

TOWN OF NEEDHAM



RADIO COMMUNICATIONS STUDY AND RECOMMENDATIONS FOR IMPROVEMENT

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**Town of Needham
Radio Communications Study
and
Recommendations for Improvement**

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Appendices 12.7 & 12.8 are included in a separate document.

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1 Introduction

Langone & Associates (“L&A”) as a sub-consultant to Kaestle Boos Associates, Inc. (KBA) was tasked to perform a Radio Communications Study and Recommendations for Improvement. This study will identify the necessary changes to improve radio communications throughout the Town for Fire (NFD) and Police (NPD) radio users. The upgrades required are planned to be implemented as part of the new fire and police station project.

The Town’s Public Safety Answering Point (“PSAP”) is in the existing NPD communications center and answers all 911 and other emergency calls. The PSAP dispatches calls for the NPD. Calls for NFD are transferred to the NFD communications center which is the Secondary PSAP for dispatch.

L&A met with representatives of the NFD, NPD and Public Facilities as well as made site visits to all existing radio equipment locations to gather information for this study.

The components of the NFD and NPD radio systems addressed in this study are the:

- Repeaters
- Receivers
- Antenna Systems and Structures
- Comparators
- Radio Dispatch Consoles
- Connectivity to the Radio Sites
- Office Radios/Control Stations
- Portable Radios
- Mobile Radios

There are other systems that are required to support the public safety dispatch process and the communications center which are provided under a separate budget. These systems are noted in this document.

2 Emergency Response Network

The public safety emergency response network requires high reliability operation of the following critical components:

- 911 emergency telephone system to deliver the calls for service to the Public Safety Answering Point (PSAP) communications center; equipment and services provided by the State 911 office
- communications dispatch center to receive, assess and dispatch the necessary information to the appropriate response units by radio
- effective radio system to deliver the information to the response units

Radio system reliability is a function of equipment and coverage. *Does the radio system talk and listen in the required areas?*

Mission critical public safety radio systems (also referred to as Land Mobile Radio – LMR) operate as a one button push to talk one to many communications networks directly under control of the public safety agency. Cellular phones operate as one to one communications network and not directly under the

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operational control of the public safety agencies. Therefore, cellular phones are not practical for mission critical public safety radio communications.

3 Existing Radio System Configuration

NFD and NPD radio system infrastructure uses analog technology and includes equipment at the following Town-owned and private locations throughout the Town:

- NFD HQ Communications Center
- NFD HQ Basement Equipment Room
- EOC at the NFD HQ
- NPD HQ Communications Center
- NPD HQ Basement Equipment Room
- NFD/NPD HQ Shared Antenna Tower
- 75 Second Ave (Private)*
- Birds Hill Water Tank*
- North Hills (Private)*
- Water Treatment Plant*
- Walker School (Private)*

Refer to the existing radio system drawing for NFD and NPD in the Appendix. All the radio system infrastructure includes equipment that is out of production or at or near its manufacturer's End of Life support with spare parts becoming harder to find. Many of the portable and mobile radios are in the same situation. However, there have been some recent purchases of portable and mobile radios. The plan is to replace all obsolete radio equipment with current technology equipment.

The most important issue that was noticed during the site visits was the condition of the equipment shelter at the Birds Hill Water Tank. I understand that plans had been started to replace this shelter. Those plans should be accelerated due to the overall condition of the shelter. This shelter contains the only transmitters for the current NFD, NPD and DPW radio systems. The antennas for this location are mounted on the water tank structure.

Another issue is that all the remote radio locations indicated by an asterisk (*) are connected to the NFD HQ and NPD HQ communications centers by Verizon leased copper lines. These lines are increasingly subject to outages as Verizon is reducing its support for this very old infrastructure and increasing support for its new IP/Ethernet infrastructure. The proposed radio system would use microwave and/or fiber to connect all radio sites using IP/Ethernet.

4 Radio System Frequencies, Licenses and T-Band

NFD operates on the frequency pair 453.0750/458.0750 under FCC License Call Sign WQBE338.

NPD operates on the frequency pair 470.3625/473.3625 under FCC License Call Sign KZR401. This frequency is currently part of the T-Band give back Law enacted by Congress in 2012. This Law requires the FCC to auction these T-Band frequencies by 2021 and affects public safety agencies in 11 major cities in the US. Many are in eastern Massachusetts. Each T-Band user is required to be off the T-Band frequencies within two (2) years after the auction is completed. Some of the proceeds from the auction will be used to offset the cost of the department's relocation. This give-back law was part of the legislation to

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create a Public Safety Nationwide Broadband Network (FirstNet). FirstNet is a network dedicated for use by first responders.

Since the T-Band spectrum will not provide an auction winner nationwide exclusive use, many believe that the auction will not provide the expected benefits and that the law will be repealed but it has not happened yet. However, a U.S. House of Representatives Minority Report was released in September 2017 on the 10-year anniversary of *Implementing the Recommendations of the 9/11 Commission Act of 2007*. A copy of the pages pertaining to the T-Band give-back issues is included in the Appendix. A link to the full report is available at

https://insidcybersecurity.com/sites/insidcybersecurity.com/files/documents/sep2017/cs09112017_911Act_Report.pdf. This is the first time that I have seen the Congress discuss the T-Band give-back issue and its disruptive effect on public safety agencies that rely on T-Band.

The approach taken in this study is to assume continued use of the UHF T-Band frequencies and that the law will be repealed or suspended until FirstNet is available for mission critical voice communications.

It is recommended and included in the budget for the NPD to obtain mobile and portable radios that can operate in the UHF/T-Band frequencies as well as on the 700/800 MHz frequencies used by the State Police and other state agencies

A review of the NFD and NPD FCC Licenses noted above indicated that they require modifications to update their system information to the current system configuration.

NFD and NPD radio users currently have access to many other frequencies licensed by other agencies such as MetroFire, BAPERN and local towns to improve interoperable radio communications. This will not change after implementation of the proposed radio system.

Implementation of the recommendations included in this document will require future FCC License modifications once the final design is completed.

5 Radio Coverage Propagation Analysis

The most important function of the radio system is to provide reliable radio coverage where it is needed. Meetings with the representatives of the NFD and NPD identified weak coverage areas in the Town. Refer to the Appendix for the coverage maps of the existing radio systems and the proposed radio systems. The propagation analysis is based on the following typical public safety parameters:

- Portable radio on the hip with an external speaker/microphone
- Portable radio with a power output of 5 watts at the antenna port
- Portable radio with a receive sensitivity of -113 dbm at the antenna port
- 95% of the area
- 95% of the time
- Voice quality with minimum background noise (Delivered Audio Quality – DAQ 3.0)
- Generally accepted attenuation levels for inside residential and industrial building radio communications
- Multiple fixed transmit locations operating in a simulcast mode requiring strict timing equipment and stable site connectivity systems such as fiber or microwave radio

The primary change is that the current radio systems use:

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- NFD – one transmitter and six (6) receive locations
- NPD – one transmitter and four (4) receive locations

The proposed radio systems will be more robust by using more strategically located radio sites:

- NFD – three (3) transmitters and four (4) receive locations
- NPD – three (3) transmitters and four (4) receive locations

In selecting the proposed radio sites, existing town-owned structures were analyzed, consideration was given to the telecommunications district and the radio coverage required by the NFD and NPD before recommending the radio system represented by Maps 32 and 33.

The additional strategically placed transmitters, operating in a simulcast mode, provide the improved talkout (dispatch to portable) signal strength for reliable in building coverage. Simulcast means that the transmitters *simul*-taneously broad-*cast*. The multiple receiver locations provide reliable talkback (portable to dispatch). Mobile coverage for NFD and NPD radio systems currently extends beyond the Town's borders and will continue with the proposed configuration.

Unlike the current NFD and NPD radio systems, the proposed radio systems include radio equipment for both at the same radio sites.

In doing coverage analysis for public safety two-way radio systems, we look at both sides of the conversation. This is required because a critical component of the system is the officer/firefighter's portable (handheld) radio. The portable radio is not as powerful and its antenna is not as good as the vehicle mounted mobile radio. For public safety radio systems, we optimize the system design for portable radios to ensure reliable radio coverage when the officer/firefighter is outside of the vehicle.

In the typical public safety repeat radio system, such as Needham's current fire and police radio systems, the talkout side is the communication outbound containing the dispatcher or field unit's voice. The repeat function is very important as it allows multiple field units to communicate during an incident.

How effective the talkout side is based on the location of the fixed transmitter(s) within the Town. Currently Needham has only one primary transmit location (Birds Hill Water Tank) and multiple receive locations for fire and police. Based on information received about the current system, many areas, especially in buildings, have unreliable radio coverage where the officer/firefighter can't understand the dispatcher's talkout communication.

The talkback side is the communications from the field unit whether it is a portable or mobile radio sent back to the communications center for the dispatcher to receive as well as repeated out to the other field units. Based on information received about the current system, many areas, especially in buildings, have unreliable radio coverage where the dispatcher can't understand the officer/firefighter's talkback communication.

The reason why we identified new radio transmit and receive sites is because the current systems lack sufficient radio signal strength both for talkout and talkback. The solution will require additional strategic locations for transmitters and receivers.

The maps illustrate the level of radio coverage by color for a portable radio as described in the operating parameters above:

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- Gray is no or poor coverage
- White is in street coverage
- Yellow is coverage inside residential buildings; this is simulated by adding 8 db of signal loss
- Green is coverage inside industrial buildings; this simulated by adding 20 db of signal loss

The software program used to develop these coverage maps is a good planning tool to provide a means to create a conceptual radio system design and are not guaranteed radio coverage.

The existing T-Band Bi-Directional Amplifiers (BDA) that are installed in various buildings throughout the Town can remain in use with the proposed radio system.

The software program used to develop the microwave antenna heights for unobstructed line of sight between locations is a good planning tool. However, these paths need to be field verified to ensure high reliability of the microwave system.

6 New Radio System Requirements

This section will identify the specific radio equipment required and each location. The existing NFD and NPD radio systems use analog technology. Many public safety agencies are transitioning to P25 digital technology. P25 systems provide improved voice quality over a larger area than analog and includes more features such as seamless integration of voice encryption. The planning budget estimate developed includes the capability for NFD and NPD infrastructure and radios to operate in either the analog or P25 modes on their main channels.

Connectivity between the radio sites is accomplished using a microwave radio system. This system is configured in a loop to provide a level of redundancy should a path fail. In the future, the Town may also connect the radio sites with fiber to increase the level of redundancy.

6.1 NFD Communications Center/Watch Room

Radio dispatch console with two (2) operator positions with access to the following radio channels:

- NFD
- NPD
- DPW
- MetroFire Control Station 1
- MetroFire Control Station 2
- MetroFire Control Station 3
- VOC Alarm
- Emergency Management

Back up NFD control station independent from the radio dispatch console.

Each NFD radio dispatch console will include:

- Monitor and Workstation
- Four (4) Speakers
- Desk Microphone

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- Footswitch
- Headset Jacks (2)
- Display of calling radio ID
- Display of emergency radio ID
- Channel cross patch
- Multi-channel transmit
- Control of selected doors in the building
- Display the receiver site equipment status

6.2 EOC Room

The EOC will be equipped with:

- Existing Zetron 4010 Radio Dispatch Console with access to the following radio channels:
 - Emergency Management
 - NFD
 - NPD
 - DPW
- Cache of VHF Portable Radios (6)
- Six-Unit Portable Radio Battery Charger
- Cache of VHF Mobile Radios (6) w/Mag Mount Antennas for Temporary Installations

6.3 NPD Communications Center

Radio dispatch console with four (4) operator positions with access to the following radio channels:

- NFD
- NPD
- DPW
- BAPERN West
- BAPERN Central
- BAPERN South
- BAPERN Area 3
- BAPERN Area 4
- State 800 MHz Control Station
- MetroFire Control Station 1
- MetroFire Control Station 2
- MetroFire Control Station 3
- Emergency Management

Back up NPD control station independent from the radio dispatch console.

Each NPD radio dispatch console will include:

- AES256 Encryption
- Monitor and Workstation
- Four (4) Speakers
- Desk Microphone
- Footswitch

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- Headset Jacks (2)
- Display of calling radio ID
- Display of emergency radio ID
- Channel cross patch
- Multi-channel transmit
- Control of selected doors in the building
- Display the receiver site equipment status

6.4 Radio Equipment Room

This room will contain the following:

- Radio Dispatch Console Interface Gateways
- Simulcast Radio Equipment
- GPS Receiver for Radio Simulcast
- NFD Standby Repeater with Active Receiver
- NPD Standby Repeater with Active Receiver
- NFD Comparator (4 Receiver Locations) – Analog
- NFD Comparator (4 Receive Locations) – P25
- NPD Comparator (4 Receiver Locations) – Analog
- NPD Comparator (4 Receive Locations) – P25
- MetroFire Control Station 1
- MetroFire Control Station 2
- MetroFire Control Station 3
- Emergency Management Base Station
- EOC NFD Control Station
- EOC NPD Control Station
- EOC DPW Control Station
- Microwave radio and antenna pointing to Birds Hill
- Microwave radio and antenna pointing to RTS
- Future - Fiber cable termination and electronics for connection to the remote radio sites and Station 2
- Three (3) six (6) foot 19” two-post open equipment racks

6.5 NFD/NPD HQ Shared Roof Mounted Antenna Structure

A roof antenna structure (sled type) will be provided as part of the building for mounting all the antennas at the NFD/NPD HQ building location. Individual omni antennas (~5 Ft in length) will be required for each of the following equipment:

- NFD Standby Repeater
- NPD Standby Repeater
- MetroFire Control Station 1
- MetroFire Control Station 2
- MetroFire Control Station 3
- BAPERN Special Control Station for West, Area 3 & Area 4
- BAPERN Control Station for Central
- BAPERN Control Station for South

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- Emergency Management Base Station
- NFD/NPD receivers with Multi-Coupler
- NFD Communications Center Back Up Control Station
- NPD Communications Center Back Up Control Station
- EOC NFD Control Station
- EOC NPD Control Station
- EOC DPW Control Station
- GPS Receiver for Radio Simulcast
- GPS Receiver for NG-911 (Provided by State 911)
- Radio Fire Alarm Box System (2); provided under a separate contract

6.6 Birds Hill Water Tank

Equipment required at this location includes:

- NFD transmitter and receiver with the antenna mounted on the water tank
- NPD transmitter and receiver with the antenna mounted on the water tank
- DPW transmitter and receiver with the antenna mounted on the water tank (replacement equipment not part of this project)
- Simulcast equipment
- GPS receiver with antenna mounted on the shelter
- Equipment and environmental monitoring system
- Microwave radio and antenna pointing to Dunster
- Microwave radio and antenna pointing to HQ
- Future - Fiber patch panel and termination electronics (assumes fiber from the NFD/NPD HQ equipment room will be available at this equipment shelter)

As noted earlier, the equipment shelter and generator should be replaced as soon as possible due to its condition. The new radio system budget provided does not include these items and assumes they will be replaced under a separate budget and include:

- Equipment Shelter – 8' x 12' with:
 - Aggregate Panel Exterior
 - 100 A Service, Single Phase
 - HVAC (1 Ton and 5KW heater)
 - Cable Tray (12")
 - R-11 Insulation
 - Lifting Brackets
 - 19" Equipment Racks (3)
 - 100A Generator Plug
 - Interior LED Lights
 - 20A Outlets (6)
 - R-56 Grounding
 - Antenna Port
 - Environmental Alarms
- 15KW Diesel Generator
 - Automatic Transfer Switch
 - Exercise Timer
 - 48 Hour Base Tank

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- Foundations and Conduits, As Required

6.7 Dunster Water Tank

Equipment required at this location includes:

- NFD transmitter and receiver with the antenna mounted on the water tank
- NPD transmitter and receiver with the antenna mounted on the water tank
- Simulcast equipment
- UPS
- GPS receiver with antenna mounted on the shelter
- Equipment and environmental monitoring system
- Microwave radio and antenna pointing to RTS
- Microwave radio and antenna pointing to Birds Hill
- Future - Fiber patch panel and termination electronics (assumes fiber from the NFD/NPD HQ equipment room will be available at this equipment shelter)
- Equipment Shelter (same as Birds Hill Water Tower site)
- Generator (same as Birds Hill Water Tower Site)

6.8 RTS Site

Equipment required at this location includes:

- NFD transmitter and receiver with the antenna mounted on the tower
- NPD transmitter and receiver with the antenna mounted on the tower
- Simulcast equipment
- UPS
- GPS receiver with antenna mounted on the shelter
- Equipment and environmental monitoring system
- Microwave radio and antenna pointing to Dunster
- Microwave radio and antenna pointing to HQ
- Future - Fiber patch panel and termination electronics (assumes fiber from the NFD/NPD HQ equipment room will be available at the equipment location in the building)
- 180 Ft Self-Supporting Lattice Tower
- Foundation for tower, shelter and generator, cable bridge and fences
- AM Detuning system due to proximity to the WEEI-AM towers
- Equipment Shelter (same as Birds Hill Water Tower site)
- Generator (same as Birds Hill Water Tower Site)

6.9 Fire Stations 1 & 2

Equipment required at each location includes:

- Radio Control Station with antenna mounted to building and interface to station public address system (provided under a separate procurement)

6.10 NFD Subscriber Radios

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New NFD subscriber radios will include the following:

- UHF Mobile radio for rear mount with antenna; the budget quantity includes the net of the required and ordered radios
- UHF Portable radio with lapel speaker/microphone and case; the budget quantity includes the net of the required and ordered radios
- Portable radio vehicle charger
- Portable radio six-unit charger

6.11 NPD Subscriber Radios

New NPD subscriber radios will include the following:

- Dual band UHF & 700/800 MHz Mobile radio for rear mount with AES256 encryption and antenna
- Dual band UHF & 700/800 MHz Portable radio with AES256 encryption, lapel speaker/microphone and case
- Manual encryption key loader
- Portable radio six-unit charger
- Portable single unit charger

7 Temporary Operating Locations

During the construction of the new building, the NFD and NPD staff will operate out of temporary locations. Each location should have at a minimum separate radio control stations to access the NFD and NPD radio systems. These control stations can be mobile radios with an external power supply and outside antenna. They may also want access to MetroFire and BAPERN channels.

Also, these locations may require a BDA to provide reliable NFD and NPD radio communications inside the building for the officer and firefighter's portable radios.

The costs for the equipment identified in this section is not included in the new radio system planning budget estimate.

8 Other Technology Systems for the New NFD/NPD HQ Building

It is assumed that the systems listed below are included in the new NFD/NPD HQ building specifications/drawings and will be provided under separate procurements and budget. These systems are not included in the Capital Planning Budget Estimate provided with this document. Where appropriate, it is also assumed that the necessary pathways, conduits and wall boxes will be provided to accommodate this technology equipment located throughout the building. Detailed evaluations of the following systems are beyond the scope of this study:

- NFD/NPD HQ shared antenna mounting structure (sled type) with cable access from the equipment room
- Communications Center dispatch furniture with motorized adjustable surfaces, personal comfort controls, monitor mounts and 24-hour intensive use chairs
- Fire Station Alerting System for the NFD communications center and stations 1 & 2
- NFD communications center central station equipment for the radio fire alarm boxes

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- NG-911 telephone equipment, administrative workstation, printer and logging recorder; all equipment and installation costs will be provided by the State 911 Department
- Administrative telephone system
- Computer Aided Dispatch (CAD) system
- Records Management System (RMS)
- Criminal Justice Information System (CJIS)
- Town/Building LAN
- Office Computers/Printers/Faxes etc.
- Internet access
- Video for monitoring the building with cameras to monitor inside, outside, holding cells, remote fire stations etc.
- Video for selective monitoring of all cameras located throughout the Town; assumes adequate connectivity to the building from outlying areas
- Video for selective monitoring of all cameras at the schools; assumes adequate connectivity to the building from the schools
- Large wall mounted monitors located in the dispatch room to view all the cameras, call status, CATV etc.
- Large wall mounted monitors in the EOC/Training and conference rooms
- Intercom system that includes monitoring of selected doors and holding cells
- Panic alarm system in selected locations to summon help
- Access control that includes control of selected inside and outside doors as well as cell check logging
- Audio/Visual equipment for the EOC/Training room and conference rooms
- Interrogation and Interview Audio/Visual system with the proper certifications for evidence, storage and selected permissions for access
- Premise cabling to support voice, data and other low voltage applications
- BDA for cell phone coverage improvement in the building
- BDA for NFD and NPD coverage improvement in the building
- Standby generator to operate entire building
- Critical equipment UPS that will support at a minimum the rooms for dispatch, radio equipment, server equipment, booking and EOC etc. with isolated grounds
- Building ground of 5 ohms or less with a single point ground system
- Grounding and lightning surge protection with Transient Voltage Surge Suppressor (TVSS) following R-56 guidelines
- Dispatch room with conductive carpet, acoustic material for ceiling walls and floor, dimmable lights and emergency battery packs for some lights
- Raised floor for the dispatch and equipment rooms with conduit access between the rooms to permit easy access for system cabling initially and continuing over the years for technology upgrades

The following information is supplied for consideration by the Town and Architect:

- Review the space programmed for the radio and technology systems
- Town contract directly with technology vendors according to the Town's procurement policies relating to existing local contracts, state contracts or chapter 30B procurement; this approach would provide the Town with more direct control over implementing these important systems as well as eliminate any General Contractor mark up.

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9 Assumptions

The recommendation is based on the following assumptions:

- Planning budget estimate includes capital costs only
- Existing Birds Hill Water Tank equipment shelter and generator will be replaced under a separate project
- Unrestricted access to all radio sites
- UHF T-Band frequency giveback law will be repealed in total or suspended until the Public Safety Nationwide Broadband Network (FirstNet) is available for mission critical voice
- Initially – Microwave will connect all radio sites and HQ in a loop network which provides path redundancy
- Future - Fiber may connect all radio sites to the HQ IT room for additional redundancy; no fiber costs are included and are considered operating costs
- No DPW radio system upgrades are included
- Approval of a 180 Ft tower at the RTS facility with AM detuning equipment

10 Recommendation

Maintaining the use of the UHF T-Band radio frequencies, maps 32 and 33 provide the optimum radio coverage as identified by the working group. The capital planning budget estimate range for this radio system configuration includes:

• Infrastructure =	\$1,643,088 to \$2,019,064
• EOC =	\$ 31,460 to \$ 35,679
• Subscriber Radios (Mobiles & Portables) =	\$ 655,600 to \$ 655,600
• Project Total =	\$2,330,148 to \$2,710,342

The above estimate does not include any receive only radio sites except at HQ. Receive only sites are considered optional for possible future implementation. The cost range for each additional receive only site assuming the use of an existing building to locate equipment and mount an antenna is \$121,620 to \$154,655.

11 Next Steps

The next steps for this project include:

- Approve budget
- Complete final requirements for coverage, equipment and system design
- Notify WEEI-AM of the plans for the RTS tower
- Engage an AM Tuning Company to design the detuning system for the RTS tower
- Obtain approvals for access to the radio equipment sites
- Field verify microwave path surveys
- File FCC License modifications and waiver request
- Prepare procurement specifications
- Obtain Vendor quotes
- Execute Vendor contract
- Implementation and Acceptance of the New System

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12 Appendix List

The following information is included in the Appendix:

12.1 Existing NFD and NPD Radio System Configuration

12.2 U. S. House of Representatives Minority Report on T-Band

12.3 Coverage Maps for Existing NFD and NPD Radio Systems

- Map-1 indicating the terrain elevations throughout the Town
- Map-2 Existing for NFD Talkout
- Map-3 Existing for NFD Talkback
- Map-4 Existing for NPD Talkout
- Map-5 Existing for NPD Talkback

12.4 Proposed NFD and NPD Radio System Configuration for Maps 32 & 33

12.5 Coverage Maps 32 & 33 for Proposed NFD and NPD Radio System with Path Analysis for Microwave Loop Connectivity Paths M1, M3, M4 & M6

12.6 Capital Planning Budget Estimate Detail for Maps 32 & 33 Radio System

Included in a separate document are the following Appendices:

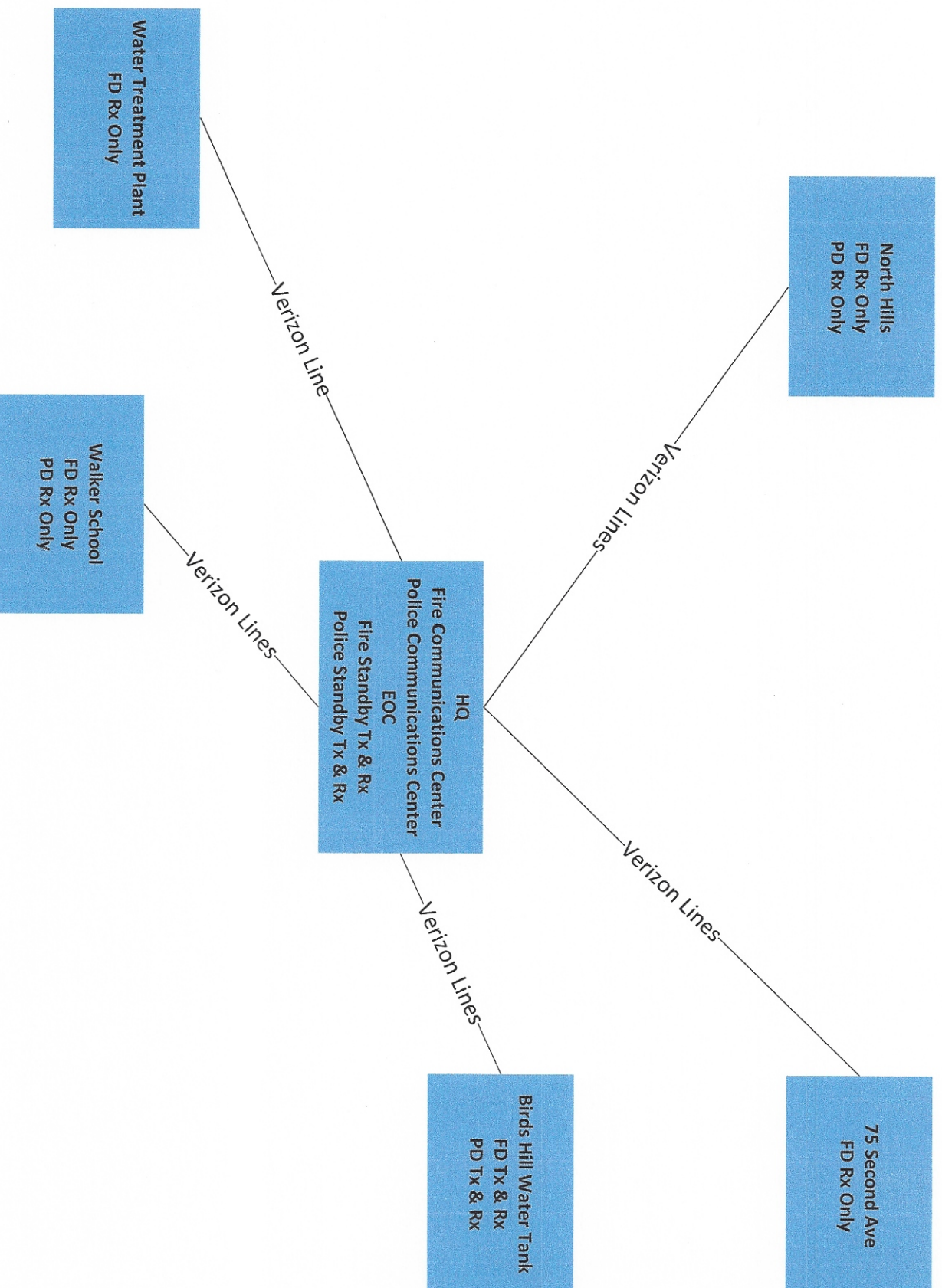
12.7 Additional Coverage Maps Illustrating Options – Maps 1 to 37 (Maps 32 & 33 are also included)

12.8 Additional Microwave Path Analyses – M1 to M9 (M1, M3, M4 & M6 are also included)

APPENDIX 12.1

EXISTING NFD AND NPD RADIO SYSTEM CONFIGURATION

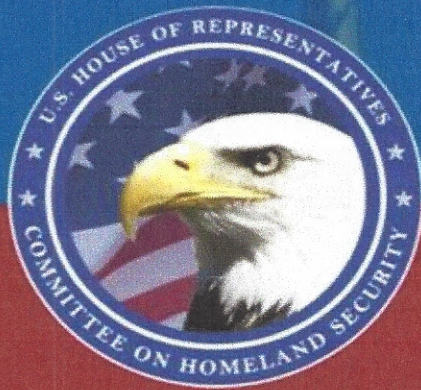
EXISTING FIRE & POLICE RADIO SYSTEM
WITH VERIZON COPPER LINES FOR SITE CONNECTIVITY
FOR MAPS 2, 3, 4 & 5



APPENDIX 12.2

U.S HOUSE OF REPRESENTATIVES MINORITY REPORT ON T-BAND

TEN YEARS LATER
MAJOR HOMELAND SECURITY
MANDATES OF THE 9/11
COMMISSION ACT



U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON HOMELAND SECURITY
REP. BENNIE G. THOMPSON, RANKING MEMBER

MINORITY STAFF REPORT

TEN MAJOR DHS MANDATES: THE STATE OF PLAY

I. Homeland Security Grants (*Sec. 101*)

On September 11, 2001, first responders heroically ran into unknown dangers to save as many lives as possible. However, their efforts were undermined by a national failure to adequately invest in building and maintaining a robust emergency management and response infrastructure and a coordinated communications system. Enactment of the *9/11 Commission Act* triggered substantial investments in first responder capabilities, with funding for the State Homeland Security Grant Program (SHSGP) and Urban Area Security Initiative (UASI) peaking at \$950 million and \$868 million, respectively. The response to the April 2013 Boston Marathon Bombings demonstrated how, with Federal support, first responder capabilities have improved since the 9/11 attacks. Unfortunately, in recent years, the arbitrary discretionary spending caps imposed by the *Budget Control Act of 2011* have significantly curtailed DHS' efforts to support critical State and local homeland security preparedness and response.

Congress and the Administration should take a range of actions including restoring needed funding, improving the grant risk formula, providing support to former UASI cities that, because of budget constraints, were eliminated from the program, authorizing the Nonprofit Security Grant Program, and helping enhance cybersecurity capabilities at the State and local levels.

II. Interoperability (*Sec 301*)

Emergency communications failures during the 9/11 attacks costed lives. The communications systems of emergency response agencies were overwhelmed by the amount of users, suffered from weak radio signal strength, and were not interoperable across jurisdictions and across disciplines. The *9/11 Commission Act* directed the Department to address these interoperability challenges at the State level by creating a targeted interoperability grant program and conditioning grant funding on compliance with governance plans. Between Fiscal Year (FY) 08 through FY11, Congress appropriated \$50 million annually in interoperability grant funding, but under the Republican-controlled Congress, funding for the program was eliminated in FY12.

To ensure the continuation of critical interoperability efforts, particularly governance efforts, Congress should provide new resources. Additionally, Congress should act to ensure that major jurisdictions that rely upon the T-Band radio spectrum for mission critical voice capabilities—Boston, Chicago, Dallas, Houston, Los Angeles, Miami, New York, Philadelphia, Pittsburgh, San Francisco, and Washington, DC—continue to have access to it until capabilities are available on the Public Safety Broadband Network.

Five years after the Department released the first NECP, the Boston Marathon bombings occurred. The strong multi-jurisdiction, multi-discipline, response was attributed largely to the emergency communications infrastructure established pursuant to NECP guidance and gains achieved with IECGP resources.³⁷ Previously, in 2010, DHS made a series of recommendations to the region's first responder community based on its observations during the Boston Marathon. Subsequently, with IECGP money, the Boston region worked to address the issues identified by DHS, including training additional Communications Unit Technicians (COMTs).³⁸ According to Steve Staffier, the SWIC for Massachusetts at the time of the 2013 Boston Marathon bombings: "[T]he key to our success is that we have the State communications unit team, which is made-up of [Communications Unit Leaders], COMTs, and all of the subject matter experts who run these radio systems."³⁹ Moreover, he observed that planning "is more key than anything money can buy as far as systems and technology."⁴⁰

A related communications challenge identified by the 9/11 Commission was the need for "expedited and increased assignment of radio spectrum for public safety use."⁴¹ In response, Congress passed the *Public Safety and Spectrum Act* in 2012 to direct the establishment of the First Responder Network Authority (FirstNet), a public safety broadband network on dedicated spectrum.⁴² That law authorized \$7 billion in funding to build out the network, supported in part by proceeds from spectrum auctions. It also directed that, by 2023, public safety users be required to relocate from the T-Band spectrum, an important emergency communications spectrum resource.⁴³ Currently, the following jurisdictions rely on T-Band spectrum: Boston, Chicago, Dallas, Houston, Los Angeles, Miami, New York, Philadelphia, Pittsburgh, San Francisco, and Washington, D.C.⁴⁴

Findings and Recommendations

Governance

Despite gains in interoperable communications, continued focus on closing operational challenges and overcoming governance gaps is needed. This point was underscored in a quote shared, in testimony before the Committee, by the Chairman of the National Council of Statewide Interoperability Coordinators (NCSWIC) from the former Massachusetts SWIC, Steve Staffier:

As I witnessed during the Boston Marathon Bombings, even though we have all made significant investments in equipment and systems around the

³⁷ Office of Emergency Communications, U.S. Department of Homeland Security, *Emergency Communications Case Study: Emergency Communications During the Response to the Boston Marathon Bombing*, (Washington, DC: April 2013), <https://www.dhs.gov/sites/default/files/publications/oec-case%20study-support%20for%20response%20to%20boston%20marathon%20bombing-2013.pdf>.

³⁸ Ibid.

³⁹ Ibid.

⁴⁰ Ibid.

⁴¹ Ibid.

⁴² Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 206 (2012).

⁴³ Ibid.

⁴⁴ "T-Band Update Report: 2016," National Public Safety Telecommunications Council, (May 31, 2016) 3, http://npstc.org/download.jsp?tableId=37&column=217&id=3696&file=T_Band_Update_Report_Final.pdf.

T-Band

The Federal Communications Commission is required to begin auctioning off the T-Band spectrum used by certain public safety agencies by 2021 and to remove all public safety agencies from the spectrum by 2023.⁴⁷ Presently, it is unclear whether the Public Safety Broadband Network will be capable of providing mission critical voice capabilities to public safety users by 2023. Regarding the possibility of public safety users will have to relocate from the T-Band, New York City Mayor Bill de Blasio testified that:

T-Band is a critical part of the work we do in terms of emergency communications. Disrupting that reality could prove to be very dangerous. We have, as you know, a very highly developed apparatus in New York City to protect our people and protect again the 60 million people who visit every year. It has to do with a number of agencies constantly working together in a very crowded complex environment and the current communications structure allows us to do that work. If Congress doesn't act and we have to relinquish the current approach, we fear a situation that's really disruptive.⁴⁸

Fire Chief Gerald R. Reardon from the City of Cambridge, Massachusetts, similarly expressed concern that forcing first responder agencies to relocate off the T-Band would result not only in millions of dollars in sunk costs, but also lost capabilities. In particular, the Boston Area Police Emergency Radio Network, which was used by responding law enforcement agencies during the Boston Marathon Bombings, is currently used by 166 law enforcement agencies from the New Hampshire border to Cape Cod Canal. That network is on the T-Band.⁴⁹

Recommendation: Congress must allow for public safety organizations that rely on the T-Band to remain on this spectrum until mission critical voice capabilities on the Public Safety Broadband Network are available.

⁴⁷ *Supra*, note 42.

⁴⁸ *State of Emergency: The Disaster of Cutting Preparedness Grants, Hearing before the Subcmte. on Emergency Preparedness, Response, and Communications, Comm. on Homeland Security, House of Representatives, 114th Cong. (March 15, 2016)* (statement of Hon. Bill de Blasio, Mayor of New York City).

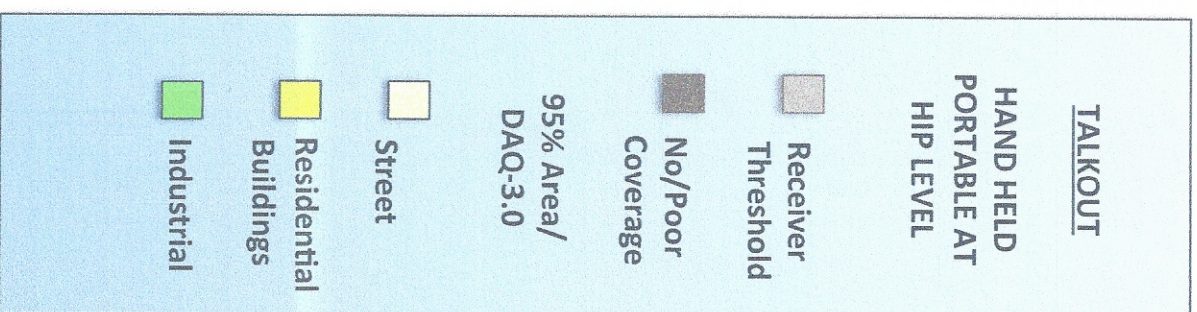
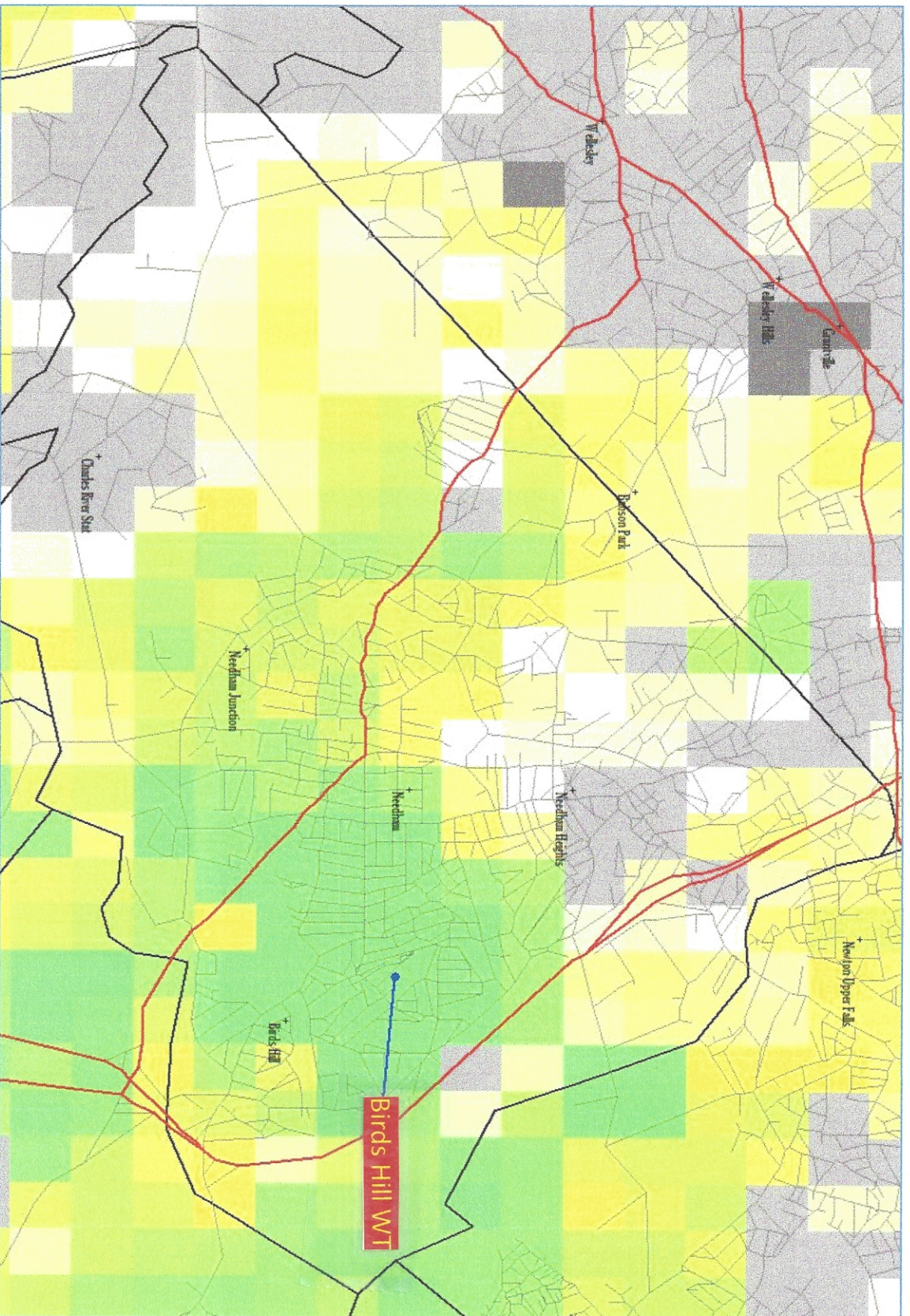
⁴⁹ *Supra*, note 44 at 6.

APPENDIX 12.3

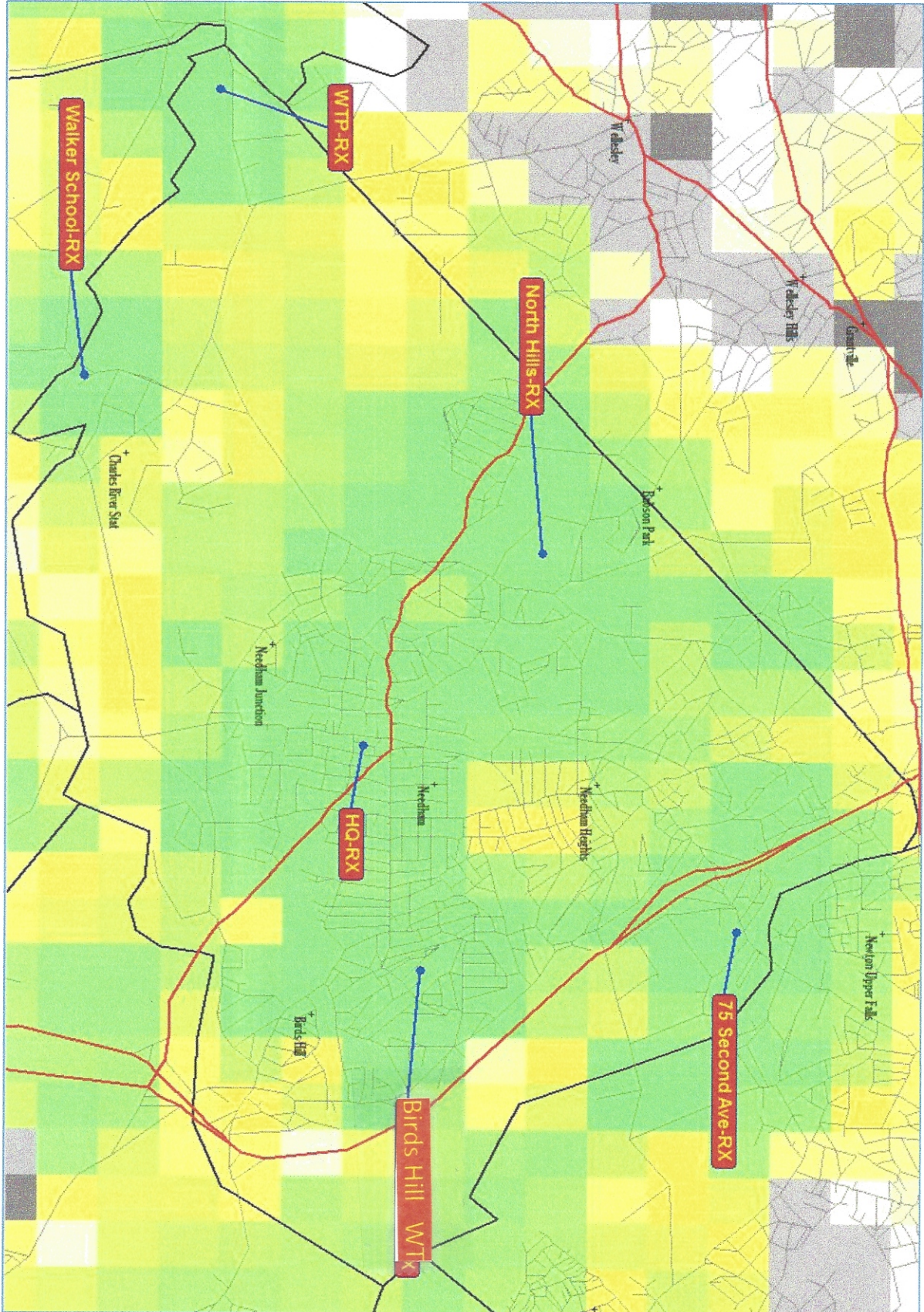
TERRAIN MAP AND COVERAGE MAPS FOR EXISTING NFD AND NPD RADIO SYSTEMS MAPS 1, 2, 3, 4 & 5

Clr	Level [ft]
	0.00
	10.00
	125.00
	150.00
	175.00
	200.00
	225.00
	250.00

MAP-2 / NEEDHAM, MA / FIRE DEPARTMENT PORTABLE TALKOUT - UHF



MAP-3 / NEEDHAM, MA / FIRE DEPARTMENT PORTABLE TALKBACK - UHF

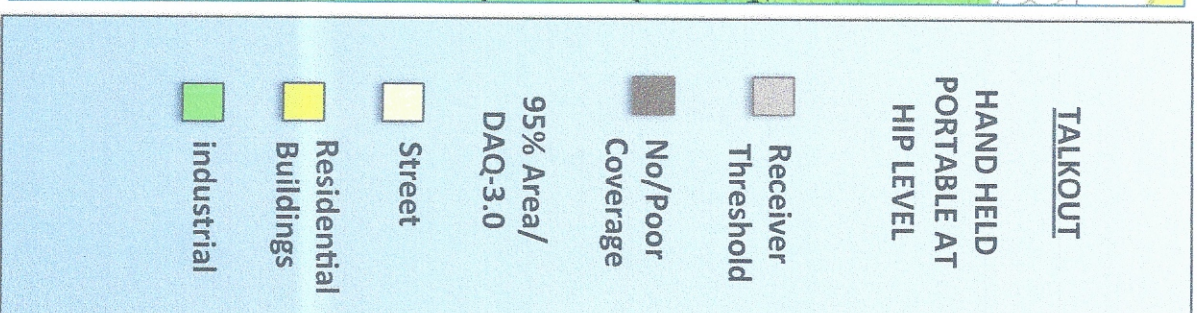
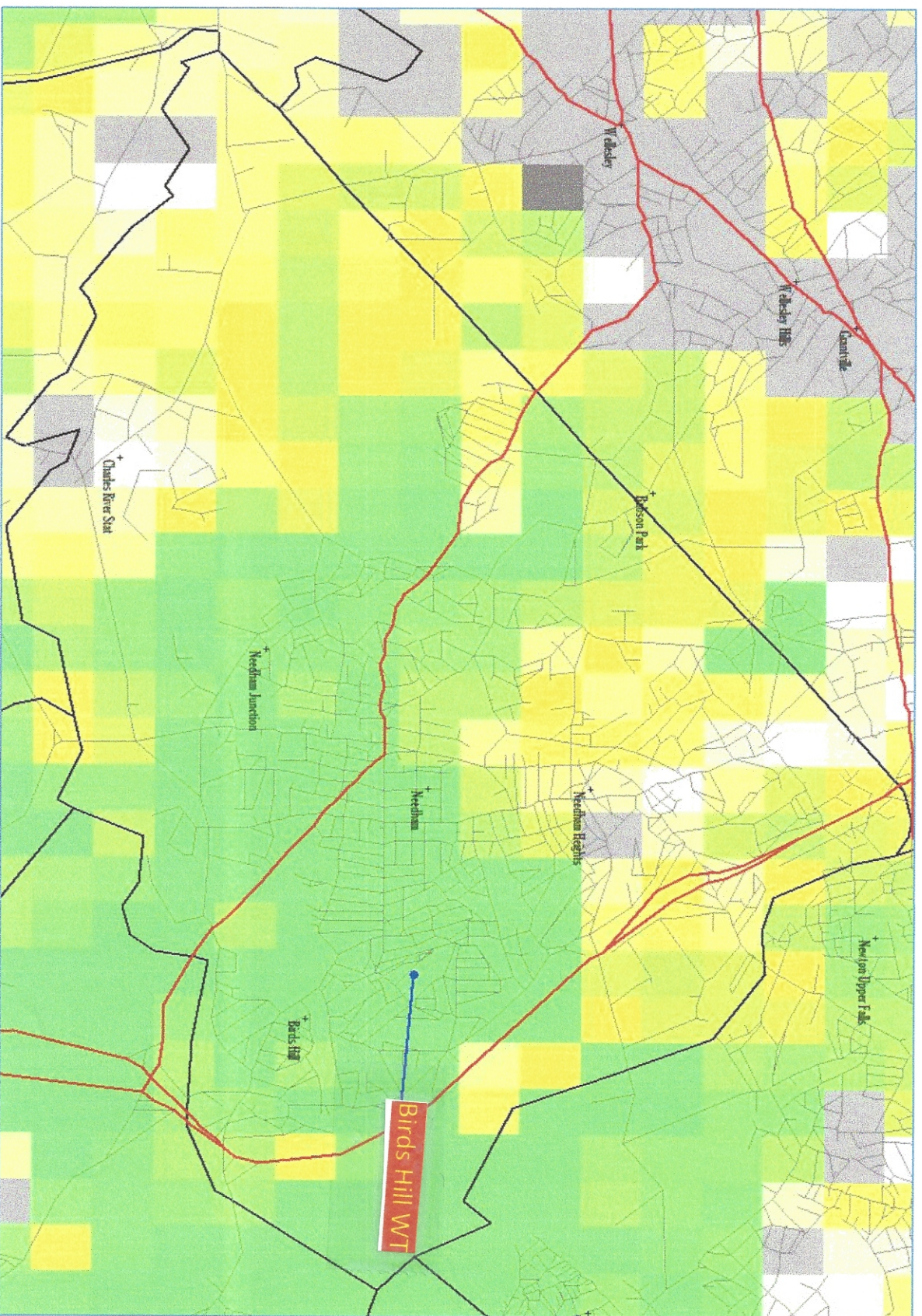


TALKBACK

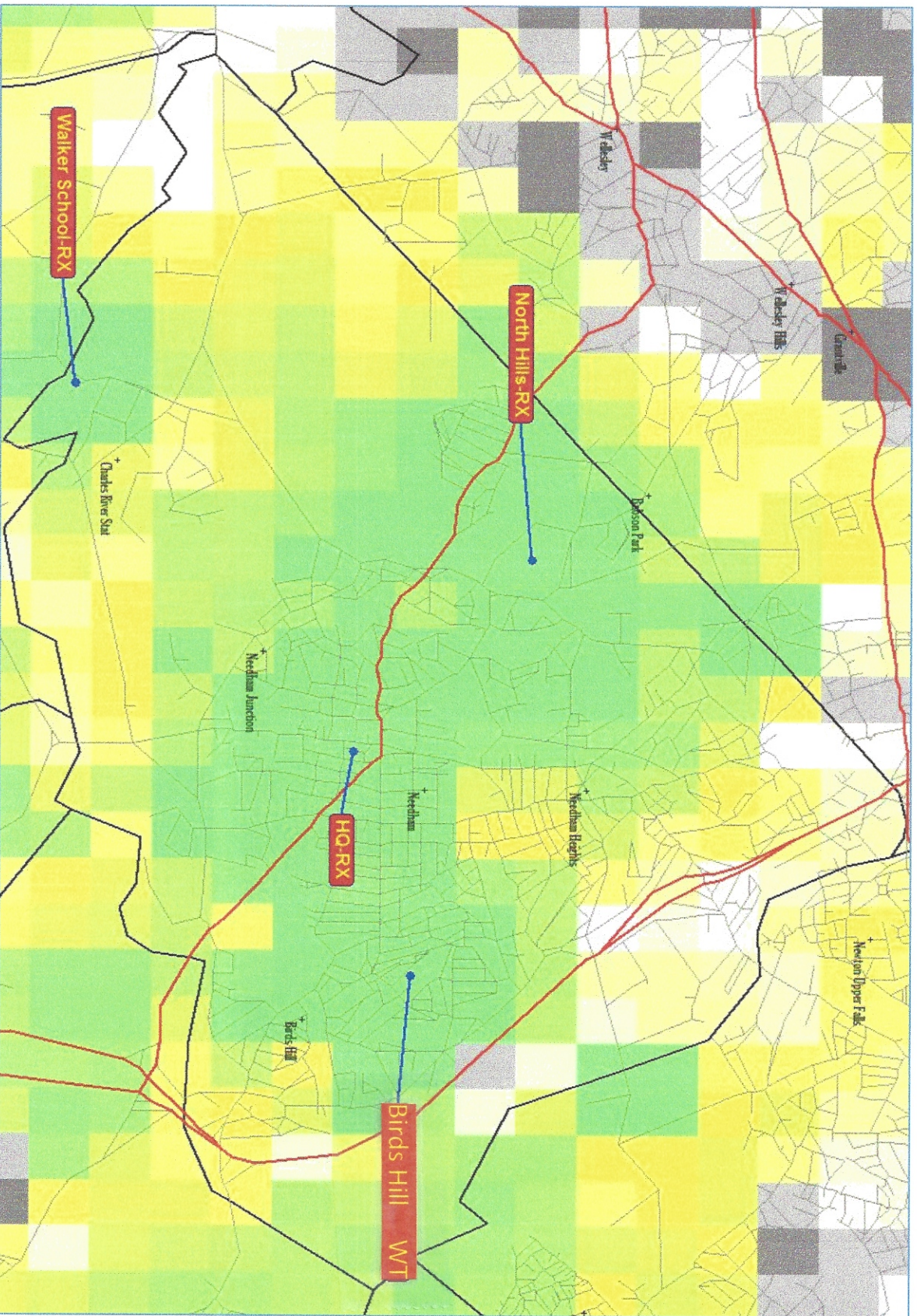
HAND HELD PORTABLE AT HIP LEVEL

- Receiver Threshold
- No/Poor Coverage
- 95% Area/DAQ-3.0
- Street
- Residential Buildings
- Industrial

MAP-4 / NEEDHAM, MA / POLICE DEPARTMENT PORTABLE TALKOUT - UHF



MAP-5 / NEEDHAM, MA / POLICE DEPARTMENT PORTABLE TALKBACK - UHF



TALKBACK

HAND HELD PORTABLE AT HIP LEVEL

Receiver Threshold

No/Poor Coverage

95% Area/DAQ-3.0

Street

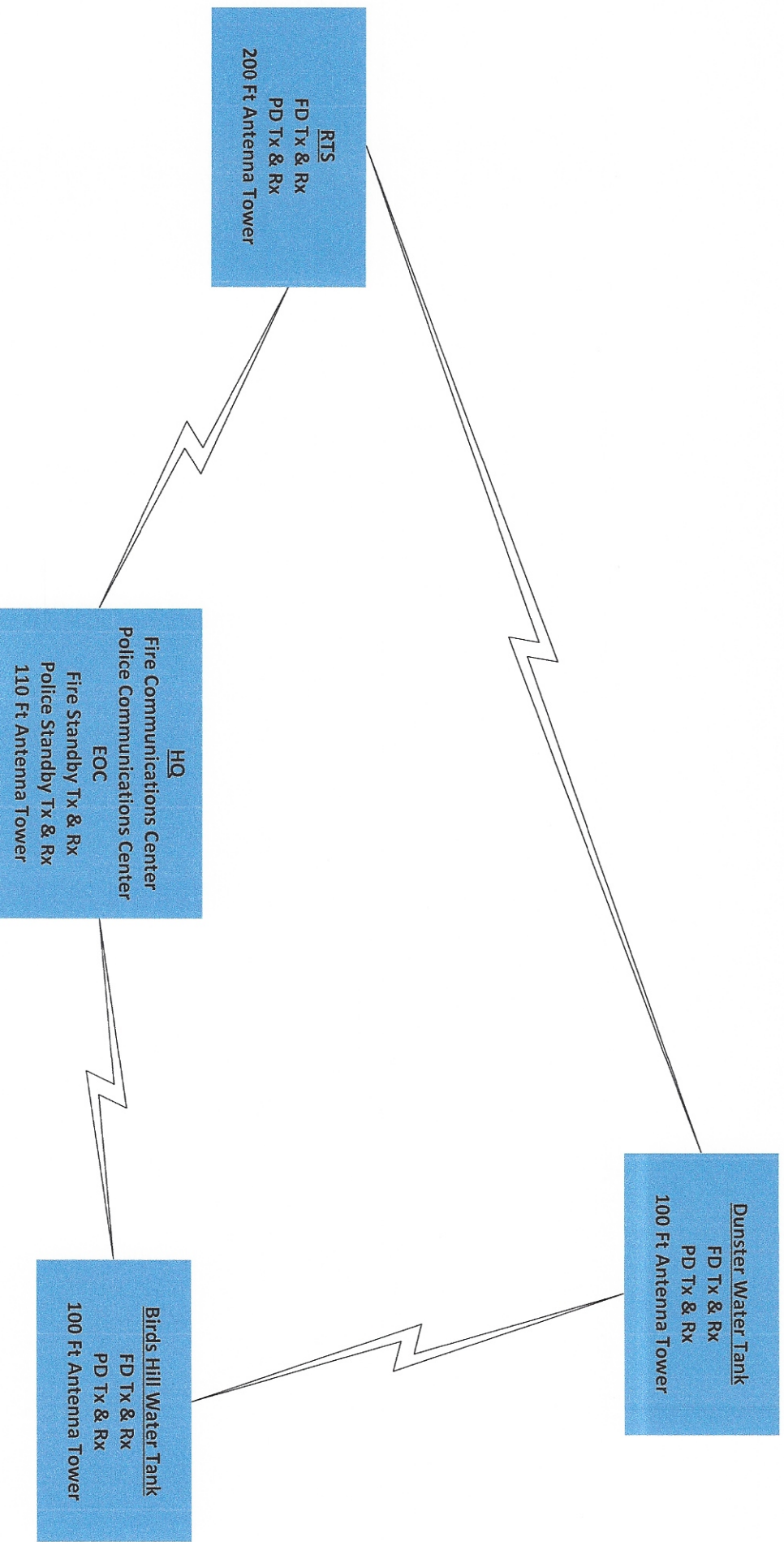
Residential Buildings

industrial

APPENDIX 12.4

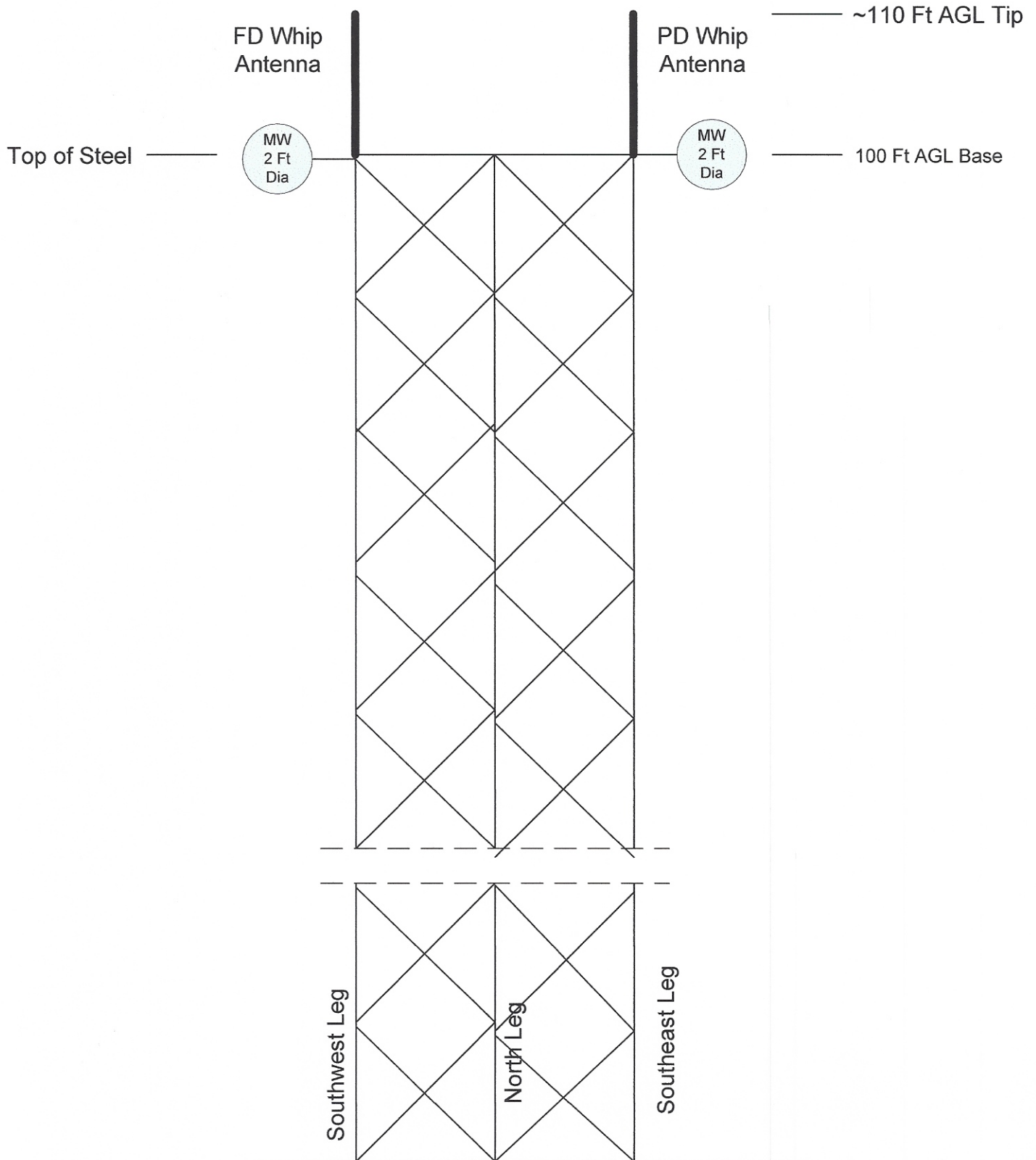
PROPOSED NFD AND NPD RADIO SYSTEM
CONFIGURATION FOR MAPS 32 & 33 WITH
PATH ANALYSIS FOR MICROWAVE LOOP
CONNECTIVITY PATHS M1, M3, M4 & M6

PROPOSED FIRE & POLICE RADIO SYSTEM
WITH LOOP MICROWAVE FOR SITE CONNECTIVITY
FOR COVERAGE MAPS 32 & 33
WITH ANTENNA SUPPORT STRUCTURE HEIGHTS



Tower Heights Based on Drone Survey of Microwave Paths

Lattice Tower Shown
Needham FD & PD Antenna Information Only
Birds Hill Water Tank Example



Not to Scale
12/5/17

ANT450D, D3, D6-9

DIPOLE AND DIPOLE ARRAY 1 TO 9 dBd

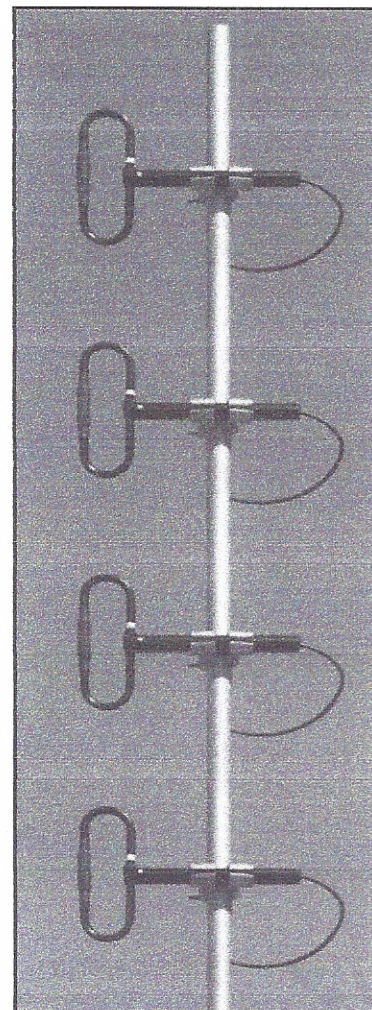
The Telewave ANT450D series consists of single, dual, and 4-element dipole array antennas with a precision phasing harness for optimum performance. The antenna horizontal pattern is field-adjustable, for any current or future coverage requirements. The wide bandwidth and high efficiency of these antennas make them ideal for many applications, including trunking, business, public safety, government, and amateur radio.

Each dipole element is constructed with 6061-T6 aluminum, and welded at the base for maximum strength. Each antenna is also completely sealed with our high-tech Txylan™ coating, which resists water and ice

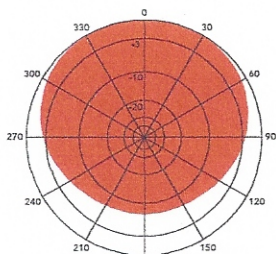
buildup, and provides exceptional protection from corrosive gases, UV radiation, salt spray, acid rain and windblown abrasives. The phasing harness is fully sealed by Telewave's Millenium Seal™ technology.

All components are at DC ground potential for lightning protection. Each dipole element includes a heavy-duty custom clamp set for mounting to a 1.5"-2.5" diameter galvanized steel support pipe or tower leg.

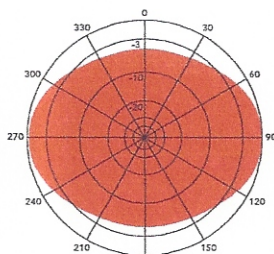
Up to 15 degrees of electrical uptilt or downtilt may be specified for D3 or D6-9 models. Desired tilt angle must be included on the order, and consultation with our antenna engineering staff is requested.



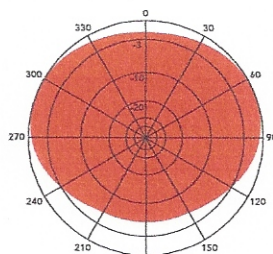
ANT450D6-9
(Harness not shown)
Support mast is
customer-supplied



H-Plane gain 9.1 dBd
1/4 wl. spacing from tower



H-Plane gain 9.1 dBd
1/2 wl. spacing from tower



H-Plane gain 8.5 dBd
3/8 wl. spacing from tower

COMMON SPECIFICATIONS

Frequency (continuous)	406-512 MHz	Lightning protection	DC Ground
Power rating (typ.)	500 watts	Wind rating	175 MPH
Impedance	50 ohms	(with 0.5" ice)	150 MPH
VSWR	1.5:1 or less		
Pattern	Adjustable: Offset circular, cardioid, or bidirectional		
Termination	N-Male or 7-16 DIN (opt.) on harness feed cable		

MODEL SPECIFICATIONS	ANT450D	ANT450D3	ANT450D6-9
Gain (dependent on pattern)	1-2.5 dBd	3-6 dBd	6-9 dBd
Vertical beamwidth (3/8 wl.)	71°	34°	15°
Dimensions (H x D) (max)	13 x 12 in.	31 x 12 in.	71 x 12 in.
Weight (antenna + clamps)	6 lbs	13 lbs	18 lbs
Maximum exposed area	0.27 ft. ²	0.68 ft. ²	1.4 ft. ²
Lateral thrust at 100 MPH	11 lbs	28 lbs	60 lbs
Electrical uptilt / downtilt	N/A	1-15°	1-15°

HPD2-18

0.6 M | 2 FT HIGH PERFORMANCE PARABOLIC REFLECTOR ANTENNA, DUAL-POLARIZED, 17.7-19.7GHZ



SPECIFICATIONS

General

Antenna Type	High Performance Parabolic Reflector Antenna
Size, nominal	2 ft 0.6 m
Polarization	Dual

Standard RF Connector Type	WR42
Standard RF Connector Suffix	RS (append suffix to model number)

Electrical

Operating Frequency Band	17.7 - 19.7 GHz
Half Power Beamwidth, Horizontal	2 degrees
Half Power Beamwidth, Vertical	2 degrees
Cross-Polarization Discrimination	30 dB
Front to Back Ratio (F/B)	67 dB

Gain, Low Frequency	38 dBi
Gain, Mid Frequency	38.4 dBi
Gain, High Frequency	38.6 dBi
VSWR	1.37:1
Return Loss	-16.1 dB

Mechanical

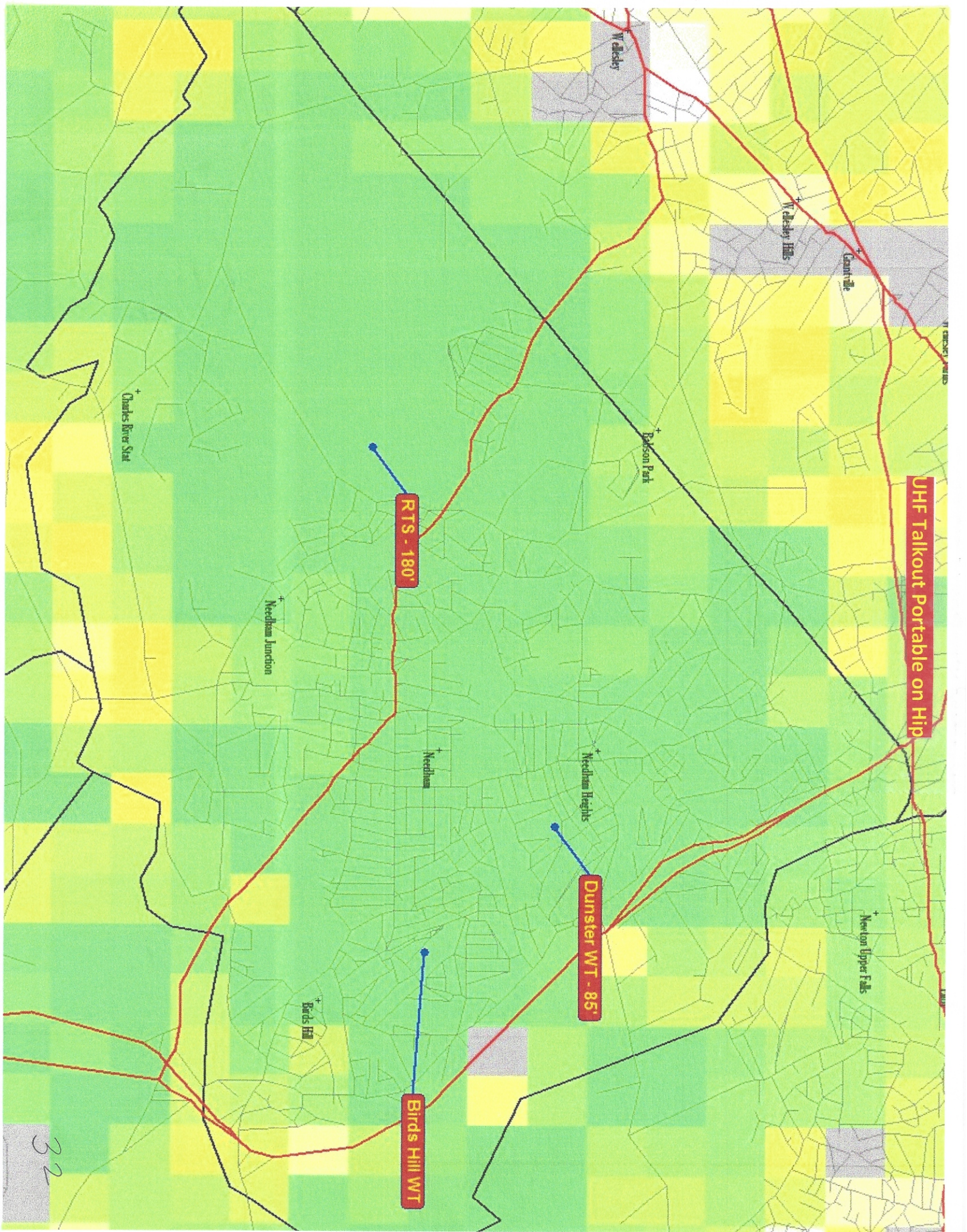
Fine Azimuth Adjustment	+/- 10 degrees
Fine Elevation Adjustment	+/- 30 degrees
Mounting Pipe Diameter, Min	2 inch 5.08 cm
Mounting Pipe Diameter, Max	4.5 inch 11.4 cm
Net Weight	27 lbs 12.3 kg
Wind Velocity Operational	90 mph 145 km/h
Wind Velocity Survival Rating	125 mph 201 km/h

Mechanical Configuration	HP2
Axial Force (FA)	202 lbs 899 N
Side Force (FS)	100 lbs 445 N
Twisting Moment (MT)	194 ft-lbs 263 Nm
Operating Temperature Range	-40 to +60 C
Max Pressure, PSIG, (if waveguide interface)	5

APPENDIX 12.5

COCERAGE MAPS 32 & 33 FOR PROPOSED NFD AND NPD RADIO SYSTEM

UHF Talkout Portable on Hip



UHF Talkback Portable on Hipp

Charles River State

Needham Junction

RTS - 180'

PDHQ

Needham

Dunster WT - 85'

Needham Heights

Birds Hill

Birds Hill WT

Belmont Park

Wellesley Hills

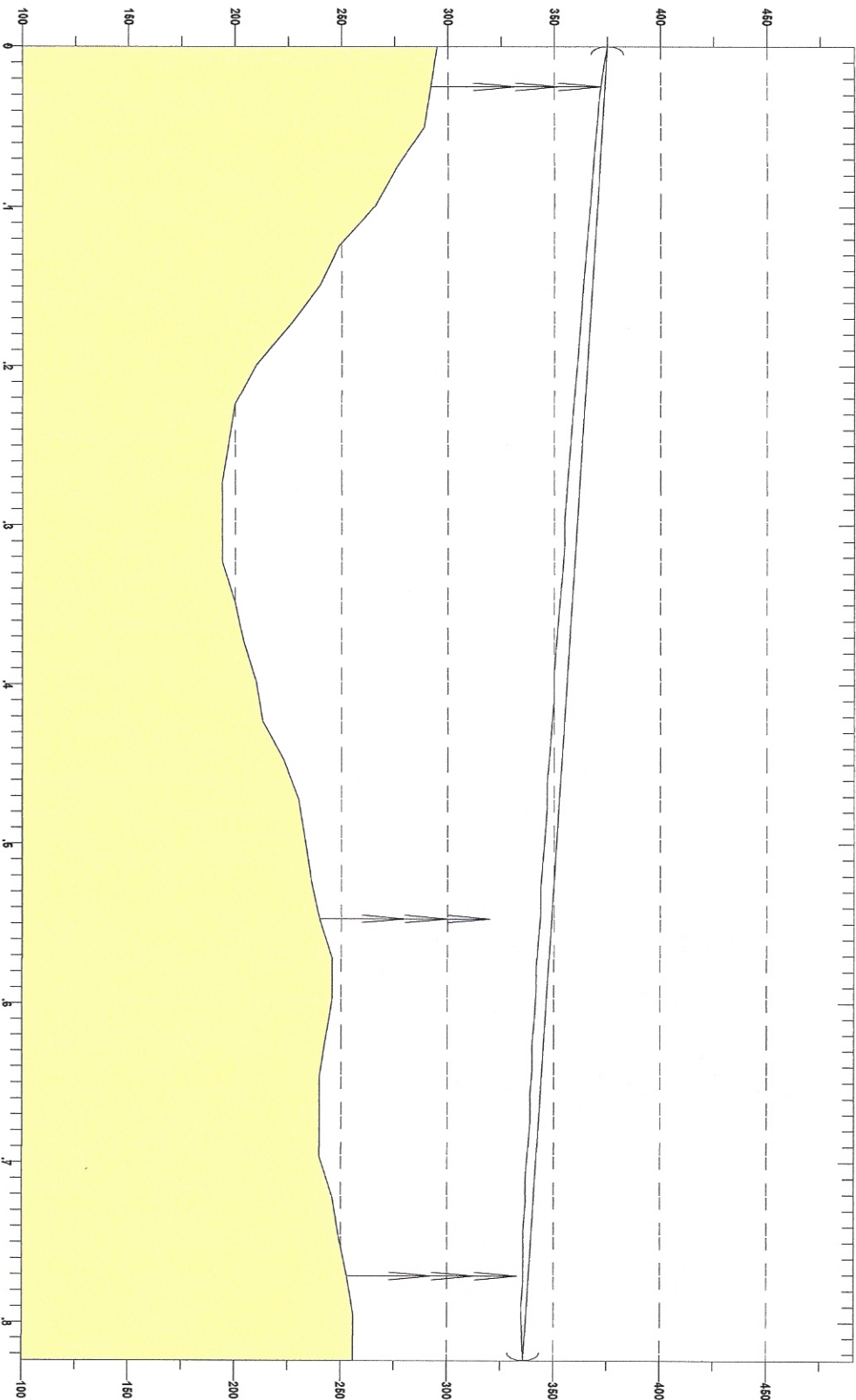
Cambridge

Wellesley

Newton Upper Falls

Path Distance: 0.824 mi.
Tx LOS Path Inclination: -0.5183 deg.

Tx LOS Path Inclination: 0.5183 deg.



Birds Hill 42° 16' 56.50" N

071° 12' 59.40" W

Elevation 295.3 ft.

Ant. AGL - Tx/Rx/Div

Frequency - Tx 80.0/80.0/0.0 ft.

Frequency - Tx 11500.00000 MHz

Azimuth 319.512 deg T

Dunster 42° 17' 29.20" N

071° 13' 37.00" W

Elevation 255.9 ft.

Ant. AGL - Tx/Rx/Div

Frequency - Tx 80.0/80.0/0.0 ft.

Frequency - Tx 11500.00000 MHz

Azimuth 139.505 deg T

KEY:

Profile

K = 4/3

K = 4/3, F = 0.6F1

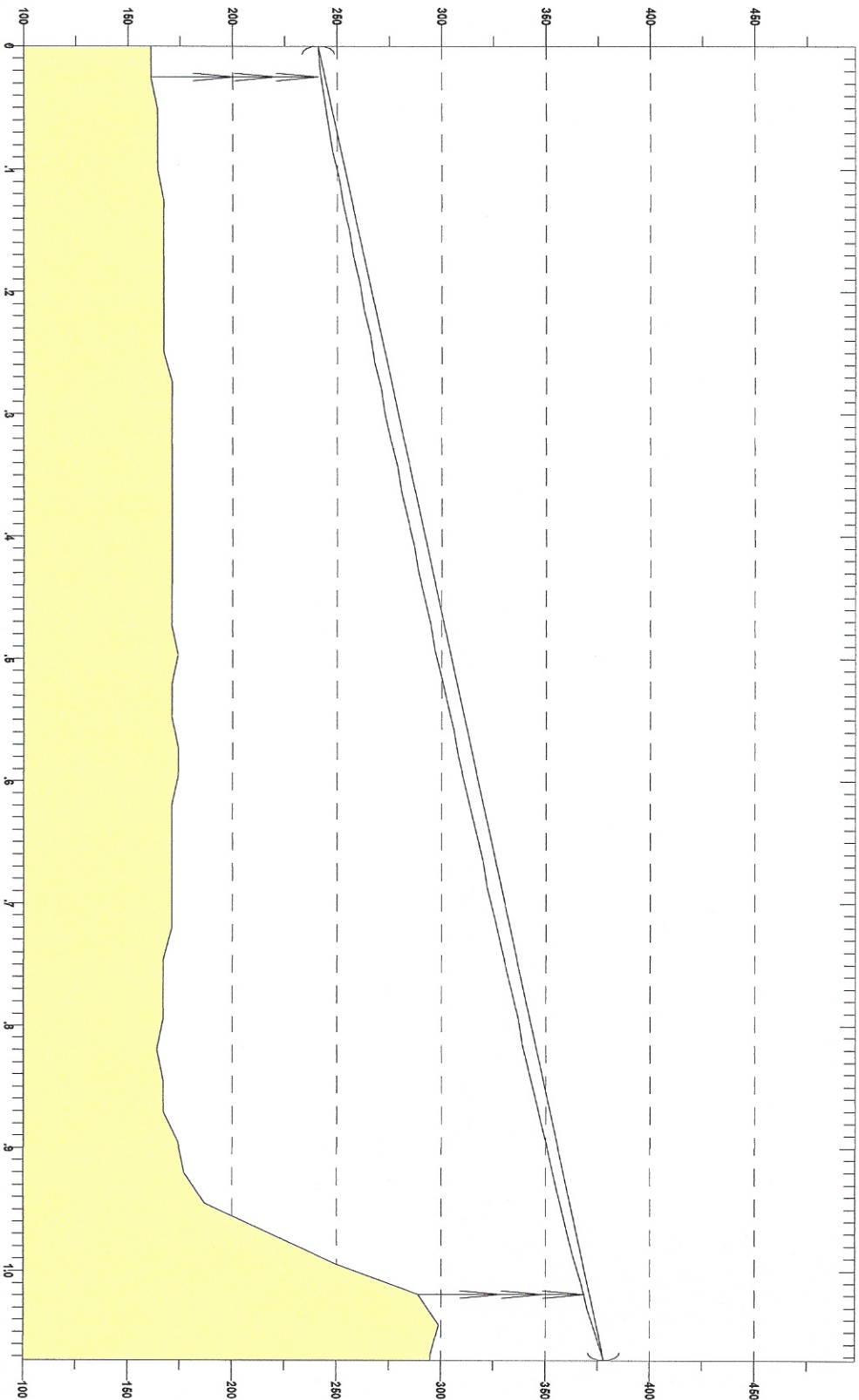
80'

80'

M/1

Path Distance: 1.073 mi.
Tx LOS Path Inclination: 1.3912 deg.

Tx LOS Path Inclination: -1.3912 deg.



PD/FD HQ
42° 16' 42.13" N
071° 14' 12.20" W
Elevation 160.8 ft.
Ant. AGL - Tx/Rx/Div 80.0/80.0/0.0 ft.
Frequency - Tx 11500.00000 MHz
Azimuth 075.108 deg T

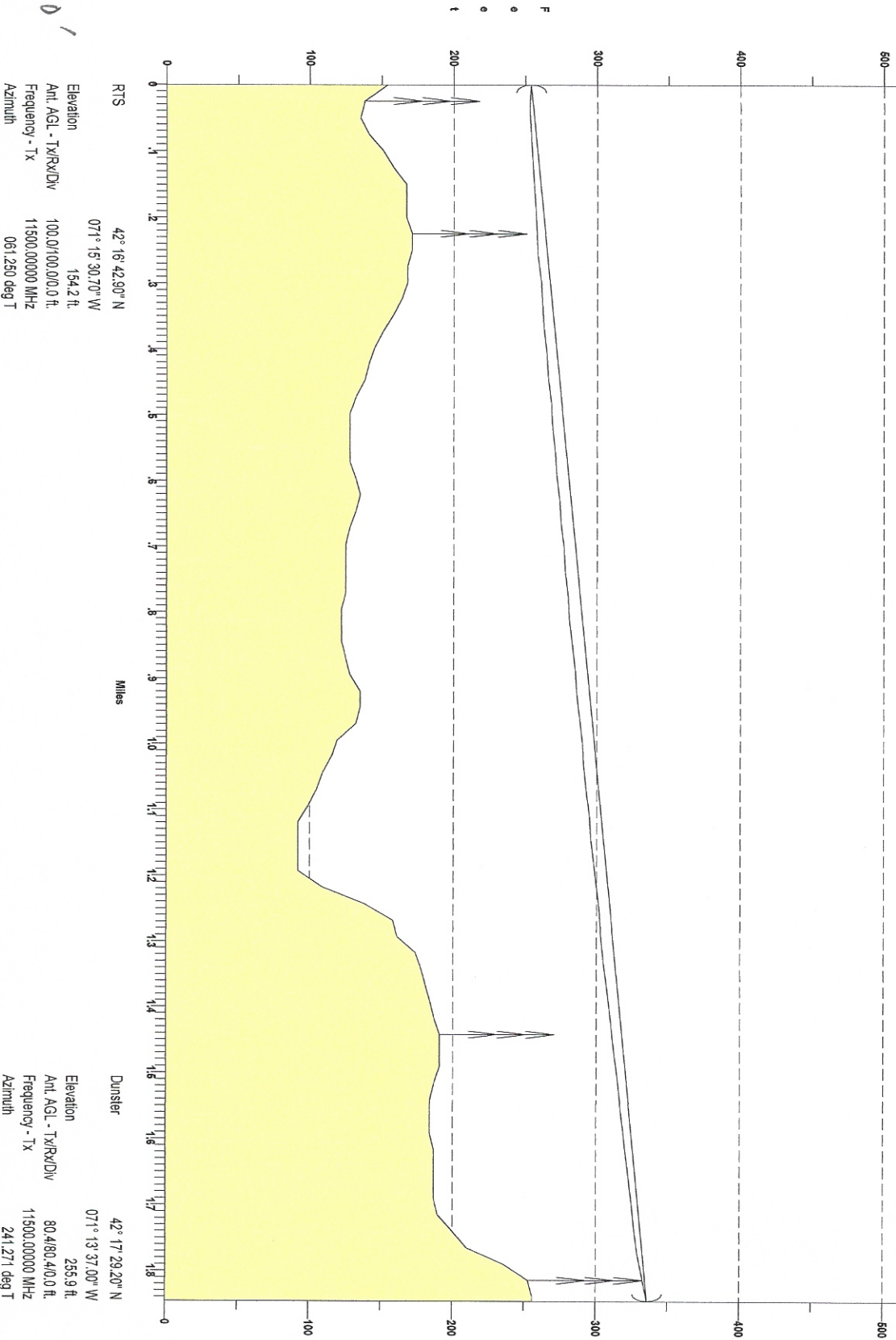
Birds Hill
42° 16' 56.50" N
071° 12' 59.40" W
Elevation 295.3 ft.
Ant. AGL - Tx/Rx/Div 83.3/83.3/0.0 ft.
Frequency - Tx 11500.00000 MHz
Azimuth 255.122 deg T

KEY: Profile
K = 4/3 K = 4/3, F = 0.6°F1

M3

Path Distance: 1.346 mi.
Tx LOS Path Inclination: 0.4803 deg.

Tx LOS Path Inclination: -0.4803 deg.



KEY: Profile
K = 4/3 K = 4/3, F = 0.8°F1

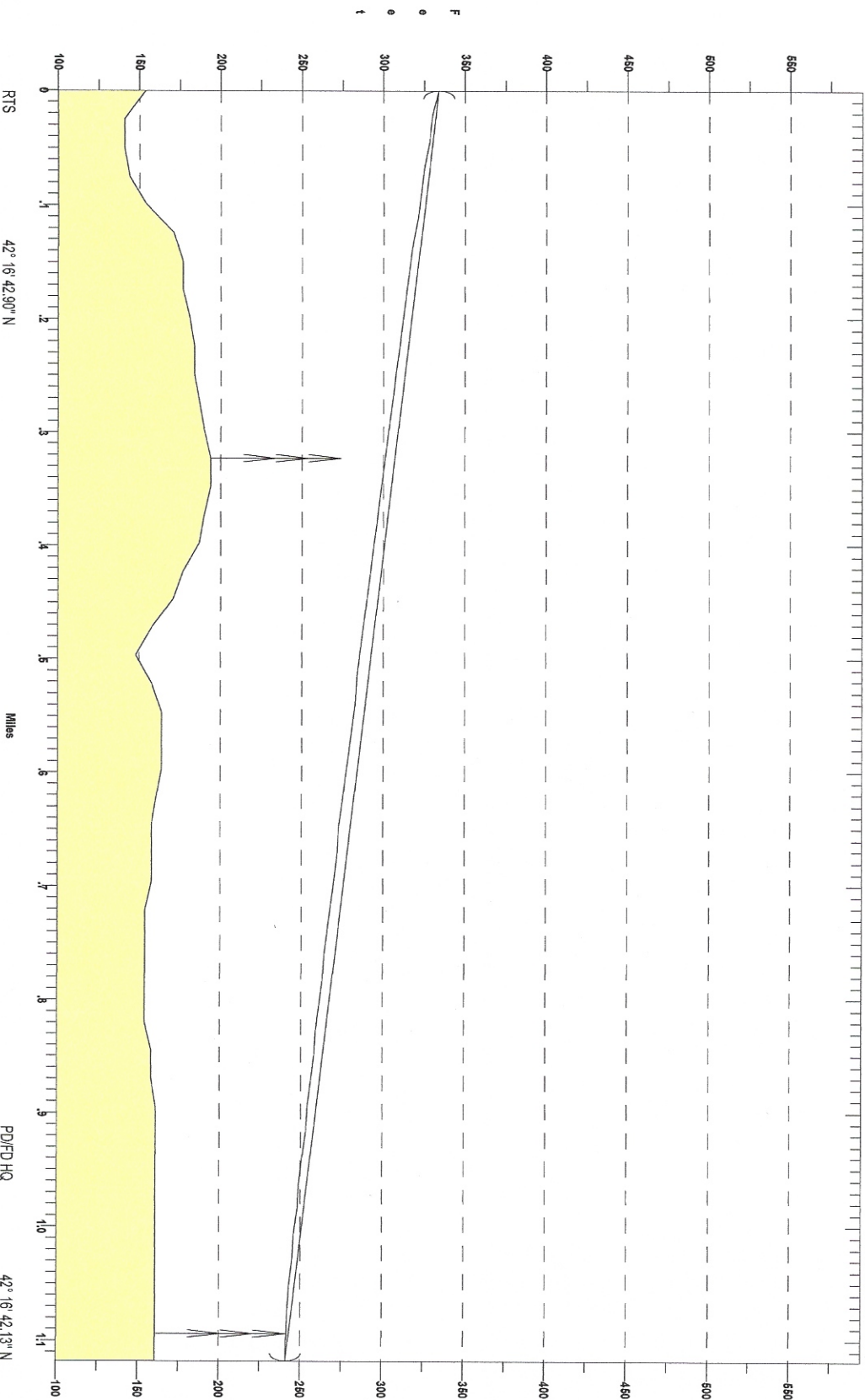
100'

81'

1094

Path Distance: 1.118 mi.
Tx LOS Path Inclination: -0.907 deg.

Tx LOS Path Inclination: 0.807 deg.



RTS 42° 16' 42.90" N
071° 15' 30.70" W
Elevation 154.2 ft.
Ant. AGL - Tx/Rx/Div 180.0/180.0/0.0 ft.
Frequency - Tx 11500.00000 MHz
Azimuth 090.749 deg T

PD/FD HQ 42° 16' 42.13" N
071° 14' 12.20" W
Elevation 160.8 ft.
Ant. AGL - Tx/Rx/Div 80.0/80.0/0.0 ft.
Frequency - Tx 11500.00000 MHz
Azimuth 270.764 deg T

KEY: Profile
K = 4/3 K = 4/3, F = 0.6*F1

180'

86'

196

APPENDIX 12.6

CAPITAL PLANNING BUDGET ESTIMATE DETAIL FOR MAPS 32 & 33 RADIO SYSTEM

**Town of Needham
Radio System Improvement
Planning Budget Estimate**

Description		Unit-\$ Low	Unit-\$ High	NPD CC	NPD CC & Watch Room	NPD/NPD Equip Room & Art Mt	EOC	Birds Hill	Dunster	I-95 Area Receive Site TBD	North Hills	RTS	NPD Station 1	NPD Station 2	Qty	Ext-\$ Low w/Services	Ext-\$ High w/Services
1.3																	
IP Dispatch Console Position w/Gateways		\$ 78,000	\$ 97,500	4	2										6	\$ 468,000	\$ 585,000
Fire Repeater w/IP Interface (A/P25) w/Antenna		\$ 15,600	\$ 19,500			1		1	1			1			4	\$ 62,400	\$ 78,000
Police Repeater w/IP Interface (A/P25) w/Antenna		\$ 15,600	\$ 19,500			1		1	1			1			4	\$ 62,400	\$ 78,000
Simulcast & Backhaul Network Switches		\$ 23,400	\$ 29,400			1		1	1			1			4	\$ 78,000	\$ 93,600
GPS Receiver Timing System w/Antenna		\$ 9,100	\$ 11,700			1		1	1			1			4	\$ 36,400	\$ 46,800
Fire Compactor - Analog		\$ 6,500	\$ 9,100			1									1	\$ 6,500	\$ 9,100
Fire Compactor - P25		\$ 13,000	\$ 15,600			1									1	\$ 13,000	\$ 15,600
Police Compactor - Analog		\$ 6,500	\$ 9,100			1									1	\$ 6,500	\$ 9,100
Police Compactor - P25		\$ 13,000	\$ 15,600			1									1	\$ 13,000	\$ 15,600
Site Monitoring System		\$ 6,500	\$ 9,100	1		1		1	1			1			5	\$ 32,500	\$ 45,500
Fire Receiver w/Antenna		\$ 10,400	\$ 13,000												0	\$ -	\$ -
Police Receiver w/Antenna		\$ 10,400	\$ 13,000												0	\$ -	\$ -
Microwave/Fiber Termination Equipment for IP		\$ 3,900	\$ 5,200			1		1	1			1			4	\$ 15,600	\$ 20,800
Microwave IP w/Antenna		\$ 15,600	\$ 19,500			2		2	2			2			8	\$ 124,800	\$ 156,000
Tower 180 Ft Self Supporting Lattice - Standard Foundation & Fence		\$ 234,000	\$ 260,000									1			1	\$ 234,000	\$ 260,000
AM Detuning System for RTS		\$ 26,000	\$ 39,000									1			1	\$ 26,000	\$ 39,000
Existing Site/Tower Modifications, SE Analysis Etc.		\$ 19,500	\$ 26,000					1	1						2	\$ 39,000	\$ 52,000
Equipment Shelter for Tx/Rx w/HVAC		\$ 45,500	\$ 52,000						1			1			2	\$ 91,000	\$ 104,000
Generator Diesel - 15KW & Auto Transfer Switch		\$ 19,500	\$ 23,400									1			1	\$ 19,500	\$ 23,400
UPS/Battery		\$ 3,250	\$ 4,550					1	1			1			3	\$ 9,750	\$ 13,650
MetroFire UHF Rmt Control Stations 1, 2 & 3 w/Antenna		\$ 6,500	\$ 9,100			3									3	\$ 19,500	\$ 27,300
State 800 Mhz Rmt Control Station w/Antenna		\$ 6,500	\$ 9,100			1									1	\$ 6,500	\$ 9,100
BAPERN Special Rmt Control Station w/Antenna		\$ 32,500	\$ 35,100			1									1	\$ 32,500	\$ 35,100
BAPERN Central Rmt Control Station w/Antenna		\$ 6,500	\$ 9,100			1									1	\$ 6,500	\$ 9,100
BAPERN South Rmt Control Station w/Antenna		\$ 6,500	\$ 9,100			1									1	\$ 6,500	\$ 9,100
Backup Basic Control Station w/Antenna		\$ 2,340	\$ 2,600	1	1										2	\$ 4,680	\$ 5,200
Remove Obsolete Equipment		\$ 650	\$ 650	2	2			1	1						8	\$ 5,200	\$ 5,200
FCC License Modifications		\$ 3,000	\$ 3,000			1									1	\$ 3,000	\$ 3,000
Critical Spare Equipment															1	\$ 3,000	\$ 3,000
Planning Contingency															5%	\$ 70,987	\$ 87,268
Infrastructure Subtotal															10%	\$ 149,372	\$ 183,551
																\$ 1,643,088	\$ 2,019,064
EOC NPD UHF Basic Control Station w/Antenna		\$ 2,340	\$ 2,600			1									1	\$ 2,340	\$ 2,600
EOC NPD UHF Basic Control Station w/Antenna		\$ 2,340	\$ 2,600			1									1	\$ 2,340	\$ 2,600
EOC DPW UHF Basic Control Station w/Antenna		\$ 2,340	\$ 2,600			1									1	\$ 2,340	\$ 2,600
EOC Radio Console Modification for Reuse		\$ 650	\$ 975												1	\$ 650	\$ 975
VHF Emergency Mgt Base Station w/Antenna		\$ 7,800	\$ 10,400			1									1	\$ 7,800	\$ 10,400
VHF Portable Radio Cache		\$ 1,040	\$ 1,040												6	\$ 6,240	\$ 6,240
Siz-Unit Battery Charger		\$ 650	\$ 780			1									1	\$ 650	\$ 780
VHF Mobile Radio Cache w/Antenna		\$ 1,040	\$ 1,040			6									6	\$ 6,240	\$ 6,240
Planning Contingency															10%	\$ 2,860	\$ 3,214
EOC Subtotal																\$ 31,460	\$ 35,679
*Fire Portables UHF w/Vehicle Charger - Analog/P25		\$ 3,500	\$ 3,500												16	\$ 56,000	\$ 56,000
*Fire Mobiles UHF - Analog/P25		\$ 4,000	\$ 4,000												13	\$ 52,000	\$ 52,000
Fire Basic Control Station UHF - Analog/P25 w/PA I/F		\$ 2,000	\$ 2,000										1		2	\$ 4,000	\$ 4,000
Police Portables Dual UHF & 700/800 - Analog/P25		\$ 5,000	\$ 5,000												75	\$ 375,000	\$ 375,000
Police Mobiles Dual UHF & 700/800 - Analog/P25		\$ 5,500	\$ 5,500												18	\$ 99,000	\$ 99,000
Encryption Key Loader		\$ 5,000	\$ 5,000												2	\$ 10,000	\$ 10,000
Planning Contingency															10%	\$ 59,600	\$ 59,600
Subscriber Radio Subtotal																\$ 655,600	\$ 655,600
PROJECT TOTAL																\$ 2,330,148	\$ 2,710,342
Vendor Services Estimate for Engineering, Project Management, Installation, Optimization, Testing, Training & Warranty																*Fire Radios: 18 Ordered: 5 Net: 13	Mobiles 38 22 16

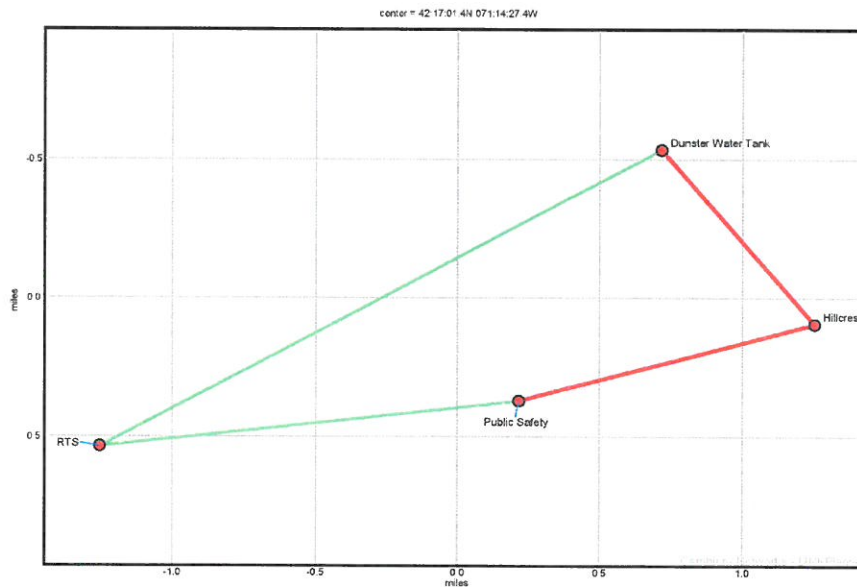


Town of Needham Public Safety Microwave Network survey Report

After completing the survey Cyber Communications has determined that that the proposed public safety communications network is possible if the the following criteria are meet.

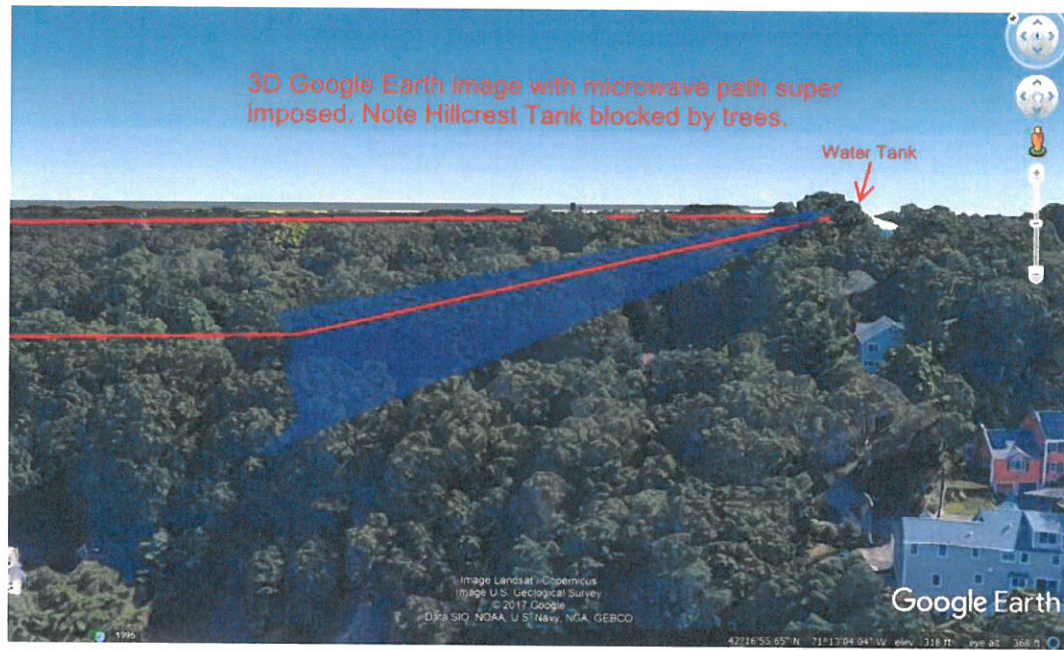
The Needham public safety microwave network requires the following antenna center lines for high reliability

HQ (Public Safety) = 110 feet
Birds Hill (Hillcrest) = 100 feet
Dunster St. = 100 feet
RTS = 200 feet





Google Earth 3D view of Hillcrest Tank

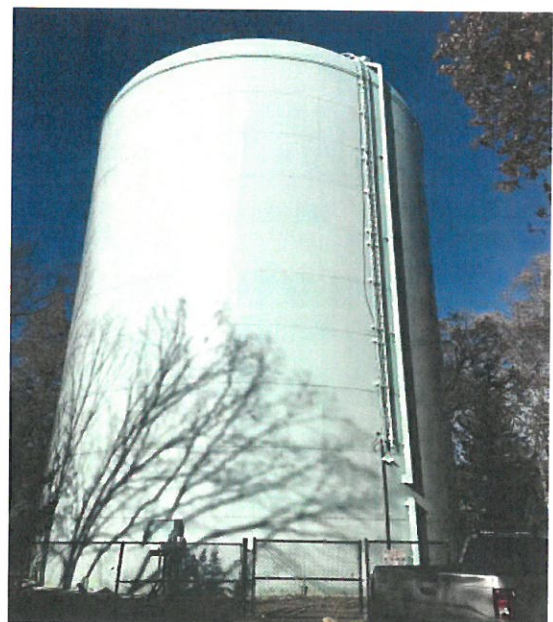
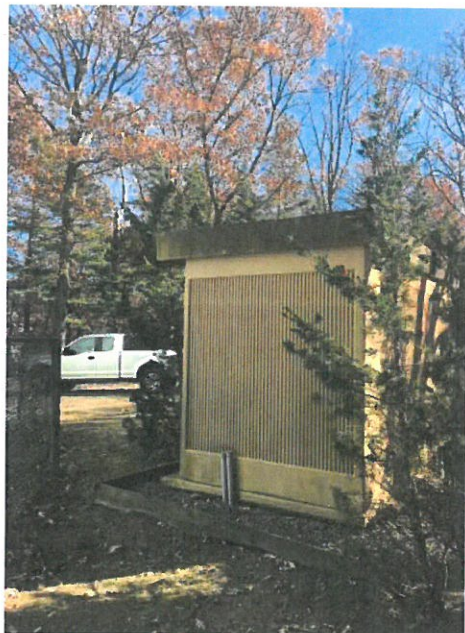


Drone view of Hillcrest Tank



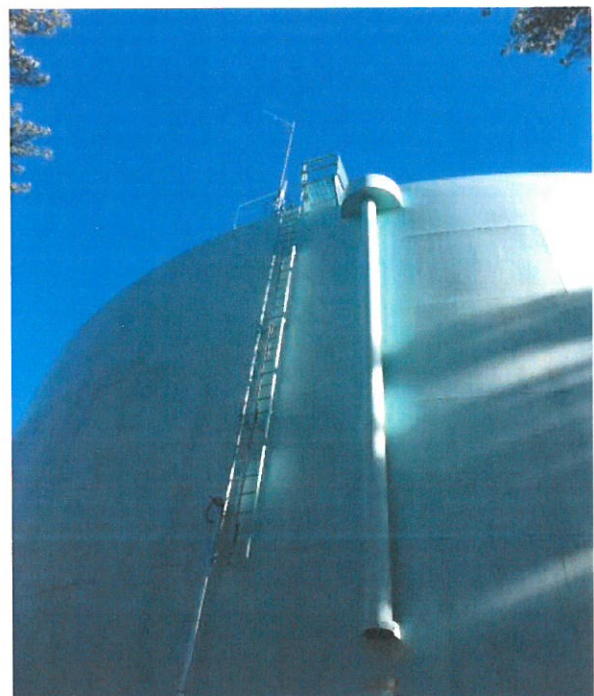
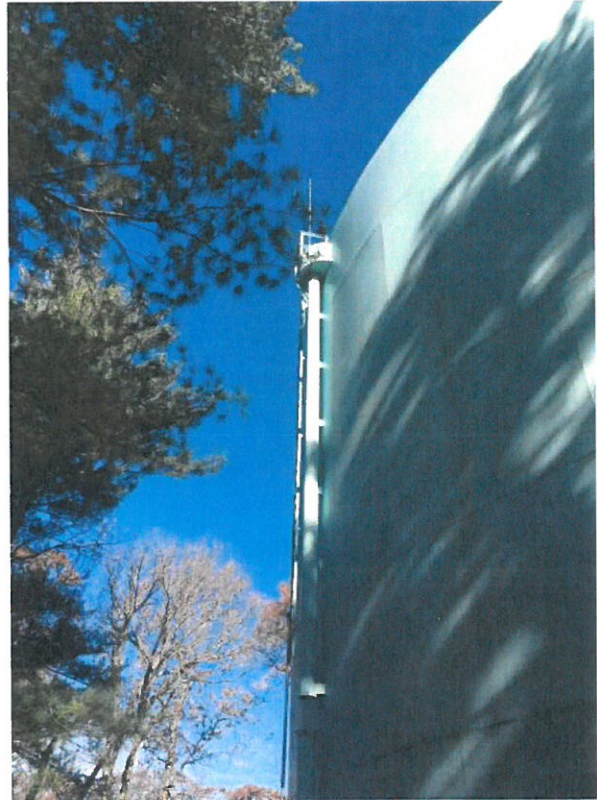
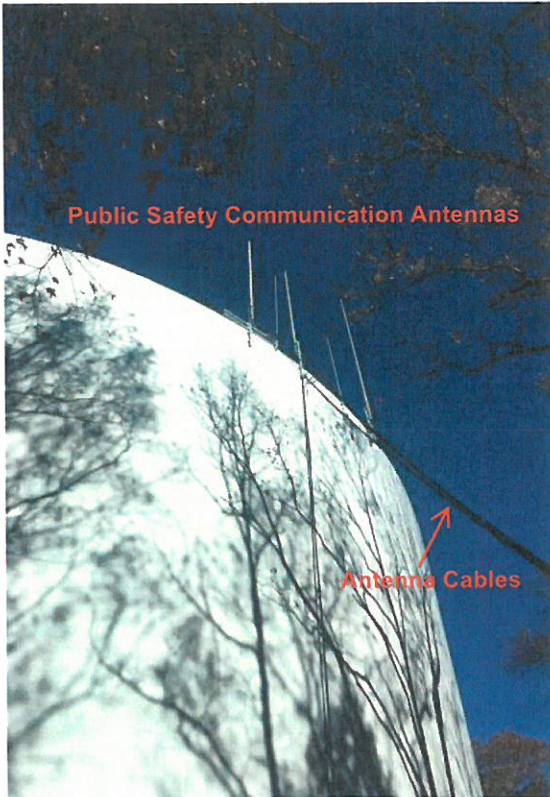


Dunster St Tank view from 100' @ Police Station





Hillcrest Street Water Tank



The cables running into the shelter are installed on a messenger cable and are subjected to the stress of movement during windy conditions, shortening usable life and causing possible communication issues. Also the cables installed like this act as a path for rain water egress into the shelter.



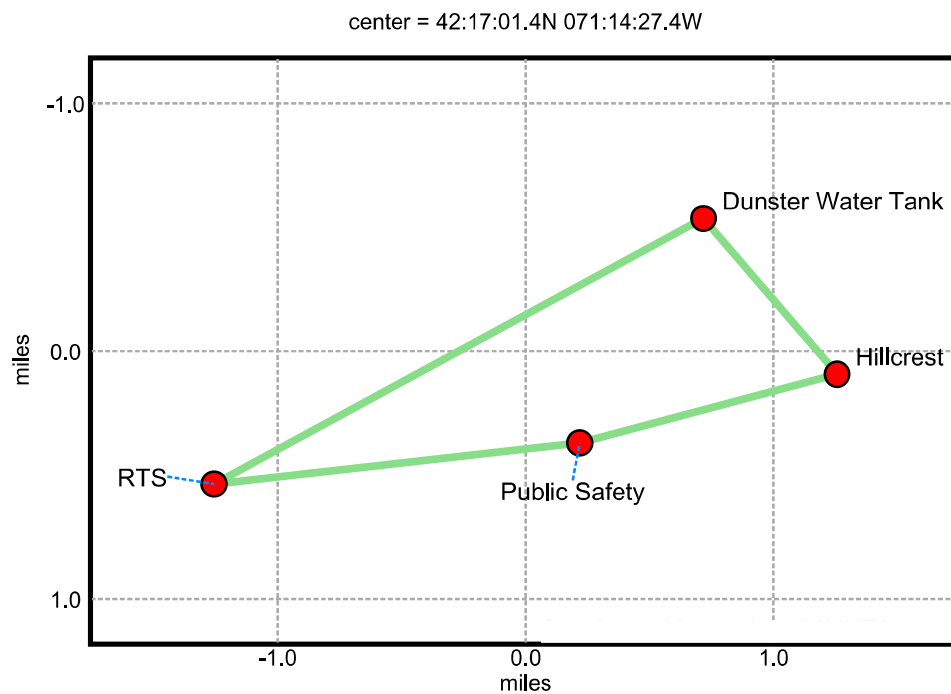
Town of Needham

Public Safety Communications Network

Microwave Link Engineering Report

05 January 2018

Jeffrey Boles
Organization: Cyber Communications Inc
Phone: 978-317-4570
Email: jboles@cybercomminc.com



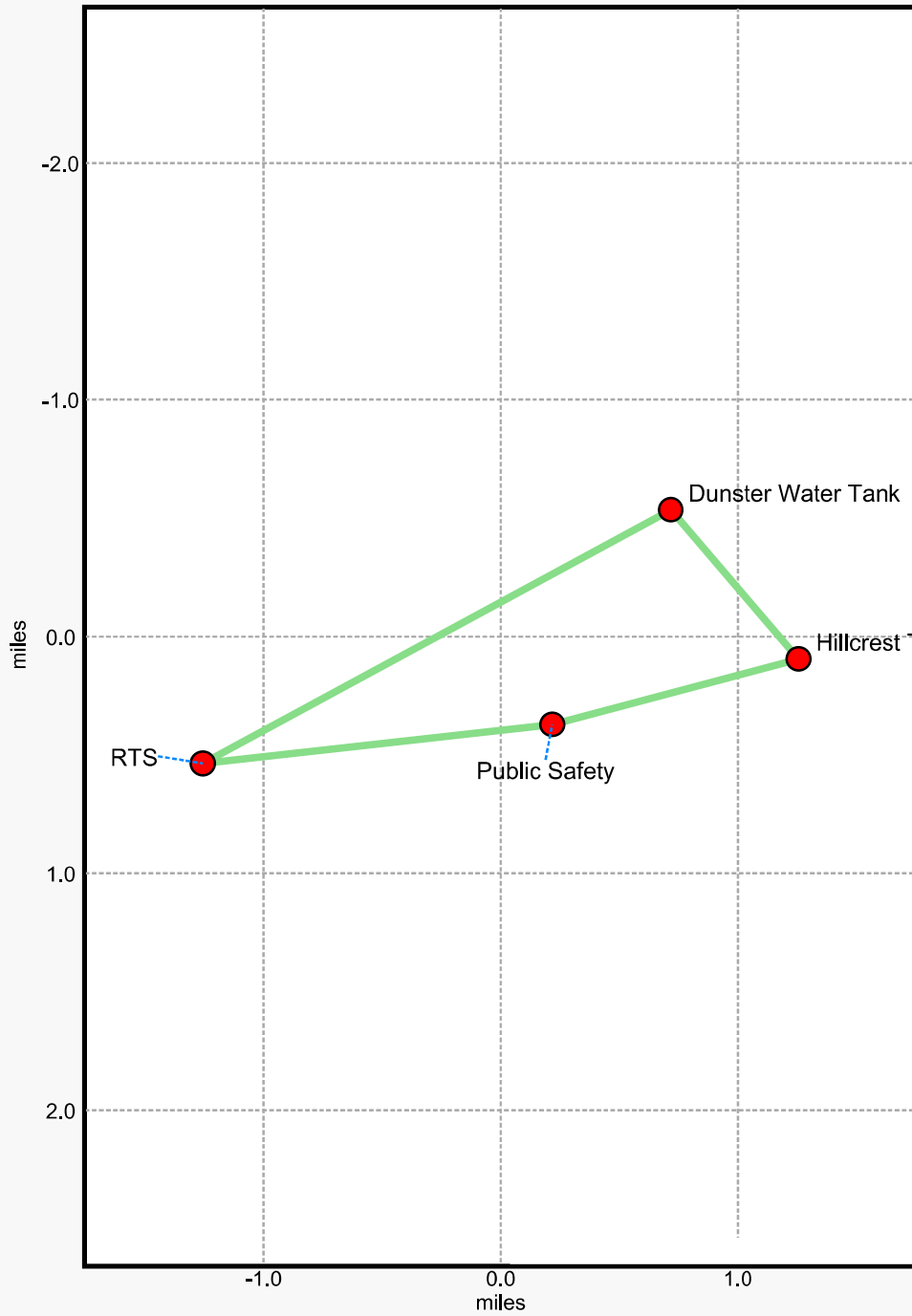
1. Project Summary

Project: Needham Police & Fire_1-5-2018

General Information	
Customer Name	Town of Needham
Company Name	Police Department
Address	99 School St Needham, MA 02492
Phone	(781) 455-7570
Cell Phone	
Email	

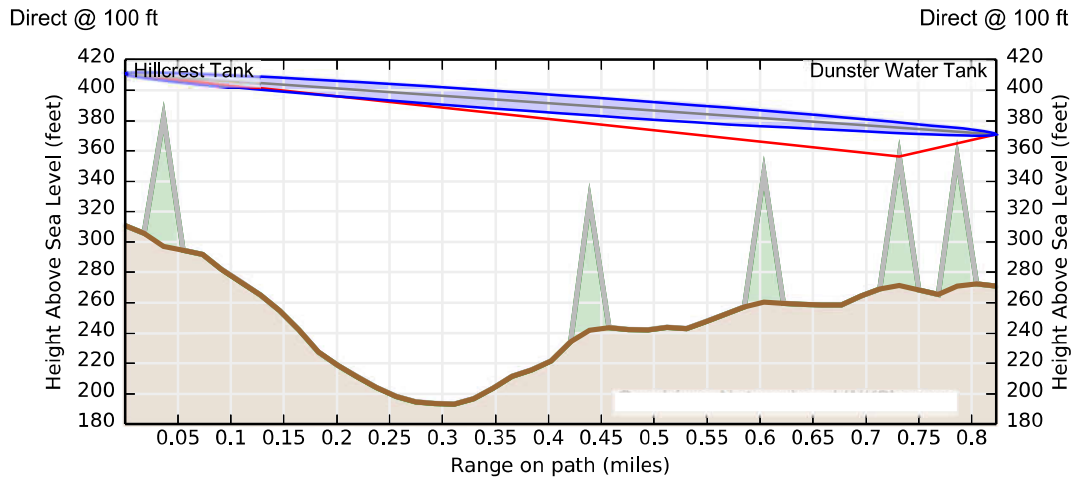
Network Map

center = 42:17:01.4N 071:14:27.4W





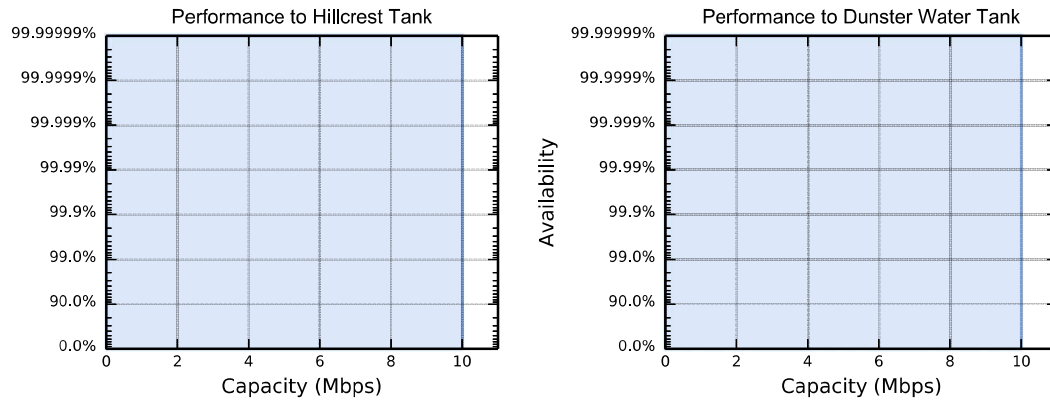
Hillcrest Tank to Dunster Water Tank



	Performance to Hillcrest Tank	Performance to Dunster Water Tank
Mean IP	10.0 Mbps	10.0 Mbps
IP Availability	100.0000 % for 10.0 Mbps	100.0000 % for 10.0 Mbps

Link Summary			
Link Length	0.823 mi.	System Gain	174.50 dB
Band	18 GHz	System Gain Margin	54.06 dB
Regulation	FCC	Mean Aggregate Data Rate	20.0 Mbps
Modulation	QPSK 0.86 (13.84 Mbps)	Annual Link Availability	100.0000 %
Bandwidth	10 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	120.44 dB	Prediction Model	ITU-R

Performance Charts

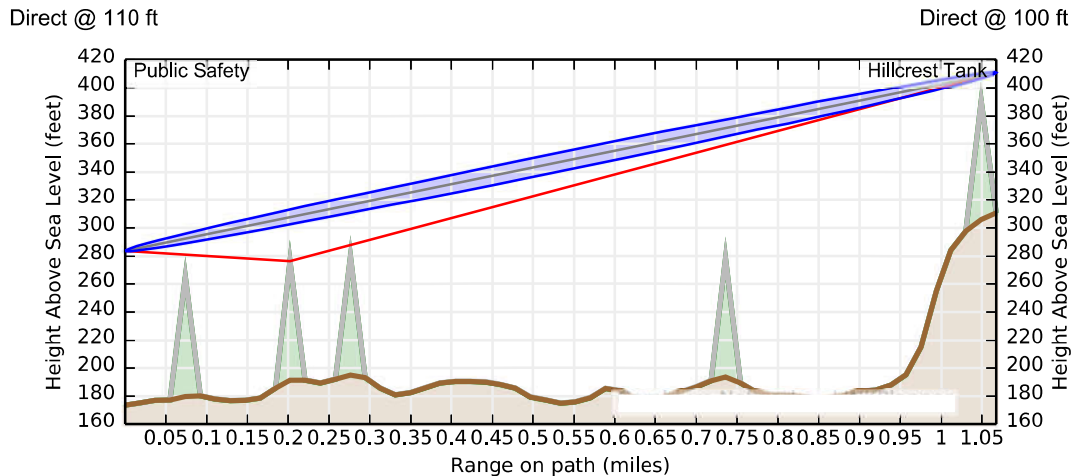


Climatic Factors, Losses and Standards

dN/dH not exceeded for 1% of time	-372.16 N units/km	Excess Path Loss	0.00 dB
Area roughness 110x110km	71.94 metre	Annual 2-way Availability	100.0000 %
Geoclimatic factor	2.73e-04	Annual 2-way Unavailability	0 secs/year
Fade Occurrence Factor (P0)	2.24e-06	Rain Availability	100.0000 %
Path inclination	9.21 mr	Rain Unavailability	0 secs/year
Value of K Exceeded for 99.99% (ke)	0.40	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Excess Path Loss at ke	0.00 dB	Diffraction Loss	ITU-R P.526-10
0.01% Rain rate	41.04 mm/hr	Propagation	ITU-R P.530-12
Free Space Path Loss	120.33 dB	Rain Rate	ITU-R P.837-5
Gaseous Absorption Loss	0.11 dB	Refractivity Index	ITU-R P.453-9
Profile Type	Line-of-Sight		



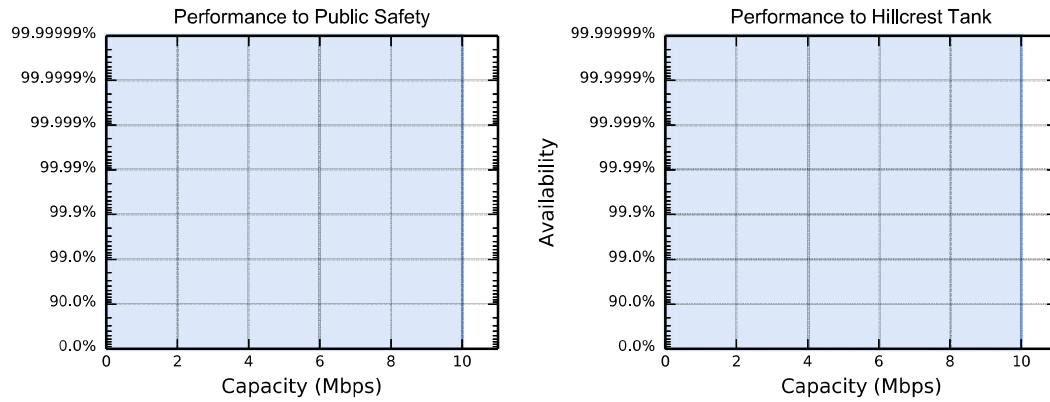
Public Safety to Hillcrest Tank



	Performance to Public Safety	Performance to Hillcrest Tank
Mean IP	10.0 Mbps	10.0 Mbps
IP Availability	100.0000 % for 10.0 Mbps	100.0000 % for 10.0 Mbps

Link Summary			
Link Length	1.067 mi.	System Gain	172.43 dB
Band	18 GHz	System Gain Margin	49.70 dB
Regulation	FCC	Mean Aggregate Data Rate	20.0 Mbps
Modulation	QPSK 0.80 (39.35 Mbps)	Annual Link Availability	100.0000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	122.73 dB	Prediction Model	ITU-R

Performance Charts

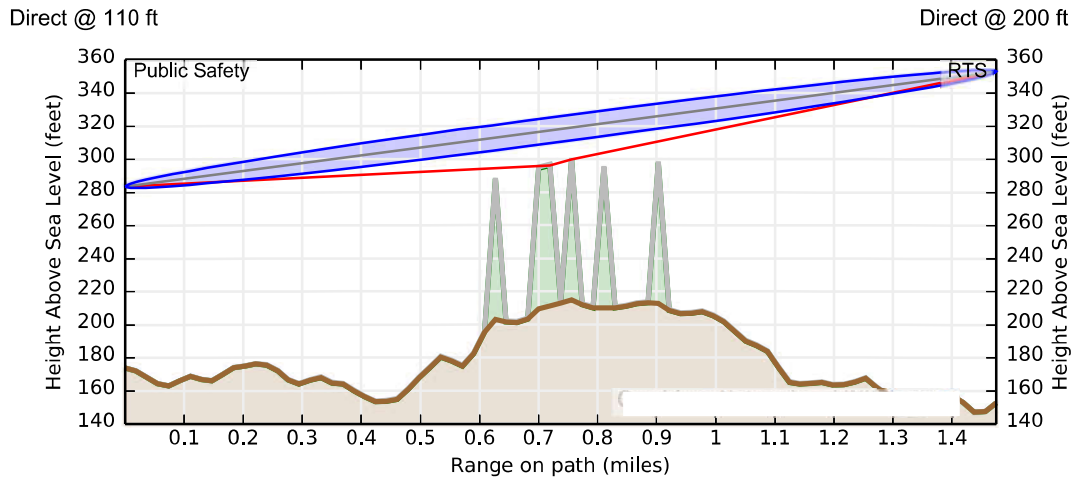


Climatic Factors, Losses and Standards

dN/dH not exceeded for 1% of time	-372.30 N units/km	Excess Path Loss	0.00 dB
Area roughness 110x110km	72.30 metre	Annual 2-way Availability	100.0000 %
Geoclimatic factor	2.73e-04	Annual 2-way Unavailability	0 secs/year
Fade Occurrence Factor (P0)	2.41e-06	Rain Availability	100.0000 %
Path inclination	22.54 mr	Rain Unavailability	0 secs/year
Value of K Exceeded for 99.99% (ke)	0.40	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Excess Path Loss at ke	0.00 dB	Diffraction Loss	ITU-R P.526-10
0.01% Rain rate	41.06 mm/hr	Propagation	ITU-R P.530-12
Free Space Path Loss	122.58 dB	Rain Rate	ITU-R P.837-5
Gaseous Absorption Loss	0.15 dB	Refractivity Index	ITU-R P.453-9
Profile Type	Line-of-Sight		



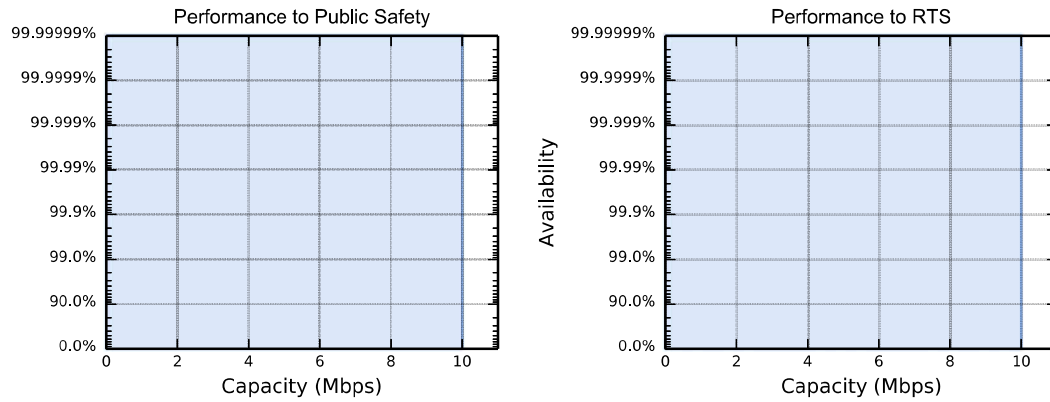
Public Safety to RTS



	Performance to Public Safety	Performance to RTS
Mean IP	10.0 Mbps	10.0 Mbps
IP Availability	100.0000 % for 10.0 Mbps	100.0000 % for 10.0 Mbps

Link Summary			
Link Length	1.475 mi.	System Gain	175.43 dB
Band	18 GHz	System Gain Margin	49.84 dB
Regulation	FCC	Mean Aggregate Data Rate	20.0 Mbps
Modulation	QPSK 0.80 (39.35 Mbps)	Annual Link Availability	100.0000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	125.59 dB	Prediction Model	ITU-R

Performance Charts

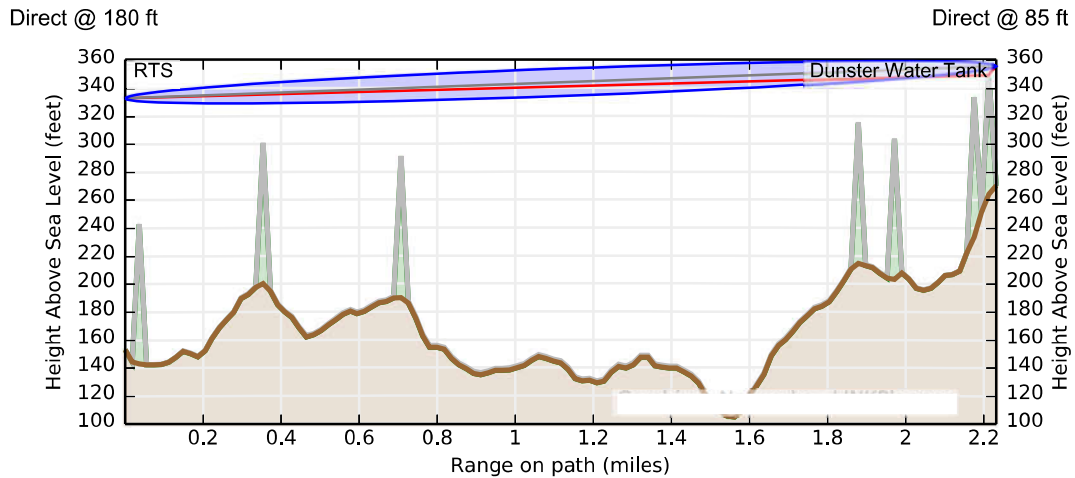


Climatic Factors, Losses and Standards

dN/dH not exceeded for 1% of time	-370.44 N units/km	Excess Path Loss	0.00 dB
Area roughness 110x110km	75.51 metre	Annual 2-way Availability	100.0000 %
Geoclimatic factor	2.65e-04	Annual 2-way Unavailability	0 secs/year
Fade Occurrence Factor (P0)	1.52e-05	Rain Availability	100.0000 %
Path inclination	8.89 mr	Rain Unavailability	0 secs/year
Value of K Exceeded for 99.99% (ke)	0.40	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Excess Path Loss at ke	0.00 dB	Diffraction Loss	ITU-R P.526-10
0.01% Rain rate	41.07 mm/hr	Propagation	ITU-R P.530-12
Free Space Path Loss	125.39 dB	Rain Rate	ITU-R P.837-5
Gaseous Absorption Loss	0.20 dB	Refractivity Index	ITU-R P.453-9
Profile Type	Line-of-Sight		



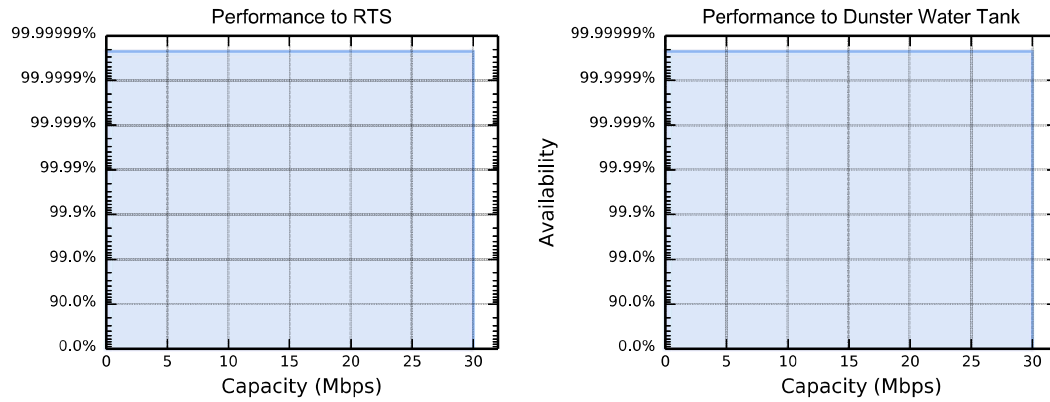
RTS to Dunster Water Tank



	Performance to RTS	Performance to Dunster Water Tank
Mean IP	30.0 Mbps	30.0 Mbps
IP Availability	100.0000 % for 30.0 Mbps	100.0000 % for 30.0 Mbps

Link Summary			
Link Length	2.232 mi.	System Gain	178.93 dB
Band	18 GHz	System Gain Margin	49.63 dB
Regulation	FCC	Mean Aggregate Data Rate	60.0 Mbps
Modulation	QPSK 0.80 (39.35 Mbps)	Annual Link Availability	100.0000 %
Bandwidth	30 MHz	Annual Link Unavailability	7 secs/year
Total Path Loss	129.30 dB	Prediction Model	ITU-R

Performance Charts



Climatic Factors, Losses and Standards

dN/dH not exceeded for 1% of time	-370.31 N units/km	Excess Path Loss	0.00 dB
Area roughness 110x110km	75.21 metre	Annual 2-way Availability	100.0000 %
Geoclimatic factor	2.65e-04	Annual 2-way Unavailability	0 secs/year
Fade Occurrence Factor (P0)	1.81e-04	Rain Availability	100.0000 %
Path inclination	1.93 mr	Rain Unavailability	7 secs/year
Value of K Exceeded for 99.99% (ke)	0.40	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Excess Path Loss at ke	0.00 dB	Diffraction Loss	ITU-R P.526-10
0.01% Rain rate	41.04 mm/hr	Propagation	ITU-R P.530-12
Free Space Path Loss	128.99 dB	Rain Rate	ITU-R P.837-5
Gaseous Absorption Loss	0.31 dB	Refractivity Index	ITU-R P.453-9
Profile Type	Line-of-Sight		