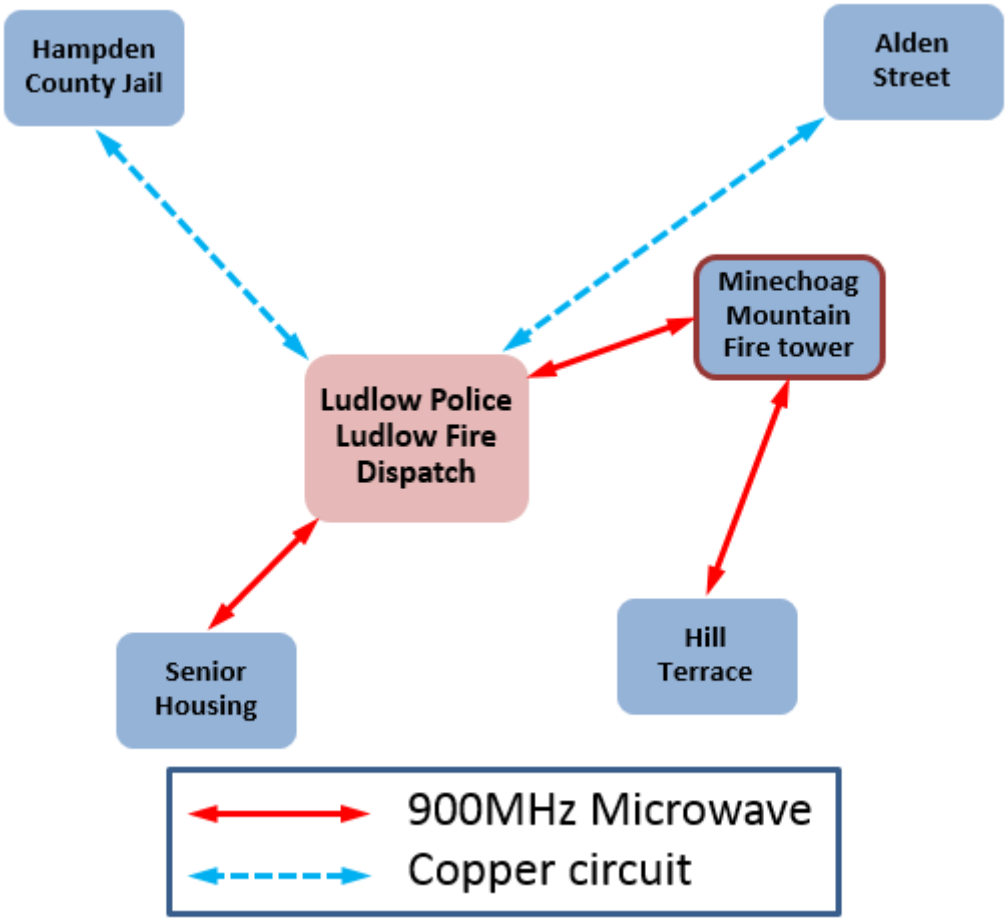
5.2.5 Backhaul Network

The connectivity between sites is established with MDS 900MHz licensed microwave radios. Microwave links connect between Ludlow Police headquarters, Minechoag Fire Tower, Senior Housing, and Hill Terrace. The two additional sites at the Hampden County Jail and Alden Street are connected by copper wireline circuits.

5.3 Ludlow Site Map



5.4 Ludlow Connectivity Plan



5.5 Ludlow Current Site List

Site Name	Latitude	Longitude	Tower Height	Site Elevation	ASR#
Ludlow Police Headquarters	42-10.31.2N	72-28-18.5W	100’	74.0m 243'	NA
Minechoag Mountain Fire Tower	42-10-50.5N	72-25-49.1W	65’	219.8m 721’	NA
Hampden County Jail (HCJ)	42-12-15.3N	72-30-34.3W	NA	76.2m 240’	NA
Ludlow Senior Center	42-09-29.4N	72-28-57.2W	NA	70.1m 230’	NA
Hill Terrace	42-09-43.4N	72-26-43.5W	NA	86.0m 282’	NA
Alden Street	42-12-13.6N	72-24-28.4W	NA	107.3m 352’	NA

5.6 Ludlow Operational Channels

FRN 0005193610 (Public Safety)		
Assignment	**Transmit Frequency**	**Receive Frequency**
Police Primary Dispatch	453.2500	458.2500
PD - SRT	453.7625	458.7625
PD - Major Incident	453.4625	458.4625
PD - Detail	453.3125	458.3125
Fire Primary Operation & Paging	154.2050	159.3150
Fire Ground Simplex	154.2500	
RIT Simplex	154.0475	
Public Works	151.1300	159.2625
Schools	463.7250	468.7250

6 Site Data Sheets

6.1 Minechoag Mountain Fire Tower

SITE IDENTIFICATION	
SITE NAME	Minechoag Mountain Tower
ADDRESS	Tower Rd, Ludlow MA 01056
TOWER OWNER	MA DCR
SITE CONTACT INFO	Officer Daniel Soares
FCC/FAA INFORMATION	
LAT/LONG	42-10-50.5N 72-25-49.1W
SITE AMLS HEIGHT	721’
TOWER HEIGHT	60’ Steel fire tower with 10’x10’ lookout cab on top
FCC ASR#	NA
SERVICES SUPPORTED	
EQUIPMENT	Ludlow PD, Ludlow FD, Ludlow PW
OTHER EQUIPMENT (TENANTS) in shelter	Wilberham Fire (UHF) & Wilberham Police (800MHz), WMLEC-2
GENERAL SITE CONDITIONS	
Ownership	Property owned by MWRA and structure owned by MA-DCR
Perimeter security	Compound fence with barb wire and locked gates
Shelter security	Standard door lock, no cameras
Climate control	Redundant HVAC in front room only
System Connectivity	900MHz microwave
Grounding in shelter	Some present but incomplete and substandard
Grounding out of shelter	Missing and/or inadequate
NARRATIVE DETAIL	
SECURITY: Overall security is good. Locked access gate on driveway and locked compound CLIMATE CONTROL: Front equipment room where PD equipment is located has dual redundant HVAC units. FD and WMLEC equipment is located in the rear generator room. GENERATOR: Generac 10KW Propane with 1000 gallon above ground tank CONNECTIVITY: 900MHz microwave to Police HQ and Hill Terrace. GROUNDING: Equipment is VERY unprotected. Only one path to earth ground identified on a single tower leg. Remaining ground wiring all feeds back into electrical utility grounds. Missing buss on tower base, line grounds cut and hanging. Poor quality and corroded mechanical connector on ground buss at entry port. There is no path to earth ground for the shelter grounds. The propane tank is ungrounded. MISC. ITEMS: Large tree inside compound area with limbs directly over the shelter. No ice bridge (overhead protection) on propane tank and exposed line.	

Minechoag Mountain, Rack #1 (Police UHF)

EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
Digital Multiplexer	MDS	MX-2100	
Digital MW radio	MDS	LEDR 900S	
Digital MW radio	MDS	LEDR 900S	
LPD Primary UHF repeater (PD Dispatch 453.250/458.250MHz)	Motorola	MTR2000	CAH05166JR
DC Power System	Samlex America	SEC-80BRM	
DC Batteries			

GENERAL NOTES:
(2) 12VDC car batteries loose in bottom of cabinet for DC power source.

Minechoag Mountain, Rack #2 (Fire VHF)

EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
DC Power supply	Duracomm		
Power amplifier	TPL Communications	RXR	
Fire repeater (159.315/154.205MHz)	Vertex Standard	VXR7000	
Public Works repeater (159.6250/151.1300MHz)	Vertex Standard	VXR7000	
(7) Cavity filters	TX/RX Systems		

GENERAL NOTES:
TX/RX filter/combiner rack with hardware store type metal angle bolted to original two post rack to mount power supply, PA, and wooden shelves added to hold desktop repeaters. Pieced together from what was available.

Minechoag Mountain, Rack #3 (WMLEC Repeater)

EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
Mobile radio	Motorola	CDM750	
Repeater interface	Motorola	HLN3333B	
Mobile radio	Motorola	CDM750	

GENERAL NOTES:
Two mobile radios on top of an empty Motorola short cabinet

6.2 Ludlow Police Headquarters

SITE IDENTIFICATION	
SITE NAME	Ludlow Police Department
ADDRESS	612 Chapin St., Ludlow MA 01056
TOWER OWNER	Town of Ludlow
SITE CONTACT INFO	Officer Daniel Soares
FCC/FAA INFORMATION	
LAT/LONG	42-10-31.2N 72-28-18.5W
SITE AMLS HEIGHT	243’
TOWER HEIGHT	100’
FCC ASR#	NA
SERVICES SUPPORTED	
EQUIPMENT	Consoles, Voter, MW radios, BU transmitter
OTHER EQUIPMENT (TENANTS) in shelter	School radio, Public Works, WMLEC-1
GENERAL SITE CONDITIONS	
Ownership	Town of Ludlow
Perimeter security	Building-Excellent, Tower-fenced & locked compound with no barb wire
Shelter security	NA – Internal building rooms
Climate control	Main building HVAC
System Connectivity	Microwave and copper line
Grounding in shelter	Non-existent
Grounding out of shelter	Limited
NARRATIVE DETAIL	
SECURITY: Excellent perimeter security. Unlocked cages in sally port CLIMATE CONTROL: All areas maintained in acceptable temperature. Humidity concern in sally port. Dust concerns in IT and voter areas CONNECTIVITY: 900MHz microwave to Minechaog Fire Tower and Senior Housing. Copper wire to Hampden County Jail site GROUNDING: Almost zero grounding on site. Equipment is unprotected MISC. ITEMS: Diesel generator supplies the entire building	

Dispatch Center

EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
(3) MCC 5500 consoles	Motorola		
Mobile radio to Wilberham Dispatch	Motorola	GTX	
Scanner	Uniden	BCT15X	

GENERAL NOTES:

Dispatch , Rack #2 (basement voter closet)

EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
MCC5500 Console Controller (CES3)	Motorola	L3358A	322CFE1276
MCC5500 Console Controller (CES2)	Motorola	L3358A	322CFE1275
MCC5500 Console Controller (CES3)	Motorola	L3358A	322CFE1274
Receive audio voter	Raytheon (JPS)	SNV-12	
Power strip/surge suppressor	Tripp-Lite		
LAN Switch	HP	2524	SG448NV2DB
Shelf with 3 I/O modules			
Shelf with 3 I/O modules			
Mobile radio with power supply	Hytera		
Rack UPS	Eaton	9130	

GENERAL NOTES:
Mobile radio is Ludlow PD dispatch channel tied into PA system for in-building audio feed
Aux IO modules control the dispatch consoles

Dispatch, Rack #3 (Sally port repeater rack)

EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
Trunking controller (Out of Service)			
SRT repeater (453.7625/458.7625MHz)	Motorola	MTR2000	CAE030DDXG
Trunking controller (Out of Service)			
Major Incident repeater (453.4625/458.4325MHz)	Motorola	MTR2000	CAE030DDX8
Trunking controller (Out of Service)			
Detail repeater (453.3125/458.3125MHz)	Motorola	MTR2000	CAH040FTTR

GENERAL NOTES:
Detail repeater is missing function and frequency labels

Dispatch, Rack #4 (Sally port cavity filters)			
EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
(5) UHF cavity filter/combiner	Bird – TX RX Systems	74-70-06257-E-R1 21-70-25-2C-T	80812-B
GENERAL NOTES:			

Dispatch, Rack #5 (Sally port microwave)			
EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
Digital Multiplexer	MDS	MX-2100	
Digital MW radio (to Firetower)	MDS	LEDR 900S	
Digital MW radio (to Senior Center)	MDS	LEDR 900S	
GENERAL NOTES:			

Dispatch, Rack #6 (misc equipment on shelf)			
EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
Motorola mini desktop repeater RX 153.9125MHz, TX 156.1125MHz	Motorola	GR300	
Ludlow High School Mobile radio with power supply and CPI tone remote	Motorola	CDM1550-LS	
Ludlow Public Works Motorola mini desktop repeater RX 468.725MHz, TX 463.725MHz	Motorola	GR300	
Fire repeater (159.315/154.205MHz)	Vertex Standard	VXR7000	
GENERAL NOTES:			

Dispatch, Rack #7 (Sally port BU PD repeater)			
EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
Major Incident Mobile radio with power supply	Motorola	CDM1550-LS	
SRT Mobile radio with power supply	Motorola	CDM1550-LS	
WMLEC-1 Mobile radio with power supply and tone remote	Motorola	CDM1550-LS	
Ludlow Public Works Mobile radio with power supply and tone remote	Kenwood		
LPD Backup UHF repeater (PD Dispatch 453.250/458.250MHz)	Motorola	MTR2000	CAH05166J2
Rack UPS	Eaton	9130	

GENERAL NOTES:

Antennas for mobile radios are mag mounted to the top of the cages

6.3 Hampden County Prison

SITE IDENTIFICATION	
SITE NAME	Hampden County Corrections
ADDRESS	627 Randall Rd., Ludlow MA 01056
TOWER OWNER	Hampden County Sheriffs
SITE CONTACT INFO	Officer Daniel Soares
FCC/FAA INFORMATION	
LAT/LONG	42-12-15.3N 72-30-34.3W
SITE AMLS HEIGHT	240’
TOWER HEIGHT	NA, Roof top installation
FCC ASR#	NA
SERVICES SUPPORTED	
EQUIPMENT	PD CS radio, FD CS radio, PD RX unit
OTHER EQUIPMENT (TENANTS) in shelter	Sheriff’s office equipment
GENERAL SITE CONDITIONS	
Occupancy	Hampden County Prison
Ownership	Hampden County
Perimeter security	Locked down
Shelter security	Interior locked room
Climate control	Only a small portable Tripp-Lite unit
System Connectivity	Copper wireline to LPD
Grounding in shelter	Adequate
Grounding out of shelter	Unable to observe
NARRATIVE DETAIL	
SECURITY: Facility is obviously very secure CLIMATE CONTROL: Room has inadequate HVAC and exceeds operating temperatures CONNECTIVITY: Copper wire back to main PD HQ GROUNDING: Buss and halo present in room tied to conductor that exits through the floor MISC. ITEMS:	

Hampden County Corrections, Prison, Rack #1			
EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
Ludlow FD DeskTrac Control Station radio	Motorola	L54SUM70D0B	
Ludlow PD DeskTrac Control Station radio	Motorola	L54SUM70D0B	154SSF0410
LPD Satellite receiver	Motorola	GTR2000	
GENERAL NOTES:			

6.4 Ludlow Senior Center

SITE IDENTIFICATION	
SITE NAME	Ludlow Senior Center
ADDRESS	37 Chestnut St., Ludlow MA 01056
TOWER OWNER	Ludlow Senior Center
SITE CONTACT INFO	Officer Daniel Soares
FCC/FAA INFORMATION	
LAT/LONG	42-09-29.4N 72-28-57.2W
SITE AMLS HEIGHT	230’
TOWER HEIGHT	Building roof top installation
FCC ASR#	NA
SERVICES SUPPORTED	
EQUIPMENT	Police dispatch Receive site
OTHER EQUIPMENT (TENANTS) in shelter	Janitor closet inside Senior living center
GENERAL SITE CONDITIONS	
Ownership	Ludlow Senior Housing
Perimeter security	Building is semi-secure, limited access
Shelter security	Closet has locked door
Climate control	None
System Connectivity	Microwave to LPD
Grounding in shelter	None
Grounding out of shelter	None
NARRATIVE DETAIL	
SECURITY: Access to building is restricted. Access to closet is restricted to maintenance and custodial staff CLIMATE CONTROL: None present. Room was hot and humid upon inspection CONNECTIVITY: 900MHz Microwave to Main PD HQ GROUNDING: There is no grounding on the cabinet. The antenna mount structure is tied back to the building smoke stack lightening rod MISC. ITEMS: There is a huge risk of water and chemical damage in this custodial closet. Dipole antennas are facing directly at the roof of the building, likely blocking signal	

Senior Center, Rack #1			
EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
LPD Satelite receiver	Motorola	GTR2000	
Digital MW radio (to LPD)	MDS	LEDR 900S	
Digital Multiplexer	MDS	MX-2100	
DC Power System	Samlex America	SEC-80BRM	
GENERAL NOTES: Transmission lines have polyphasers in room but are not connected to any ground source			

6.5 Hill Terrace

SITE IDENTIFICATION	
SITE NAME	Hill Terrace
ADDRESS	125 Hill Terrace, Ludlow MA 01056
TOWER OWNER	Pole is owned by the Town
SITE CONTACT INFO	Officer Daniel Soares
FCC/FAA INFORMATION	
LAT/LONG	42-09-43.4N 72-26-43.5W
SITE AMLS HEIGHT	282’
TOWER HEIGHT	Utility pole
FCC ASR#	NA
SERVICES SUPPORTED	
EQUIPMENT	PD receive, 900 microwave
OTHER EQUIPMENT (TENANTS) in shelter	None
GENERAL SITE CONDITIONS	
Occupancy	Pole mounted cabinet
Ownership	Town of Ludlow
Perimeter security	None
Shelter security	No shelter, cabinet mounted to pole
Climate control	None
System Connectivity	900MHz Microwave to Minechoag Mountain Site
Grounding in shelter	Equipment in cabinet and polyphasers tied to grounding rod driven at base of pole
Grounding out of shelter	
NARRATIVE DETAIL	
SECURITY: locks on both cabinet doors. Rear door lock is cut and only there for appearances CLIMATE CONTROL: None CONNECTIVITY: 900MHz microwave back to Minechoag Fire Tower GROUNDING: As expected for a pole mounted RX site MISC. ITEMS:	

Hill Terrace, Cabinet #1			
EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL #	SERIAL #
AC power distribution & surge suppressor	Tripp-Lite		
Digital MW radio (to LPD)	MDS	LEDR 900S	
Digital Multiplexer	MDS	MX-2100	
LPD Satelite receiver	Motorola	GTR2000	CAE0206X09
DC Power System	Samlex America	SEC-80BRM	
DC Batteries			
GENERAL NOTES: Receiver is mislabeled as “FIRE MAIN 453.2375MHz”. (2) 12VDC car batteries loose in bottom of cabinet for DC power source.			

6.6 Alden Street

SITE IDENTIFICATION	
SITE NAME	Alden Street
ADDRESS	718 Alden St., Ludlow MA 01056
TOWER OWNER	Pole is owned by the town
SITE CONTACT INFO	Officer Daniel Soares
LAT/LONG	42-12-13.6N 72-24-28.4W
SITE AMLS HEIGHT	352’
TOWER HEIGHT	NA
FCC ASR#	NA
SERVICES SUPPORTED	
EQUIPMENT	PD receive site
OTHER EQUIPMENT (TENANTS) in shelter	None
GENERAL SITE CONDITIONS	
Occupancy	Pole mounted cabinet
Ownership	Town of Ludlow
Perimeter security	None
Shelter security	No shelter, cabinet mounted to pole
Climate control	None
System Connectivity	Copper line back to LPD
Grounding in shelter	Grounding rod driven at base of pole
Grounding out of shelter	
NARRATIVE DETAIL	
SECURITY: Cabinet door is padlocked. Cabinet is mounted high enough that a ladder is needed for access CLIMATE CONTROL: None CONNECTIVITY: Copper wire back to main PD HQ GROUNDING: As expected for a pole mounted RX site MISC. ITEMS:	

It must be noted that ACD did not have a ladder during the site inspections. As a result, we were not able to inspect the inside of this cabinet and document the inventory.

7 Stakeholder Interviews

As part of our analysis, ACD Telecom performed a series of interviews with key stakeholders from several Town of Ludlow agencies. The survey questions are targeted to gather an understanding of how the current system is perceived to be addressing the responders' needs. In addition, the survey questions gather information on specific areas that the stakeholders feel are not meeting their current operational needs.

7.1 Current radio system performance

The evaluation of the survey responses for the Town of Ludlow's current system(s) is broken into four key areas.

1. System Coverage: Provides the basic connectivity for units to communicate between each other and dispatch.
2. Interoperability: Provides the ability for units to communicate with other agencies, resources and disciplines, both within and outside the Town of Ludlow.
3. Features: The features beyond basic push to talk communication that enhance the responder's safety and ability to perform their required duties.
4. Reliability: How often and for how long does the system experience failures or outages in operation preventing or limiting any of the first three items.

These four categories provide a good overall picture of how the system is meeting the needs of the agencies and its responders.

7.1.1 Coverage

The performance of a Land Mobile Radio (LMR) system is often judged solely by its coverage throughout the required service area. This is a direct result of the fact that coverage is the most important factor in any communications system. Without adequate signal coverage (propagation), the functions and features of any system simply do not work.

In the case of the Town of Ludlow, the majority of stakeholders surveyed identified deficiencies in coverage performance as a significant shortcoming of the current system. The coverage concerns identified during the interviews largely focus on poor or no coverage in the outlying areas of the jurisdiction.

Specific areas mentioned as being deficient in coverage during the interviews include:

- Southwest region
- In and around the Hampden County Corrections Center
- Westover Golf Course

The stakeholders report that the central portion of town has generally good radio coverage resulting in reliable communications on both mobile and portable radios when operating outdoors.

Based on the stakeholder Interviews, the following conclusions were reached regarding coverage of the current system.

- Mobile radio coverage is talk-back limited in certain areas
- Portable radio coverage is limited
- Portable street level coverage is inconsistent
- In-building, residential coverage is spotty
- In-building, commercial coverage is poor

All the systems that were evaluated operate from a single transmitter site. This single site configuration limits the signal propagation. A new simulcast radio system with multiple transmitter sites will greatly increase the ability to properly provide reliable coverage to the entire operational area of the Town of Ludlow.

7.1.2 Interoperability

Each agency has different and unique interoperability needs. These needs generally fall into three categories.

- Tier 1 – Day to day need for direct, immediate communications with other responders from different agencies within the Town of Ludlow. When multiple agencies (Police, Fire, Public Works and Schools) collaborate during an incident, how do they communicate effectively?
- Tier 2 – Day to day need for direct communication to units from outside neighboring agencies. When surrounding jurisdictions render or request mutual aid, how do units communicate effectively?
- Tier 3 – Occasional communication with other Public Safety and governmental agencies. During large scale (magnitude or geographic size) events how do local units participate, contribute, and communicate effectively?

All but one of the responder interviews reported that interoperability as a whole, does not meet the current needs.

Tier 1

During the interviews, Tier 1 interoperability was reported to be limited with the current system. A large part of this lack of interoperability is a direct result of agencies within the Town of Ludlow, each operating on their own independent systems. Enhancing the challenge of interoperability between these disparate systems, is the fact that not all the systems operate in the same frequency band.

Police and schools are operating in the UHF spectrum while Fire and Public Works are operating in the VHF High Band spectrum. Without expensive multi-band radios, this frequency disparity prevents seamless Tier 1 communication between the different agencies.

The end goal of the Town of Ludlow's current project, which is to build a single comprehensive radio system for all disciplines to operate on, will resolve many of the current shortcomings that were identified. Interoperability between Town of Ludlow agencies can be seamless under a single unified system. The need for direct interoperability between units without dispatcher intervention, was a key item that was found to reoccur in many of the responder interviews.

Tier 2
Tier 2 interoperability with neighboring jurisdictions and agencies outside of the Town of Ludlow were reported as not meeting the requirements. The sharing of radios between agencies and fixed control stations at the dispatch center provided limited Tier 2 interoperability. While these provisions provide some level of interoperability, there is still a deficiency that needs to be addressed. Units largely do not have direct communication and need to rely on dispatchers relaying information.

Tier 3
Tier 3 interoperability currently only exists with what can be provided through the WMLEC system. As the state expands the capabilities of the WMLEC system to APCO Project 25 (P25) and connects it to the State's core, this will position WMLEC as an optimal solution for seamless Tier 3 interoperability.

7.1.3 Features

While basic communications were reported as reliable in the areas that have adequate signal coverage, there are limited advanced features present in the current system and radios in use in the Town of Ludlow. Responders indicated that they have a need or desire for many of the technology advancements that a new digital radio system can offer.

Features identified as desirable or required during the stakeholder interviews included:

- Encryption
- Over The Air Rekey (OTAR)
- Over The Air Programming (OTAP)
- Covert Operation
- Portable GPS location

- Mobile radio GPS location, Automatic Vehicle Location (AVL)
- Man-Down activation
- Emergency Activation button
- Shared identifiers (alias)
- Multi-Band capability
- Private call operation (direct unit to unit)
- Status Messaging / Text capability
- Intrinsically safe operation

7.1.4 Reliability

System outages are another aspect of system performance used to evaluate an existing communications system. All reports indicate that the different systems in operation with the Town of Ludlow have a high degree of reliability with very infrequent outages being reported. The single repeater analog systems in operation have limited complexity and therefore greater overall reliability.

Backhaul connectivity to some of the additional receiver sites is provided by physical telco circuits. This method of backhaul limits the span of control and the Town of Ludlow's ability to proactively prevent or protect against outages.

8 Conclusions

8.1 Physical Equipment

The current physical infrastructure in place supporting the Town of Ludlow's system(s) is inadequate and needs immediate improvement or replacement.

Towers with adequate height, available structural capacity, and desirable geographic location to provide the required signal propagation to the entire service area are not part of the Town of Ludlow's current system. To properly address the crucial need for additional coverage, new towers will need to be identified or constructed.

Interior equipment space at the current sites is limited or substandard and will not allow for the installation of new equipment. Properly sized equipment shelters will need to be installed to house any new improvements.

In addition, supporting systems at the current facilities are absent or deficient. Grounding protection, emergency standby power, site security, and environmental protections (HVAC) are important aspects of a public safety critical infrastructure system. These aspects are either missing entirely or inadequate at many of the current radio sites.

An investment in a new LMR system and technology without addressing these underlying issues will leave any new system with many of the same shortcomings the current system(s) have.

8.2 System Operation

Currently, the day to day communications within the Town of Ludlow are limited by signal propagation of the single transmitter site design. Responders frequently travel to, and operate in areas that they cannot communicate with dispatchers or other responders. Improvements are required to ensure that responders can safely communicate throughout the entire area of operation. Future improvements will need to address the responders needs for both portable on-street and in-building communication needs.

Tier 1 interoperability between the separate agencies serving the Town of Ludlow is limited by the agencies different systems and the different frequency bands that they operate on. Changes or enhancements are required to improve responder safety and efficiency in mitigation emergencies.

8.3 Spectrum Availability

The advantage of VHF is that it propagates very well. This great propagation also leads to this band being very noisy resulting in VHF receiver de-sensitivity which is a disadvantage. The high noise floors and interference in the VHF band are also due to the historical lack of a proper frequency plan. As a result of these factors and others, no clear VHF channels could be found for any kind of interoperability and future growth. Therefore, the existing VHF radio system is not expandable and the new radio system will need to be in a different band than the existing system's VHF band. Per ACD Telecom's analysis, the desired and most available spectrum is in the 700MHz band. Therefore, it is recommended that the new system operate in the 700MHz band. If desired, we can also look at utilizing a combination of 700MHz and the available 800MHz NPSPAC channels since LMR equipment is built to operate in both bands.

8.4 Maintenance Requirements

To ensure longevity and reliability of the new system, it is important to establish a plan and schedule for preventative and extended maintenance. Ludlow must request warranty guarantees in the RFP and also request that the bidder specify how and when warranty work will be performed.

Along with establishing warranty and repair schedules with the manufacturer, Ludlow must request that the vendor outline preventative and extended maintenance schedules for the new equipment. One thing to consider in the development of the maintenance plans is the life cycle of the new equipment. The vendor should specifically outline the life cycle of the new equipment including how long the equipment will be supported and how long replacement parts will be manufactured for the equipment.

Requiring life cycle and equipment replacement plans will be important in assuring that Ludlow will not have to completely overhaul the system in the immediate future due to that equipment being manufacturer discontinued.

Ludlow must also establish requirements for turnaround time for maintenance technicians to attend to and work on problems. It is a MUST that service be available 24 hours per day 7 days per week. Response time to major failures should be addressed within no more than 2 hours of the failure. Minor issues should be addressed within 4 hours of the failure. Ludlow should also outline requirements for repairs for mobile and portable equipment. A time frame of 4 business days is reasonable for repairs to be completed.

Mandatory Maintenance Requirements

- 15 year shelf life
- Warranty
    - RFP will request 2 year parts and labor

- Post Warranty ▪

    - Ludlow has ability to choose service center
    - Ludlow provides spare parts

- Response times (warranty work)
    - 24 x 7 availability
    - Major (traffic affecting) failure repaired in 2 hours
    - Minor (traffic affecting) failure repaired in 4 hours
    - Minor (non-traffic affecting) failure repaired in 24 hours

- Remove and replace turnaround
    - Portable and mobile units in 4 business days

    - Vendor will replace field units (portables and mobiles) with spare units within the next business day of receipt of trouble complaint. Next business day is defined as Monday through Friday, 8:00 AM to 5:00 PM, excluding Holidays

    - Vendor will then return the repaired Ludlow-owned radio to Ludlow's spares inventory within four (4) business days. Should Vendor be unable to return the repaired radio to Ludlow spares inventory within four (4) business days, Vendor will provide Ludlow a Vendor-owned spare to be placed in the Ludlow's spares cache

    - Infrastructure spare parts 15 calendar days

9 Recommendations

Following is ACD Telecom's recommendation based on the findings of the site inspections and answers provided during the stakeholder interviews.

A new unified, town wide P25 simulcast system with adequate channel capacity to support all agencies and responders within the Town of Ludlow, will best meet the Town's current identified and future needs. The P25 technology is the federal government standard, which means for any new LMR system related grant money you wish to apply, the government will look to see if you have or planning to migrate to P25 system.

To build this new system and address the multiple aspects that have been identified as being deficient, we recommend that the Town of Ludlow proceed with developing a performance based RFP to procure a new P25 system including new supporting infrastructure. It is crucial that this RFP address the vendor's requirement to provide all aspects of a new Public Safety Critical infrastructure LMR system.

- New physical infrastructure
    - Towers
    - Shelters
    - Generators and UPS
- LMR system infrastructure
    - Repeaters
    - Antennas and lines
    - System core
- System backhaul connectivity
- Subscriber radios
- Interoperability

The result of this RFP will be to design and construct from the ground up an entirely new system. While this ground up approach may seem to be the most expensive option, the reality is that addressing the multitude of deficiencies and shortcomings of the current sites will cost more, and never ultimately deliver the performance and reliability that the first responders need. One additional benefit to a ground up approach is that the construction, migration and cutover to a new system will not interfere with operation and usage of the current system(s).

Based on the size and general topography of Ludlow's area of operation, ACD Telecom estimates that a three-site simulcast system can exceed 97% portable on-street coverage with 3.4 DAQ to the entire Town of Ludlow. A two-site system may be

possible but will depend on the availability of tower locations and the vendor's final design approach. ACD Telecom estimates up to a 6-channel P25 Phase II system to support the multiple agencies and the quantity of responders within the Town. Of course, the final number of channels allocated and licensed for Ludlow will be contingent up receiving the approval of the Regional Planning Committee (RPC) and FCC. This design will allow for a maximum of 10 simultaneous voice talk paths. If advanced data based features such as GPS location, OTAP, OTAR, or Status Messaging are deployed, these features consume a full Phase I channel and reduce the available voice talk paths in the system by two when in use. Below is an example of system loading based on a 6-channel P25 Phase II system with data options in use.

Future Ludlow P25 Channel Capacity Plan	
Channel 1	P25 Control channel
Channel 2	Data option 1 GPS Location
Channel 3	Data Option 2 Status messaging
Channel 4	Voice Talk Path 1
	Voice Talk Path 2
Channel 5	Voice Talk Path 3
	Voice Talk Path 4
Channel 6	Voice Talk Path 5
	Voice Talk Path 6

During the RFP proposal process, each vendor will complete Erlang traffic studies to validate channel capacity based on expected quantity of units, talk groups, and data based features in service.

10 Rough Order of Magnitude

Based on current and past projects, ACD Telecom's estimation for project costs is as follows.

10.1 Tower sites

Construction of a complete new tower facility can vary greatly based on the size and type of tower. Considering the size and topography of the Town of Ludlow, towers less than 150' should be adequate to provide the signal propagation required. Each new site built for the system will need to be comprised of the following:

- 100' to 150' tower
- Fenced security compound
- Underground grounding system
- Prefabricated 12' x 20' shelter
- Emergency standby generator & UPS

The estimated cost of construction for each new facility is $835,000.

10.2 P25 System

Radio Frequency (RF) and Core Site Equipment

Simulcast equipment for each six channel P25 RF simulcast site is approximately $380,000. For three new RF sites, the infrastructure equipment would be $1,140,000. The prime site equipment and redundant core equipment adds another estimated $750,000. Bringing the total estimate for the actual P25 system to $1,890,000.

Consoles

Consoles for the new P25 system will need to be installed at both the Police and Fire dispatch centers for a total of four new consoles. Consoles are estimated at $50,000 per seat for a total of $200,000.

Subscribers

P25 mobile and portable subscriber radios vary in price based on manufacturer and included features. Portable radios can range between $1,650 and $3,500. Mobile radios range between $2,500 and $4,500. Considering the interests identified in advanced P25 features during the stakeholder interviews, our estimate is as follows:

- Estimating 70 high tier public safety (PS) mobile radios at $4,500 per unit = $315,000.00
- Estimating 40 low tier non-public safety (NPS) mobile radios $2,500 = $100,000.00

- Estimating 140 high tier public safety (PS) portable radios at $3,500 = $490,000.00
- Estimating 130 low tier non-public safety (NPS) portable radios at $1,650.00 = $214,5000.00

Interoperability Components
Beyond the obvious interoperability that results from utilizing the P25 standards and having all internal Town of Ludlow units operating on the same system, there are additional physical provisions and components to allow system connectivity to outside surrounding systems. At the system level, this is accomplished by leveraging both ISSI gateways and control station radios connected to Interop gateways.

ISSI hardware, licensing and physical connections will vary between manufacturers based on their corporate model and pricing. An estimate of $200,000 should be included as a budgetary value for up to three ISSI connections to surrounding systems. Gateway interoperability connections are made by setting up a radio on the neighboring system and tying it back into the P25 core through a conventional channel interoperability gateway. Conventional channel interoperability gateways are approximately $35,000 each and handle multiple connections per chassis. Each control station radio to support an individual connection is estimated at $4,500.

One Gateway with five radios connected = $57,500.

10.3 Backhaul

Reliable mission critical grade backhaul is a key feature of a Public Safety LMR system. Private microwave in licensed bands ensures full control over the quality and reliability of the network between the sites. Advances in Ethernet microwave also provision the system to be ready for new features as the agencies need them. A three site Ethernet MPLS Microwave backhaul system is estimated at $450,000.

10.4 ROM Summary

Below is a table summarizing the pricing discussed in sections 10.1 through 10.3

Physical Tower location 1	
Tower structure	$400,000
Shelter & compound	$350,000
Generator & UPS	$85,000
Physical Tower location 2	
Tower structure	$400,000
Shelter & compound	$350,000
Generator & UPS	$85,000
Physical Tower location 3	
Tower structure	$400,000
Shelter & compound	$350,000
Generator & UPS	$85,000
System RF site equipment (3)	$1,140,000
System Core equipment	$750,000
Dispatch consoles (4)	$200,000
PS mobile radios (70)	$315,000
NPS mobile radios (40)	$100,000
PS portable radios (140)	$490,000
NPS portable radios (130)	$214,500
ISSI Interoperability connections (3)	$200,000
Gateway Interoperability connections (5)	$57,500
Microwave Backhaul	$450,000
Total Estimated ROM	**$6,422,000.00**

Note that this is an estimate, the final pricing will be determined by the vendor's pricing. If Ludlow pursues competitive bidding, based upon our experience you could see approximately 25% lower cost than stated above. ACD Telecom believes it is more practical and necessary to purchase at a minimum a new P25 Phase 1 system, software upgradable to Phase II. This will give Ludlow a life expectancy of 15 to 20 years for their infrastructure without any need to fork lift major hardware equipment.