City of Valdez – Radio Infrastructure Upgrade Audit

City of Valdez – Site Visit Audit/Report Performed by:
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Prepared for
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CITY OF VALDEZ, ALASKA
OPPORTUNITIES IN EVERY SEASON

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Executive Summary

New Horizons is pleased to provide The City of Valdez (The City) with our engineered assessment of the radio network infrastructure. Included is a detailed summary of the recommended upgrades and coverage analysis available to The City. The network infrastructure assessments are based on the initial site visit performed on 10/19/2021; this audit does not reflect any possible changes made thereafter.

To assist the City of Valdez with planning improvements, New Horizons recommends a phased approach to improving the Public Safety two-way radio network. Initially, there are some relatively easy first steps. A review of all antennas and the attendant grounding systems utilizing a power monitoring system[1] will ensure all systems are in peak operating condition. The tracing of all cabling between radios input/output is suggested to look for any visual damage, improperly weatherized connections, proper grounding and radio to antenna diagraming purposes.

All antennas and associated cabling should be swept using a Time Domain Reflectometer (TDR) to look for any electrical discontinuities or damage that a visual inspection cannot see.

Once antenna and grounding inspection is complete, The City can look into new improvements, like new repeaters to cover the 10 Mile corridor; possible collocations with the Keystone and Ptarmigan Trans Alaska Pipeline System microwave sites to augment the State of Alaska's ALMR regional system.

Additionally, leased circuits or The City-owned point-to-point microwave systems can be investigated in an effort to increase reliability and access to the remote communications assets, centralizing monitoring, control and management of the equipment.

Another vital step in improving the radio network will be getting a review of the Motorola System configuration by the responsible Motorola Systems entity, including the vehicle mobile and handheld units and the radios located at the Dispatch Center in City Hall ensuring all systems meet the needs of the departments operating each system.

Once a review of the Motorola system is accomplished, relocating the four radios at the Dispatch Center to a different location (e.g., the Grain Silos) could improve the overall coverage of the system.

Improving the Signal

Antenna and Ground System Inspections

The antennas and ground systems should be tested at all locations to ensure that no antennas are broken and all grounding connections are made. If not, the "incomplete system" causes improper radio radiation. The ground systems need to follow industry standard practices, protecting equipment, personnel and minimizing the noise in the antenna system. As part of this effort, power monitoring systems[1] can be put in place reporting on radio transmit power and reflected power alerting indicators when a cable, cable connections or antennas are damaged.

City Hall

Sweep Antenna Systems

The first task that can be performed is to sweep all antennas from the radio connection to the antenna with a Time Domain Reflectometer (TDR). A TDR sends a signal to the antenna and registers the reflected energy coming back, indicating if the cable, connectors or antennas are damaged. Antennas go bad from years of use and the vibration caused by higher winds, causing connectors to become loose, corrode or create a kink/break in the cable (if under tension.) Additionally, the trace can accurately report the length of the cable run and location of connectors. Loose or corroded connectors, damaged cable and damaged antennas can drastically impact the transmit and receive performance.

[1] https://www.emrcorp.com/cart/store?section=product&product=1292&name=Internet_Power_Monitor_Model_iPM-1_Includes_Power_Sensor_and_Cable

Figure 1 - Anritsu Site Master S331L

Antenna Spacing

Antenna-to-antenna isolation is particularly important in a radio network such as this, preventing a collocated transmitter and receiver from “swamping” the receiver with the transmitter energy. To provide the necessary antenna-to-antenna isolation and reduce interference for omnidirectional antennas, the rule of thumb for antennas operating in the same frequency band is horizontal spacing of 3 wavelengths.

At a nominal 150 MHz; 3 wavelengths is 20 ft. This can be accomplished on the penthouse by spacing the existing antennas to the East along the upper part of the penthouse.

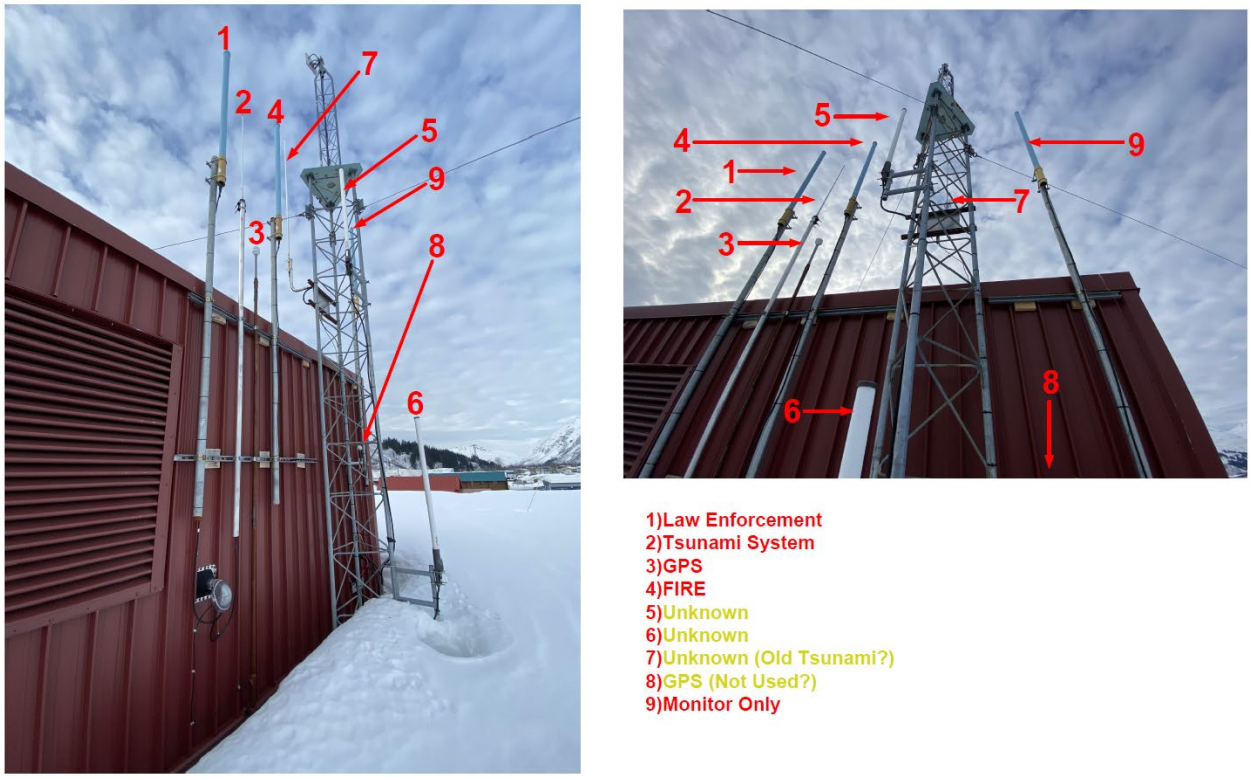


Figure 2 - Existing City Hall Antennas

We recommend leaving the existing Fire antenna where it is and moving the Law Enforcement antenna to the Northeast corner of the penthouse.

The Tsunami warning system operates in the 450 MHz UHF band. So, will not cause problems with the VHF, Fire and Law Enforcement antennas.

The GPS is receive only, and operates above 1,000 MHz; so, it should not cause any interference with the other systems and adversely the other systems should not be impacting the GPS receiver.

The Monitor antenna could be moved to the top of the tower, or at least the Northwest corner of the penthouse. If the Northwest corner is used the tower could be removed entirely.

All unused or possibly unknown antennas and cabling should be removed.

Prior to the upgraded antenna configuration, the tower will need to be evaluated for structural adequacy. The new loading design will affect the tower and its attachment to the roof and guy anchors. Also, antennas attachments to the penthouse will need structural evaluation and design.

Improve System Grounding

The target for resistance to ground for these radios systems is 10 ohms. A proper connection to ground was not observed for either of the penthouse ground bars. Resistance to ground should be measured from the ground bar located on the side of the penthouse. All antenna support steel should be grounded including tower guy wires, pipe mounts, and uni-strut. A measurement of resistance to ground should be made when grounding the penthouse ground bar to the building steel. Paint, galvanizing and other contaminants between the grounding lugs and building steel can increase the system resistance to ground causing unwanted electrical noise in the systems.

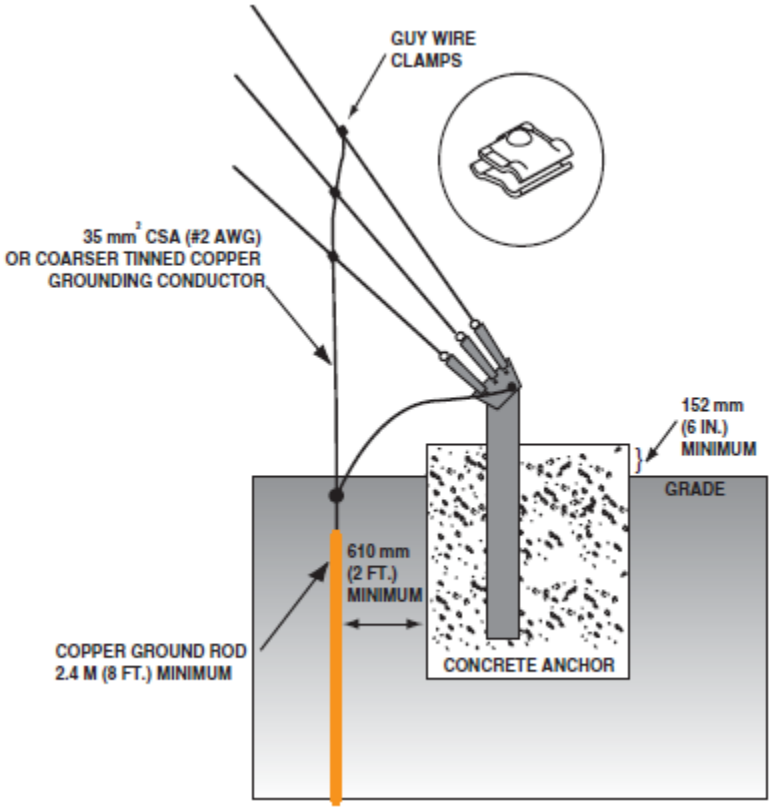


Figure 3 - Grounding Guy Wires and Anchors

Figure 4 - Penthouse Internal Ground Bar

Either the external or internal penthouse ground bar should be removed as only one ground bar is required. The more connections there are, the more failure points the system has. There should be one ground bar at the penthouse directly connected to the building ground system (usually located at the utility meter for the building).

The equipment in the dispatch center equipment room is grounded to a ground bar in the equipment room. This ground bar should also directly connect to the building ground system.

There should not be a direct connection between the penthouse ground bar and the dispatch equipment room ground bar.

These connections to the building ground can be made through the building steel as long as paint galvanizing or other contaminant is remove from where the ground lug is attached to the building steel. A direct connection to the building ground with a #6 AWG or larger copper conductor would be preferred. Also, supplemental ground rods can be added to reduce overall system resistance to ground.

Move Tsunami Radio

For ease of access, we recommend the Tsunami radio be moved to the Dispatch equipment room. A small shelf could be placed on a wall or a small table in the corner of the room would suffice.

Figure 5 - Tsunami Warning UHF Radio

Figure 6 - Penthouse External Ground Bar

Motorola System

A complete understanding of the Motorola system that is supporting the Dispatch Center needs to be produced by the responsible Motorola Systems entity, detailing the programming, maintenance and repair suggestions to this system.

The Motorola system is being used to record dispatch radio conversations, monitor environmental alarms, and operate the primary Fire and Law Enforcement radios.

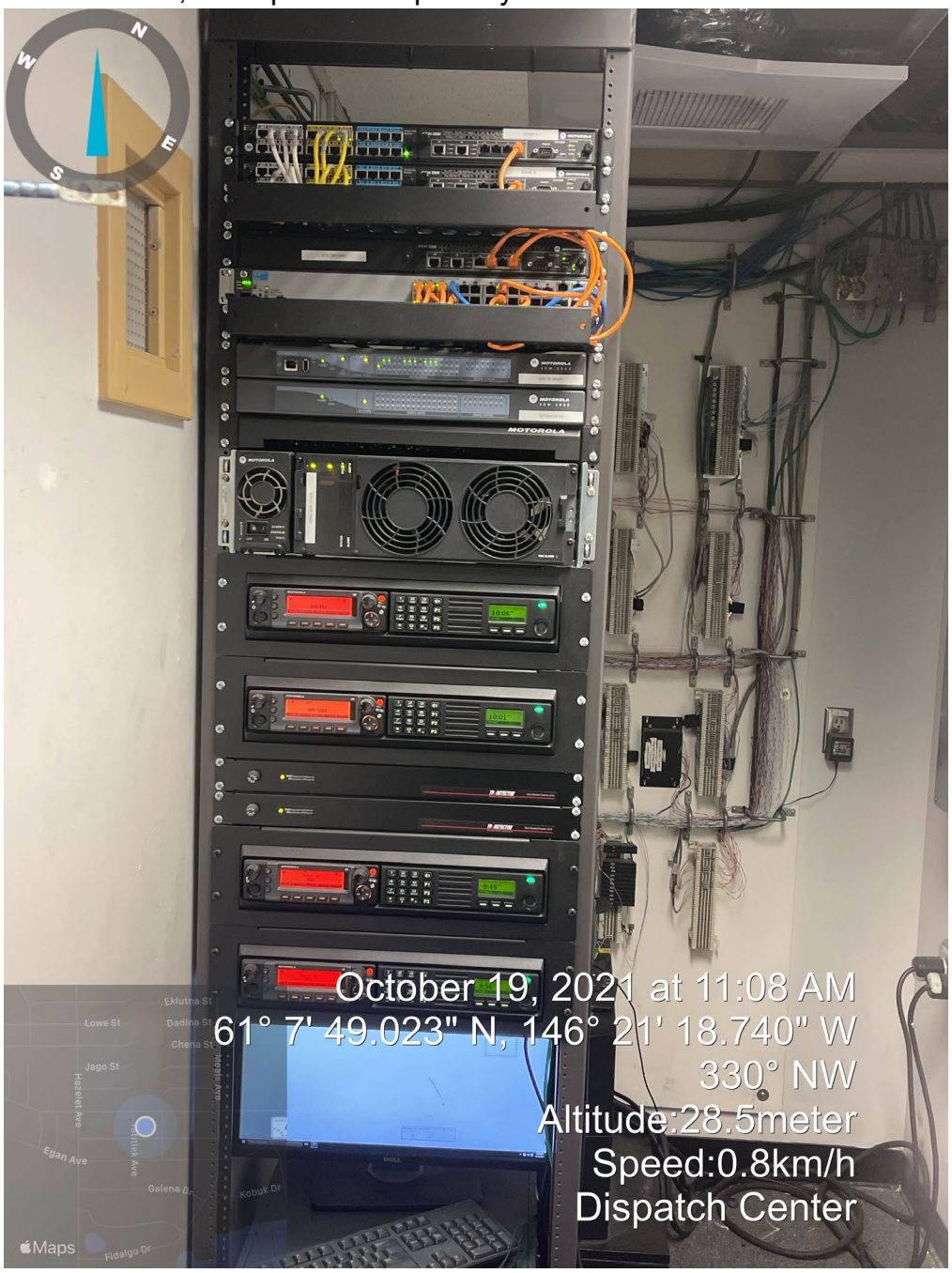


Figure 7 - Dispatch Cetner Motorola System

This appears to be a trunked radio system, and understanding how the Talkgroups and Trunking is setup is essential when planning future area wide system upgrades. Depending on the wired interface to the radios; it may be possible to move the radios to a remote location by extending the City IP network to the remote location. Motorola makes an interoperability gateway, as do third parties which could support remote location of these radios.

The radios are combined to the antennas using “T” connections. This results in only half of the transmitter power going to the antenna while the other half goes out the opposing branch of the “T” to the other radio. This may not be harming the other radio if the radios have a transmit-receive relay which disconnects the receivers from the antenna while a transmitter is active.

Grain Silos

The Valdez Grain Silos are an excellent location to provide radio coverage. It is centrally located, and tall enough to support a large coverage area.

Currently the city is using the Grain Silos for Fire and Law Enforcement repeaters supporting extension of the Fire and Law Enforcement Primary channels.

Figure 8 - Valdez Grain Silos

Sweep Antenna Systems

If new cables and antennas were not installed with the repeater installations, they should be swept with a TDR to determine if they are functional and if the cable and connectors are undamaged.

Antenna Spacing

Antenna spacing should be checked to ensure there is enough space where the antennas are mounted to provide acceptable separation. The repeaters allow the transmitters and receivers to operate in tandem through each repeaters duplexer. It is assumed that each repeater has its own transmit/receive antenna.

Improve System Grounding

The ground system should be inspected ensuring the 10 ohms to ground requirement. The antennas cables need to be grounded near the antenna before the bend from horizontal to vertical. The cable should be connected through a VHF surge protector (i.e., Polyphaser) that is connected to the ground bar near the cable entrance to the shelter. Supplemental grounding may be needed to achieve the 10 ohms to ground requirement.

The existing communication antennas that are owned by various carriers are attached to the steel framed structure adjacent to the concrete silos (see Appendix A for current antenna layout). The perimeter of the structure is populated with multiple antennas, but there should be available locations to space the City of Valdez's antennas. The attachment of the antennas to the structure will need to be designed.

Power Monitors

Power monitors can be added to the outputs of the two repeater transmitters at this site. These power monitors are web enabled and can be remotely accessed over the City's Enterprise network. These will help to identify transmitter, cable and antenna issues.

Figure 9- EMR Corporation iPM-1 Power Monitor

Airport

With the Airport being a part of the Port of Valdez, the tower cab hosts antennas for the City of Valdez coordination of Port business, maintenance and emergency response at the Airport.

Figure 10 - Airport Tower Cab

Sweep Antenna Systems

The antennas and cables should be swept with a TDR to determine if any damage is present.

Antenna Spacing

The tower cab has enough area to provide suitable antenna separation. For Maximum separation and optimal performance, antennas operating in the same band (e.g., VHF, UHF, 700/800 MHz) should be mounted in corners diagonally across from each other.

Improve System Grounding

The grounding of all antennas and cabling should be checked to ensure all connections are properly made and connections are tight.

Public Works Building (Vehicle Maintenance)

The Public Works Building (Vehicle Maintenance Facility) is just West of the Petroleum Terminal in the City of Valdez (not the Alyeska VMT).

The Public Works Building is equipped with a two element exposed dipole antenna. This should provide good coverage over the City of Valdez and out to the Grain Silos. If more coverage is needed further from the building, adding a higher gain antenna, or increasing the antenna height would be options.

Figure 11 - Public Works Building (VMF)

Sweep Antenna Systems

The antennas and cables should be swept with a TDR to determine if any damage is present.

Improve System Grounding

The antenna and cable grounding should be verified to ensure there is no damage. There should be a ground bar inside where the antenna cable enters/exits the building and the antenna cable should be connected through a VHF RF Surge Suppressor. This ground bar should have a direct connection via a #6 AWG or larger copper conductor to the building entrance grounding system. This is usually located at the utility service meter base.

Building steel can be utilized as long as proper connections are made and verified.

George Gilson Middle School

The Gilson Middle School is equipped with a single element exposed dipole antenna. If the intent for this antenna is to provide coverage in and around the school; we recommend moving the antenna away from the building so the antenna radiation pattern is pointed at the building.

Figure 12- George Gilson Middle School

Sweep Antenna Systems

The antennas and cables should be swept with a TDR to determine if any damage is present.

Move or Upgrade Antenna

There is a cell tower located at the water tank at the end of Mineral Creek Road that would work for antenna relocation. Alternatively, a directional antenna could be used at the water tank cell tower and directed at the school, increasing signal strength in and around the school.

Improve System Grounding

The antenna and cable grounding should be verified to ensure there is no damage. There should be a ground bar inside where the antenna cable enters/exits the building, and the antenna cable should be connected through a VHF RF Surge Suppressor. This ground bar should have a direct connection via a #6 AWG or larger copper conductor to the building entrance grounding system. This is usually located at the utility service meter base. Building steel can be used as long as proper connections are made and verified.

Civic Center

The Civic Center tower appears to support two WAN panel antennas. If the systems are not experiencing any issues nothing needs to be done. If these WAN connections are experiencing intermittent drop-outs we recommend the cables be verified, and the

grounding system reviewed. These antennas should be grounded to the tower steel, building steel or ground bar. Regardless of grounding used, verification of complete ground continuity to the utility services entrance needs to be verified.

Figure 13 - Civic Center

District Office

The School District Building is not included in any of the FCC licenses provided by the City. If this location has transmitters or transceivers in operation, proper FCC licensing needs to be performed in order to bring this location into compliance.

Figure 14 - School District Building

Sweep Antenna Systems

As with the other sites; the cables and antenna should be swept with a TDR to ensure there are no damaged elements in the antenna system.

Improve System Grounding

Antenna and site grounding should be reviewed to ensure that the system is properly grounded. There should be a ground bar, outside or inside, where the antenna cable enters/exits the building, and the antenna cable should be connected through a VHF RF Surge Suppressor. This ground bar should have a direct connection via a #6 AWG or larger copper conductor to the building entrance grounding system. This is usually located at the utility service meter base. Building steel can be used as long as proper connections are made and verified.

Fire Station 3

Fire Station 3 is located near the intersection of River Drive and the Richardson Highway. It is equipped with a fiberglass collinear array antenna, similar to the ones used at City Hall, the Airport, and the School District Office.

Figure 15 - Fire Station 3

Sweep Antenna Systems

As with the other sites; the cables and antenna should be swept with a TDR to ensure there are no damaged elements in the antenna system.

Improve System Grounding

Antenna and site grounding should be reviewed to ensure that the system is properly grounded. There should be a ground bar, outside or inside, where the antenna cable enters/exits the building, and the antenna cable should be connected through a VHF RF Surge Suppressor. This ground bar should have a direct connection via a #6 AWG or larger copper conductor to the building entrance grounding system. This is usually located at the utility service meter base. Building steel can be used as long as proper connections are made and verified.

Sawmill (STP)

The Sawmill site is equipped with a two element exposed dipole antenna, similar to the one at the Public Works (VMF) building.

Figure 16 - 800 Sawmill Drive (STP)

Sweep Antenna Systems

As with the other sites; the cables and antenna should be swept with a TDR to ensure there are no damaged elements in the antenna system.

Improve System Grounding

Antenna and site grounding should be reviewed to ensure that the system is properly grounded. There should be a ground bar, outside or inside, where the antenna cable enters/exits the building, and the antenna cable should be connected through a VHF RF Surge Suppressor. This ground bar should have a direct connection via a #6 AWG or larger copper conductor to the building entrance grounding system. This is usually located at the utility service meter base. Building steel can be used as long as proper connections are made and verified.

Harbor Master

The Harbor Master office provides very good coverage of downtown Valdez and the Valdez harbor. There are several antennas at the Harbor Master office, they should all be reviewed and any unused antennas and cables should be removed.

Figure 17 - Harbor Master

Sweep Antenna Systems

As with the other sites; the cables and antenna should be swept with a TDR to ensure there are no damaged elements in the antenna system.

Improve System Grounding

Antenna and site grounding should be reviewed to ensure that the system is properly grounded. There should be a ground bar, outside or inside, where the antenna cable enters/exits the building, and the antenna cable should be connected through a VHF RF Surge Suppressor. This ground bar should have a direct connection via a #6 AWG or larger copper conductor to the building entrance grounding system. This is usually located at the utility service meter base.

Fire Station 4

Fire Station 4 is equipped with a dual four element exposed dipole VHF antenna. There is also a ground plane omni-directional VHF (VHF/UHF) antenna and a cellular band yagi antenna. The yagi antenna is most likely attached to the Wilson Cellular in-building amplifier to boost indoor cellular coverage.

Figure 18 - Fire Station 4

Sweep Antenna Systems

As with the other sites; the cables and antenna should be swept with a TDR to ensure there are no damaged elements in the antenna system.

Improve System Grounding

Antenna and site grounding should be reviewed to ensure that the system is properly grounded. There should be a ground bar, outside or inside, where the antenna cable enters/exits the building, and the antenna cable should be connected through a VHF RF Surge Suppressor. This ground bar should have a direct connection via a #6 AWG or larger copper conductor to the building entrance grounding system. This is usually located at the utility service meter base.

Figure 19 - Fire Station 4 Tower Base

Figure 20 - Fire Station 4 Tower Ground

The tower ground at Fire Station 4 indicates the tower is not properly grounded. The above photo depicts the ground connection for the tower. Since the galvanizing was not removed from the tower, or the grounding bracket, this tower is ungrounded.

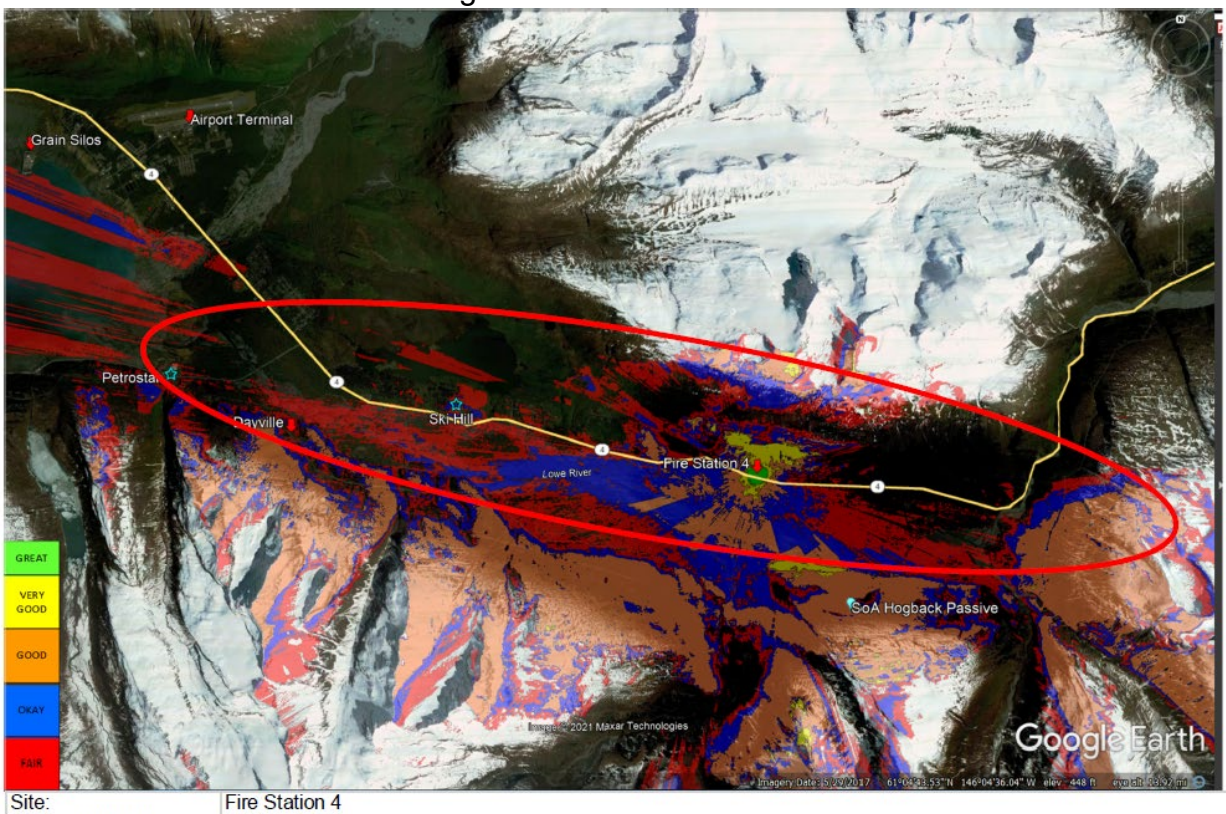
While it is not possible to install a proper ground ring around the building; a grounding system could be installed on the side of the building where the tower is located. Using several ground rods, and #2 AWG Solid Bare Tinned Copper, a proper ground could be established and then connected to the tower via exothermic weld.

10 Mile Coverage

With Coverage of the 10 Mile corridor being of primary interest to the City of Valdez. Attached below shows possible coverage options of this corridor from different locations.

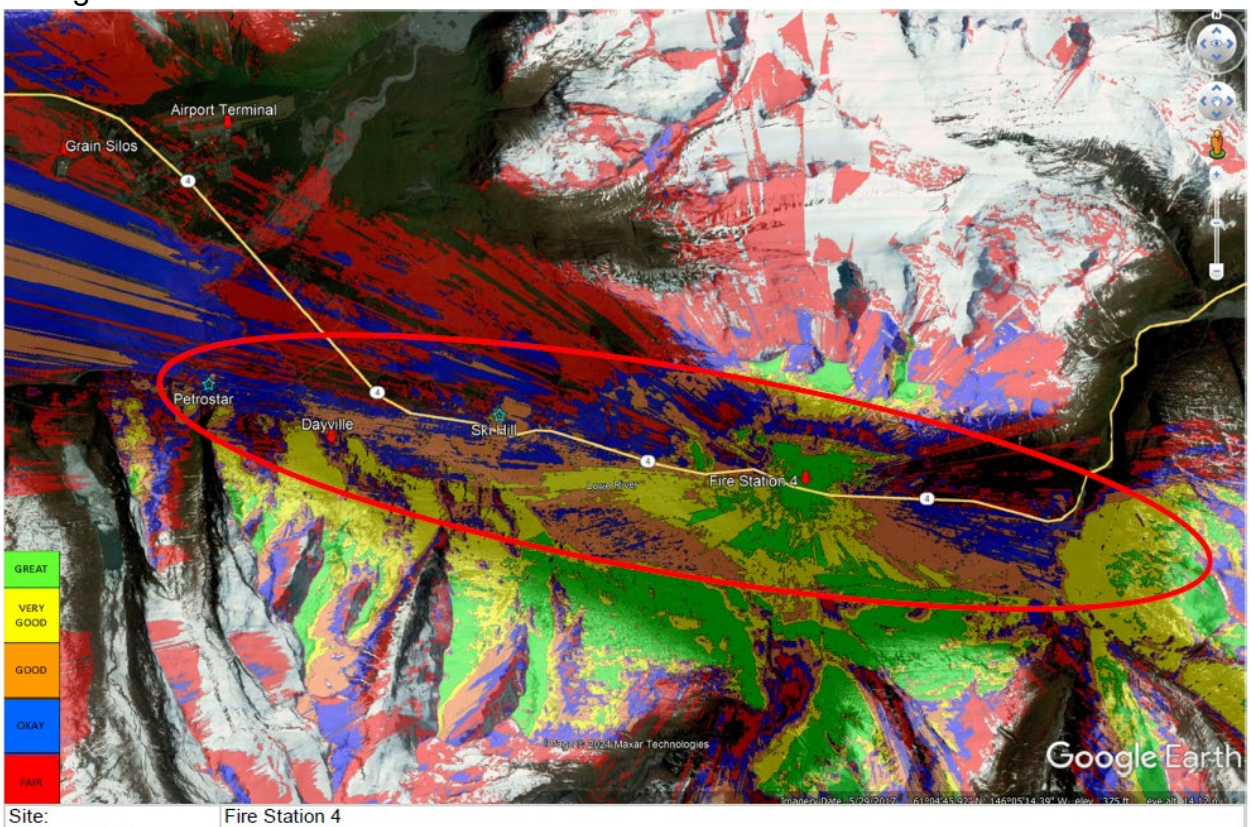
Fire Station 4

Because of the height (approximately 40 feet), of the existing Fire Station 4 antenna it does not provide sufficient coverage of this corridor. Additionally, there is terrain to the Northwest that blocks the coverage in that direction.



Site:	Fire Station 4
Antenna Height:	40 ft
Antenna Model:	Sinclair SC251-HF3LDF(D00-G3) Collinear omni antenna, 2.3-3.5 dBd gain, low PIM, PIP rated, HD, 138-174 MHz
Antenna Azimuth:	N/A
TX Power:	30 Watts
Mobile Antenna Height:	5 ft

The following shows expected coverage from a Fire Station 4 antenna positioned at height of 100 feet. The coverage is moderately better than the same antenna located at a height of 40 feet.

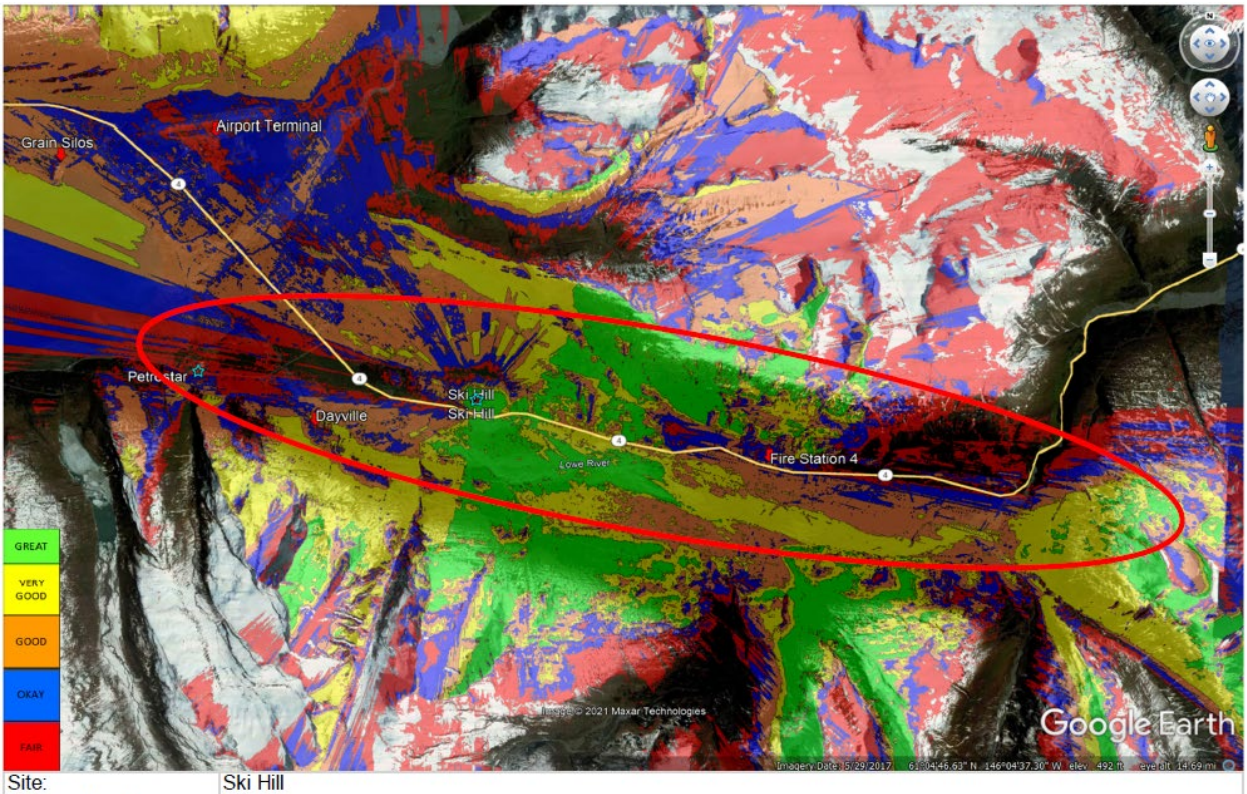


Site:	Fire Station 4
Antenna Height:	100 ft
Antenna Model:	Sinclair SC251-HF3LDF(D00-G3) Collinear omni antenna, 2.3-3.5 dBd gain, low PIM, PIP rated, HD, 138-174 MHz
Antenna Azimuth:	N/A
TX Power:	30 Watts
Mobile Antenna Height:	5 ft

Due to the radiation pattern of omnidirectional antennas; most of the energy is radiated outward in a donut shape with little downward output. A possible approach to improve coverage is to move the antenna away from the intended area of coverage and place it in the largest part of the “donut.”

Ski Hill

This shows the expected coverage from an omnidirectional antenna located at 50 feet at the top of the Ski Hill location. This is the best coverage of the four scenarios shown in the Exhibits.

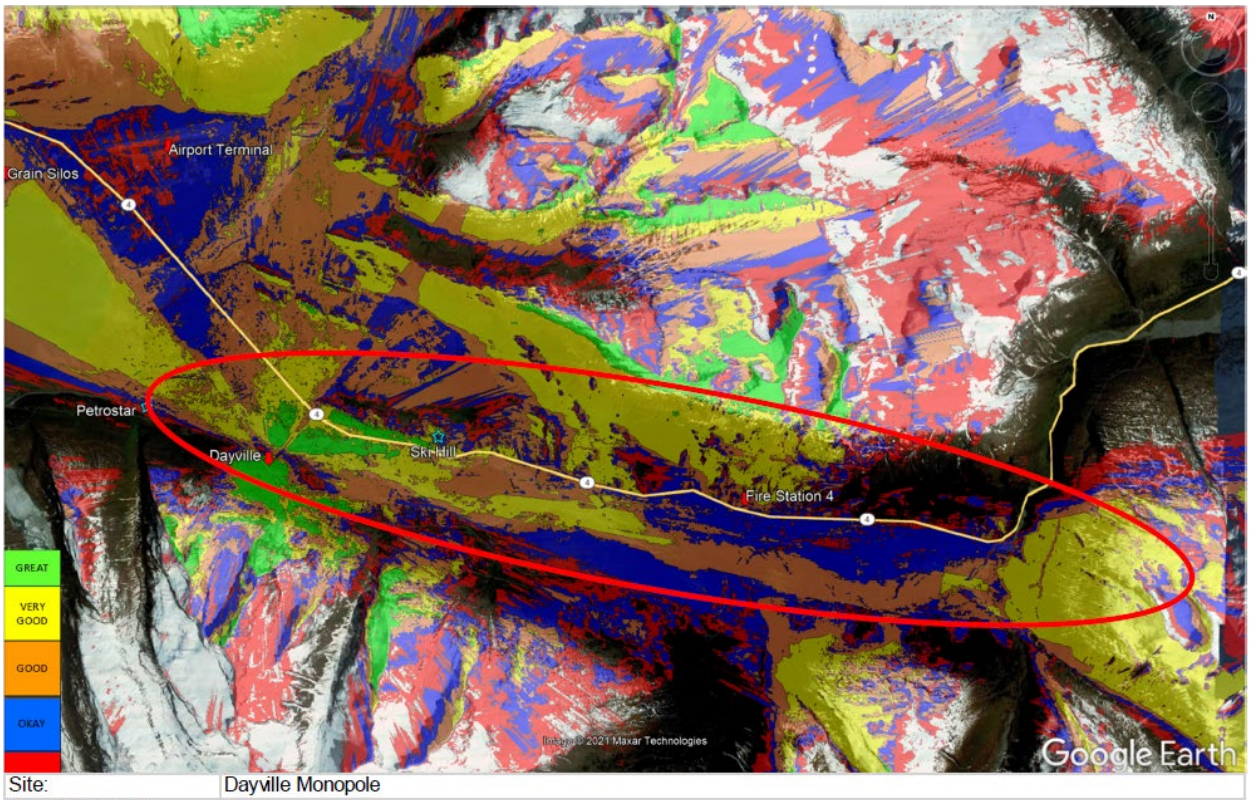


Site:	Ski Hill
Antenna Height:	50 ft
Antenna Model:	Sinclair SC251-HF3LDF(D00-G3) Collinear omni antenna, 2.3-3.5 dBd gain, low PIM, PIP rated, HD, 138-174 MHz
Antenna Azimuth:	N/A
Downtilt:	0.0°
TX Power:	100 Watts
Mobile Antenna Height:	5 ft

Dayville Cell Tower

A possible and less expensive option may be to collocate a yagi antenna on the Crown Castle monopole located on the TAPS Access Road just South of Dayville Road[2]. This is a 100 ft monopole that hosts AT&T Wireless. The following shows the expected coverage from a yagi antenna mounted at 100 feet and pointed on an azimuth of 96°. This orientates the antenna through the 10 Mile corridor.

[2] https://www.crowncastle.com/infrastructure-solutions/?level=13&center=-146.20201,61.07213



Site:	Dayville Monopole
Antenna Height:	100 ft
Antenna Model:	Sinclair SY206(C) Series Yagi directional, 9.5 dBd, center mount, 108-225 MHz
Antenna Azimuth:	96.0°
Downtilt:	0.0°
TX Power:	100 Watts
Mobile Antenna Height:	5 ft

Future Improvements

Centralized Radios

There are several radios spread around the City that would benefit from being collocated at the Grain Silos. This collocation would provide better coverage for all users on the system as the Grains Silos provide the best coverage for the City.

Centralizing the radios would require a transmit combining system and a receive combining system. There would be two antennas; one for transmitting signals and one for receiving signals. These would be spaced as far apart as possible on the Grain Silo. This might enable moving the existing Fire and Law repeaters from the Grain Silo to the Dayville monopole or a new tower on Ski Hill to provide the desired 10 Mile corridor coverage. The method of separating the transmit and receive signals on separate antennas provides the best possible isolation for each frequency. The transmit combiner runs each transmit signal through a tuned filter to provide the cleanest signal to the receivers.

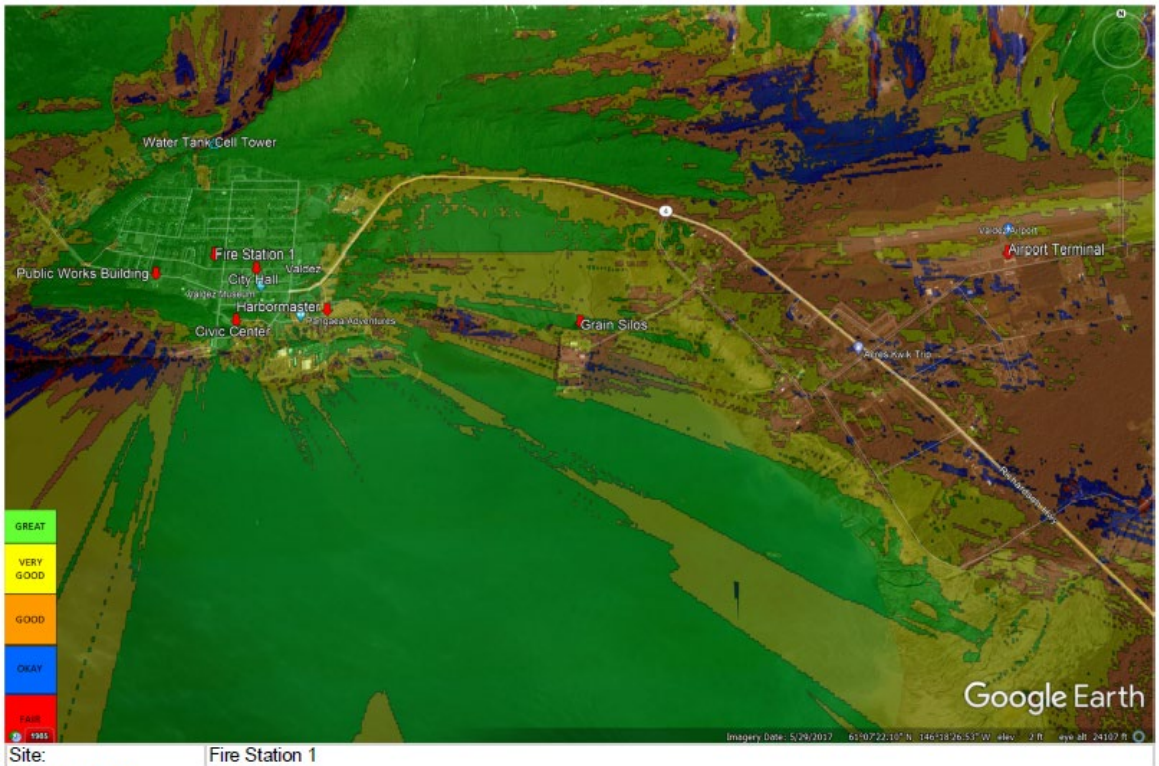
The Dispatch Center Motorola radios could be relocated either using a Motorola gateway device, or a third party (e.g. JPS Interoperability Solutions).

In Building Coverage

Issues with coverage in-building were mentioned during the site visit. As construction methods have developed to make them more economical to operate, the impact makes the radio signals ability to penetrate into buildings far more difficult. One solution to alleviate this issue is the utilization of Distributed Antenna Systems (DAS). A DAS system uses bi-directional amplifiers combined with exterior and interior antennas to boost the radio signals inside a building. The City already has a simple DAS system set up in Fire Station 4 to enhance cellular coverage inside the station.

Fire Station 1 Tower

During the site visit constructing a new tower at Fire Station 1 was discussed. This could be to support a redundant or emergency dispatch center should something happen to the one located at City Hall. Below shows the expected coverage of an omni-directional antenna at 100 ft located at Fire Station 1. It could also be used to start a development of an open based system (non-Motorola) for growth and eventual transition from the existing dispatch system.



Site:	Fire Station 1
Antenna Height:	100 ft
Antenna Model:	Sinclair SC251-HF3LDF(D00-G3) Collinear omni antenna, 2.3-3.5 dBd gain, low PIM, PIP rated, HD, 138-174 MHz
Antenna Azimuth:	N/A
TX Power:	100 Watts
Mobile Antenna Height:	5 ft

Additionally, the fire station is located in an R-A (single-family residential) zoning district. In an R-A zone, structures such as towers are limited to thirty-five feet in height. A conditional use permit (CUP) is required for the construction of communication towers exceeding thirty-five feet in height. The CUP must show that the area cannot be adequately served by a telecommunication tower located in a nonresidential zoning district.

Design Cost

We estimate that the design cost for the listed sites will be $115,201. In appendix B is a materials cost sheet we will use to discuss options with the City to fulfill the needs and budget available.

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