TECHNICAL MEMORANDUM

TO: David Zevely, Burney Water District

FROM: Matthew Couch, Staff Engineer; Sean McGuigan, Staff Engineer; Laurie McCollum, Senior Engineer

DATE: February 1, 2022

JOB NO.: 0306.42

SUBJECT: Burney Water District – Radio Improvements Project

On January 12, 2022, David Zevely, Sean McGuigan, and Matthew Couch completed a review of the Burney Water District (District) Supervisory Control and Data Acquisition (SCADA) radio communication system at several water facility sites. The sites reviewed included: the District Main Office, Bartel Lift Station, Ivan Marx Tank, Timber Drive Tank, Mountain View Tank, and Well 7. Sites not reviewed included: the Wastewater Treatment Plant (WWTP), the Main Lift Station, and the Booster Pump Station. The sites not reviewed are not currently recommended for improvements due to the construction projects already underway for wastewater collection and treatment. Additionally, the Booster Pump Station was not reviewed due to there being no radio infrastructure currently installed at this site.

The purpose of this site visit was to (1) familiarize PACE Engineering, Inc. (PACE) staff with the District's water supply radio infrastructure, (2) evaluate the condition of the existing radio infrastructure, and (3) provide recommendations for water supply radio infrastructure improvements based on our observations and discussions with District staff.

PACE recommends optimizing the existing radio system as much as possible at each site including re-aiming/realigning antennae, raising antennae heights, upgrading to greater gain antennae, and upgrading radio strengths from 2W to 5W. Existing conditions and recommendations are discussed hereinbelow. Refer to Figure 1 for the District Site Map. Refer to Attachment A for the System Radio Survey.

EXISTING RADIO CONDITIONS

Burney Water District Main Office (CP-M):

The Main Office is the central communication location to the system, and the existing SCADA system is running on an older windows workstation. The main Programmable Logic Controller (PLC) at the Main Office initiates and completes all communication in the system. The Main Office has a Teledesign TS4000 2-watt radio paired with an omni-directional antenna. During the site visit, communications fail alarms were observed for all sites on the Main Office's Lookout HMI/SCADA System. It is suspected this is likely due to one site having communication delays that are too long, resulting in poling cycle issues system-wide.

Bartel Lift Station (CP-2)

Bartel Lift Station has a Teledesign TS4000 2-watt radio that communicates with the District Main Office. Ice was observed on the Yagi directional antenna. Radio frequency drift was observed on the TS4000 software. As radios get older, internal parts age and no longer stay within the designed frequency band. It was noted that the antenna was within only three to four feet of the top of the roof, and as a result, could be easily impacted by adverse weather conditions such as snow. This site currently has radio improvements planned as part of the recently-bid Collection System Improvement Project – Phase 2, which is anticipated to be completed in approximately one year. After that project is completed, the Bartel Lift Station will be included in the new collection and wastewater radio system rather than the obsolete water supply radio system. The Bartel Lift Station had great signal strength to the District Main Office.

Ivan Marx Tank (CP-4)

The Ivan Marx Tank has a Teledesign TS4000 5-watt radio that communicates with the District Main Office. Radio frequency drift was observed on the TS4000 software. The Ivan Marx Tank is located furthest from the District Main Office, and there is a ridge between the two sites. Due to distance, a repeater is employed at the Timber Drive Tank site. However, another ridge toward the Timber Drive Tank site is taller, which hinders communication. Furthermore, the Timber Drive Tank antenna is a Yagi antenna, which is not designed for communications from multiple directions. The signal strength to the Timber Drive Tank site was decent during the site visit, with a strength of 82 -dBm. The antenna location was great, at about five to seven feet above the top of the tank.

Timber Drive Tank (CP-5)

The Timber Drive Tank has a Teledesign TS4000 2-watt radio that communicates with the District Main Office and the Ivan Marx Tank. The Timber Drive Tank also has a Yagi antenna but is functioning as a repeater for the Ivan Marx Tank. Yagi antennae are highly directional, and as such, it is aimed toward the District Main Office through a gap in the trees. Unfortunately, that means it is pointed in the wrong direction for the Ivan Marx Tank. Antenna frequency drift was observed on the TS4000 software during the site visit. The signal received was 92 -dBm, below the minimal level of 105 -dBm. The antenna location was great, at about five to seven feet above the top of the tank. This site is likely one of the sites causing communication issues.

Mountain View Tank (CP-6)

The Mountain View Tank has a Teledesign TS4000 2-watt radio that communicates with the District Main Office. Antenna frequency drift was observed on the TS4000 software during the site visit. Of all the sites, the Mountain View Tank had the worst signal strength. The signal received was 94 -dBm, below the minimal level of 105 -dBm. The antenna location was great, at about five to seven feet above the top of the tank. This site is likely one of the sites causing communication issues.

Well 7

The Well 7 site has a Teledesign TS4000 2-watt radio that communicates with the District Main Office. The highly directional Yagi antenna appeared to be pointed too far west and not directly at the District Main Office. Antenna frequency drift was observed on the TS4000 software during the site visit. Radio signal strength was great, at 75 -dBm.

WWTP

This site was not evaluated to determine if upgrades are needed due to the already planned upcoming improvements to be included in the WWTP Improvement Project. However, it is understood that the WWTP has a Teledesign TS4000 2-watt radio that communicates with the District Main Office. After that project is completed, the WWTP will be on the new collection and wastewater radio system rather than the obsolete water supply radio system.

RECOMMENDATIONS

A summary of the recommended improvements is presented below, focusing on radio system improvements.

There are multiple factors that can hinder radio communication, such as age of the system, weather, physical condition of the antenna and radio, damaged wires, new buildings, and objects between sites. Over time, radio signal strength decreases so much so that after 20 years the system should be replaced. The best solution is to design a system robust enough, with a high enough quality/strength of radio signal, that degradation in signal quality/strength is still sufficient for functional radio communication. The upcoming improvements to the water distribution system will allow for complete replacement of the radio system. However, PACE suggests the following improvements be implemented on a per-site basis until the new, complete SCADA system upgrades are finalized:

District Main Office (CP-M):

1. Adjust SCADA communication alarm settings to increase the time before triggering an alarm fail. This can be completed by the District.
2. Adjust SCADA communication alarm settings to decrease the number of reattempts to communicate after a failed attempt to communicate. This can be completed by PACE.
3. Adjust SCADA communication alarm settings to increase the rate of communications. This can be completed by PACE.
4. Upgrade the radio from 2W to 5W. This can be completed by the District or PACE.
5. Raise the antenna height by five feet. This can be completed by the District.

Bartel Lift Station (CP-2)

1. Raise the antenna height by three to five feet. This can be completed by the District.

Note: The frequency drift observed could be caused by multiple factors, but in this system is suspected to likely be due to the age of the components.

Ivan Marx Tank (CP-4)

1. Upgrade the Yagi antenna to a greater gain antenna. This can be ordered by PACE and installed by the District.

Timber Drive Tank (CP-5)

1. Upgrade the radio from 2W to 5W. This can be completed by the District or PACE.
2. Upgrade the Yagi antenna to a greater gain antenna. This can be ordered by PACE and installed by the District.

Notes: This site is likely one of the sites causing communication fails. It is recommended the District widen the gap in the trees through which the Yagi antenna is pointed, if possible.

Mountain View Tank (CP-6)

1. Upgrade the radio from 2W to 5W. This can be completed by the District or PACE.
2. Upgrade the Yagi antenna to a greater gain antenna. This can be ordered by PACE and installed by the District.

Notes: This site is likely one of the sites causing communication fails. It is recommended the District widen the gap in the trees through which the Yagi antenna is pointed, if possible.

Well 7

1. Realign the antenna directly towards the District Main Office. This can be completed by the District.

WWTP

1. Upgrade the radio from 2W to 5W. This can be completed by the District.
2. Upgrade the Yagi antenna to one with greater gain. This can be ordered by PACE and installed by the District.

Notes: Upgrades at this site would only be temporary, as complete replacement is already planned at the WWTP. Tree removal is recommended south of the office building and east of the utility transformer.

CLOSING

Two sites have been noted as particularly problematic in the system. As noted hereinbefore, it is not guaranteed that improvements to these sites will solve the system-wide communications issues, but they should improve the issues being experienced. There are also minor additional settings at each site that can be adjusted to improve the system in addition to the suggested improvements described above.

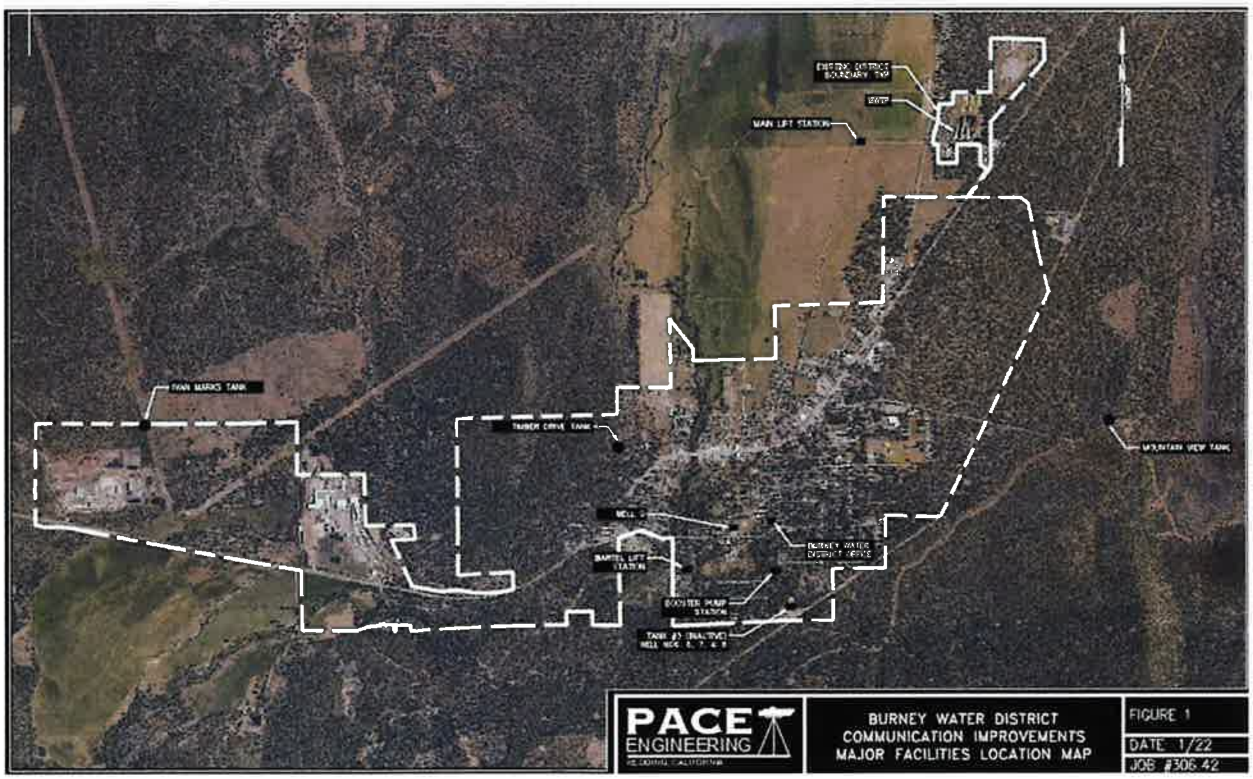
The radios currently used in the system are no longer in production and are not supported by the manufacturer. If a new radio has been recommended, it must be obtained by retailers that may still have spares in inventory or by the secondhand market. PACE can help obtain these radios as needed. Prices vary between $1,000 to $3,000 for the 5W radios. Additionally, a new antenna will cost approximately $1,000 to $1,500, depending on the desired quality. Programming and installing each radio will cost $700. Total expected cost for all suggested improvements is approximately $7,200 to $16,300.

Please call to discuss questions, concerns, or assistance needed on how best to proceed.

Sincerely,

Matthew Couch
Staff Engineer

Figure 1
Burney Water District Site Map



ATTACHMENT A

SYSTEM RADIO SURVEY

Radio Path Study
Burney, California Area

Serial Number: 1192 Rev 5
January 26, 2022

It is required to create an Ethernet wireless network in the area of Burney, California. There are many trees, presumed to be approximately 50-55 feet tall on average. The few buildings consist mostly of residences and small businesses, with heights between about 20-25 feet in this area.

The analysis presumed the use of Trio QR450 licensed Ethernet/serial data radios, configured for the default Dynamic radio data rate. The paths were designed to provide a fade margin of greater than 10 dB at the fastest speed. Each individual radio may reduce its over-the-air data rate at times when conditions are poor (weather, interference etc) to ensure a reliable data link, but will increase speed again when conditions improve.

The analysis presumed that a 5 dBd omni-directional antenna would be mounted at least 50 feet above ground at the Wastewater Treatment Plant Entry Point site. This antenna was presumed to be fed with 75 feet of LMR-400 (Schneider type "A") coaxial cable.

The Ivan Marx Tank is in a very difficult location due to a tree-covered ridge mid-path. This would require a very tall tower at the tank site to overcome. Instead it is recommended that the Well #7 radio be configured as a repeater (IP router) to forward messages. This will require a 5 dBd omni antenna, installed 40 feet above ground, at Well #7. It allows Ivan Marx to communicate to the repeater with a 9 dBd yagi installed at 30 feet, for a major cost saving.

It was presumed that the remaining remote sites would be equipped with 9 dBd yagi (directional) antennas, installed at 10-20 feet above ground (see table below for details). After Well #7 was designated as a repeater it was found that Bartel Lift Station can more easily communicate with it than direct to the WWTP.

Configuration Notes:

Due to the need for a repeater that is not at the center of the system, it will be necessary to configure this system for IP Routing mode. This means that each radio and its locally-connected network devices must be configured to exist in a unique LAN (local area network). All radios will also co-exist in a WAN (wide area network), and appropriate routing rules must be entered into each radio. See the user manual and this YouTube video for details: https://www.youtube.com/watch?v=sot8NgDrusw

Also, presuming that the customer will be provided with a simplex (single frequency) license, it is recommended that the default TGCM (Token Grant Channel Management) mode be used in all radios. The WWTP radio will be the system's TGCM Manager, and the Well #7 radio will be a TGCM repeater. The two remote radios downstream of the repeater will then be configured to use the same Segment ID as the Well #7 repeater ID. This YouTube video provides an introduction to TGCM:
https://www.youtube.com/watch?v=_7f0DdKpODM

Site Summary

Site Name	Antenna Height	Antenna Type	Antenna Aiming	General Site Notes	Fade Margin Predicted
Wastewater Treatment Plant	50 feet	5 dBd omni	N/A	Entry Point radio	N/A
Bartel Lift Station	15 feet	9 dBd yagi	108 °	Remote, up to Well #7	26 dB
Main Lift Station	10 feet	9 dBd yagi	90 °	Remote, up to WWTP	53 dB
Well #7	40 feet	5 dBd omni	N/A	**Repeater**, up to WWTP	29 dB
Ivan Marx Tank	30 feet	9 dBd yagi	106 °	Remote, up to Well #7	16 dB
Mountain View Tank	20 feet	9 dBd yagi	337 °	Remote, up to WWTP	23 dB
Timber Tank	15 feet	9 dBd yagi	50 °	Remote, up to WWTP	29 dB
Booster PS	15 feet	9 dBd yagi	26 °	Remote, up to WWTP	20 dB

Sample Bill of Materials

Qty.	Part Number	Description
8	TBURQR4HH-F00E2L00	Trio QR450 Ethernet/serial licensed data radio, 450-500 MHz, 55.4 kbps, FCC/IC, AES, 2 configurable DIO
8	TBUMDIN-KIT-TYPEA	Trio DIN rail mounting kit (optional)
8	TBUMRFJP-TNC-N-1M	Trio RF feeder tail cable, 3ft/1m, TNC-male to N-male
8	TBUMLT-ARRES-TYPEA	Surge arrestor, 125-1000 MHz, N-female to N-female, bulkhead mount
5	TBUMRFANT-25F7M-A	RF Cable Antenna Feedline 25Ft/7.6m, 0.4in/10mm, N-Male To N-Male.
1	TBUMRFANT-50F15M-A	RF Cable Antenna Feedline 50Ft/15m, 0.4in/10mm, N-Male To N-Male.
2	TBUMRFANT-75F22M-A	RF Cable Antenna Feedline, 75Ft/22m, 0.4in/10mm, N-Male To N-Male.
6	TBUMANTY-09-460	Trio Antenna, Yagi (directional), 9 dBd, 450-470 MHz range, c/w mtg clamp, N-Female Connector.
2	TBUMANTO-05-4**x**5	Trio Antenna, Omni-directional, 5 dBd, c/w mtg clamp, N-Female connector. **NOTE**: Replace **x** with **5** for 450-460 MHz range, or **6** for 460-470 MHz range

NOTE: Customer must evaluate actual required coaxial cable length for all sites. Lengths above are suggested only. Cables between 10 feet and 100 feet are available.

General Notes:

1) If any unforeseen taller structures such as buildings or trees are in the immediate vicinity of a site in a radio path, the antenna must be raised above these structures. Unreported structures or trees may otherwise cause a path to be unreliable.

2) Antenna azimuth, the direction to aim a site's directional (Yagi) antenna, is reported as "True Azimuth" in each link worksheet. Aiming should be verified with a good quality compass which has been adjusted for declination.

3) A license-free spread spectrum radio system must share the available channels with other users. These other users may cause interference, and will increase the average noise floor. For a reliable link, it is necessary to keep the receive signal at least 20 dB above the noise floor. This noise floor may change over time, and cannot be guaranteed by Schneider Electric.

4) The coaxial cable type has been specified for each site. At 460 MHz it is critical that low-loss cable be used to minimize losses. LMR-400 (0.4" – Schneider type "A") cable or equivalent is sufficient for cable lengths of 75 feet (22 metres) or less. LDF4-50A (0.5" – Schneider type "B") is required for cable lengths between 75 and 150 feet. (22 to 45 metres) If the cable must be longer, a third-party cable may be specified. The cable type used in the analysis is stated on each worksheet.

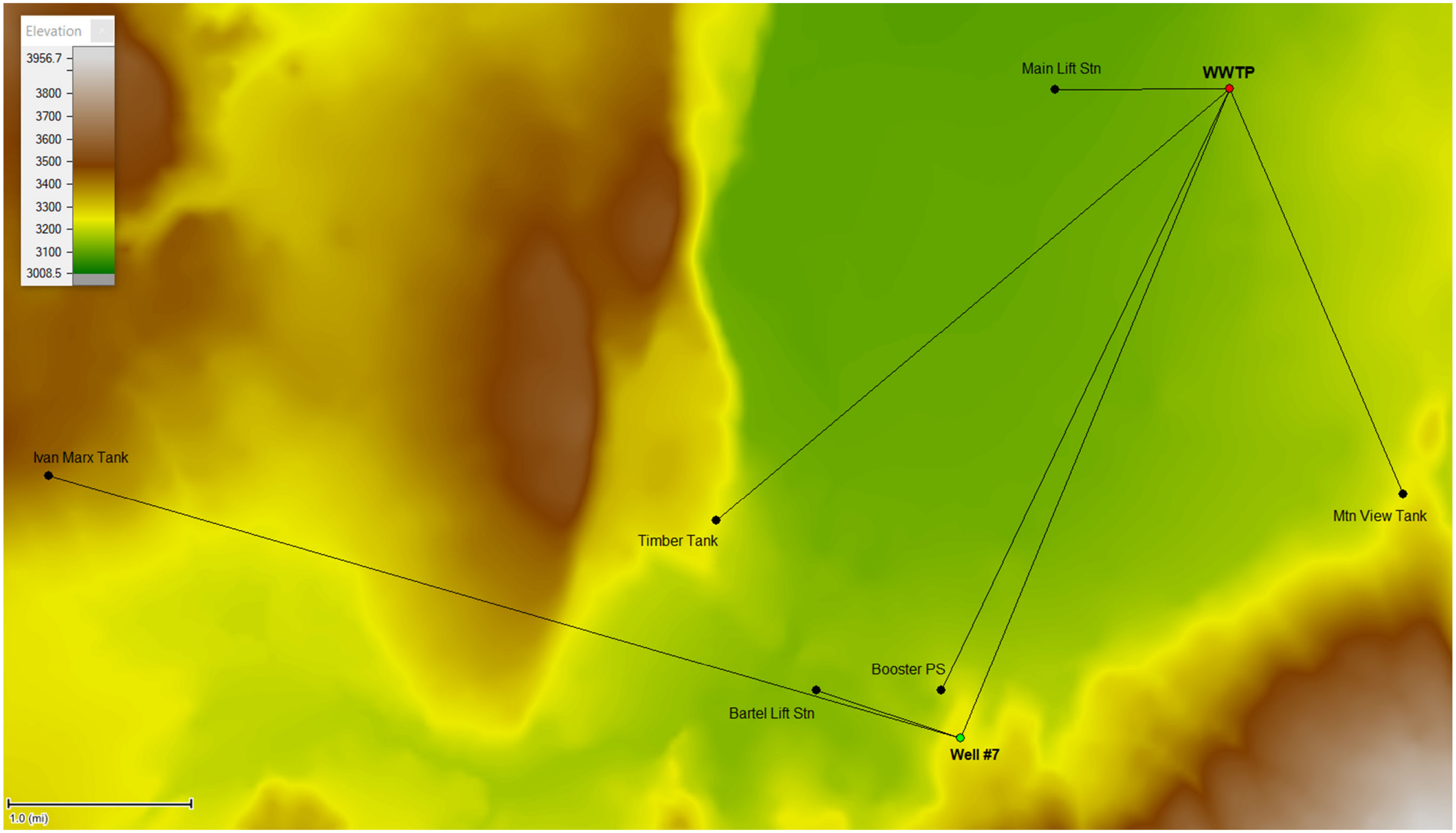
5) If LDF4-50A or similar cables are specified, please be aware this cable type must be handled with care. Do not repeatedly bend the cable, and do not create a bend with a radius of less than 3" (76 mm). Do not apply enough pressure to the outer jacket to cause distortion - either by stepping on it or other applications of force. Installation of connectors must only be performed by trained technicians.

6) It is strongly recommended that all sites be equipped with a good quality surge (lightning) arrestor to protect the radio and the site equipment. This arrestor must be connected to a good earth ground with a short heavy gage cable.

7) Schneider Electric does not guarantee the results of this path study. This study is a free sales tool which is meant to demonstrate the feasibility of the desired radio system. If guaranteed results are required the customer (or sales rep) must contact a radio systems contractor who will perform an on-site survey and may also perform their own path study.

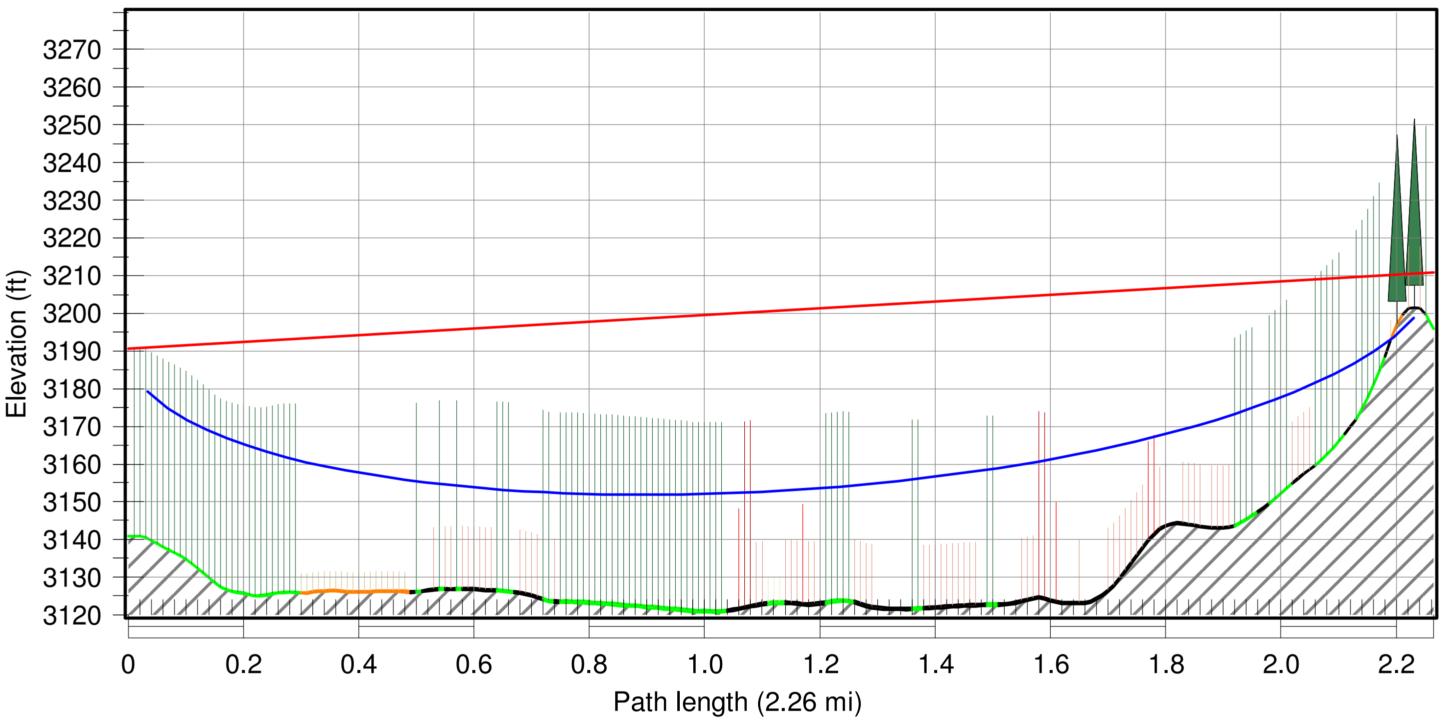
8) Customer must evaluate actual cable length requirements and order as needed.

Burney Area Terrain Map



Schneider Electric | Remote Operations

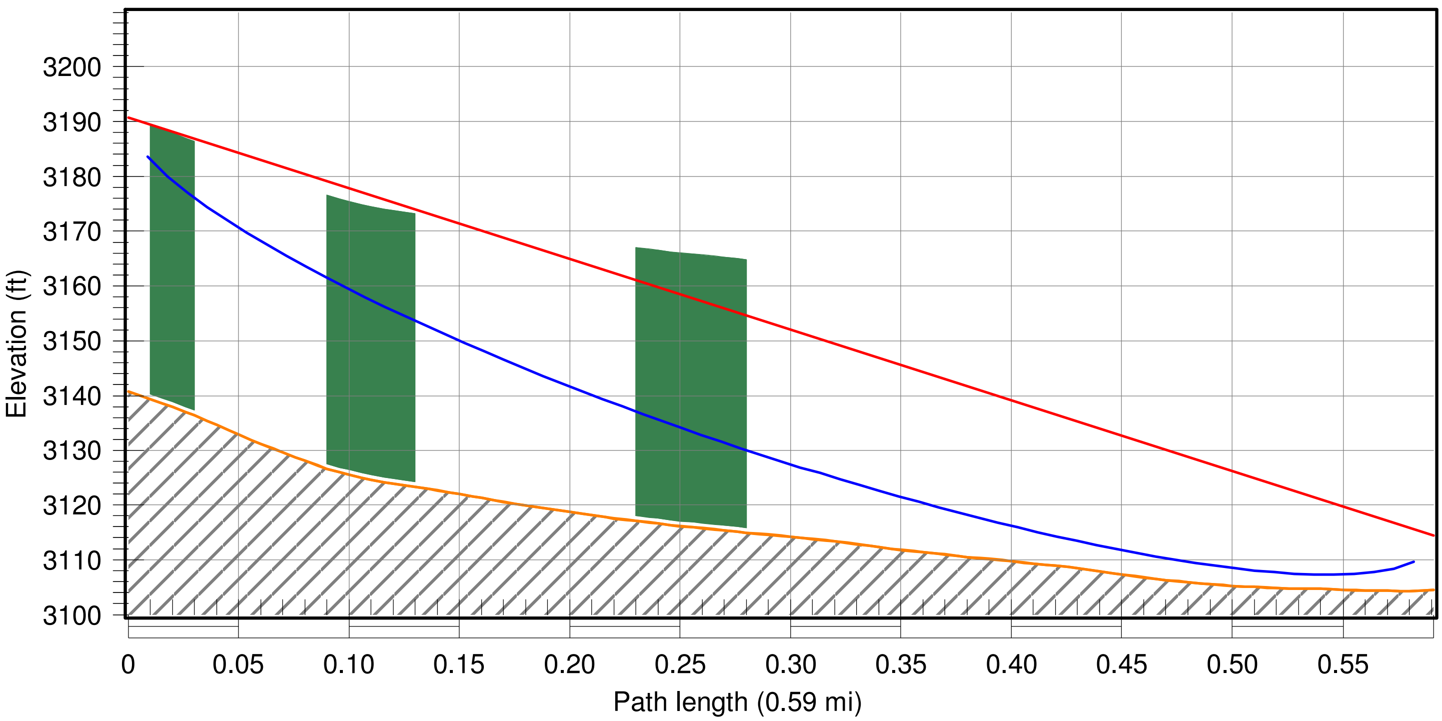
Transmission summary (WWTP-Booster PS.pl5)



F = 460.00 MHz K = 1.33 %F1 = 60.0, 60.0

	WWTP		Booster PS
Latitude	40 54 11.82 N		40 52 25.37 N
Longitude	121 38 34.35 W		121 39 41.68 W
True azimuth (°)	205.65		25.63
Vertical angle (°)	0.08		-0.11
Elevation (ft)	3140.73		3195.85
Antenna gain (dBd)	5.00		9.00
Antenna height (ft)	50.00		15.00
TX line model	LMR-400		LMR-400
TX line length (ft)	75.00		25.00
TX loss (dB)	3.05		1.68
RX loss (dB)	3.05		1.68
Frequency (MHz)		460.00	
Path length (mi)		2.26	
Free space loss (dB)		96.95	
Diffraction loss		30.08	
Net path loss (dB)	113.47		113.47
Radio model	Trio FCC Qx450 12.5k 55.4kbps		Trio FCC Qx450 12.5k 55.4kbps
TX power (dBm)	34.00		34.00
ERP (dbm)	35.95		41.32
ERP (watts)	3.94		13.55
Receive signal (dBm)	-79.47		-79.47
Receive signal (µv)	23.77		23.77
Thermal fade margin (dB)	20.53		20.53

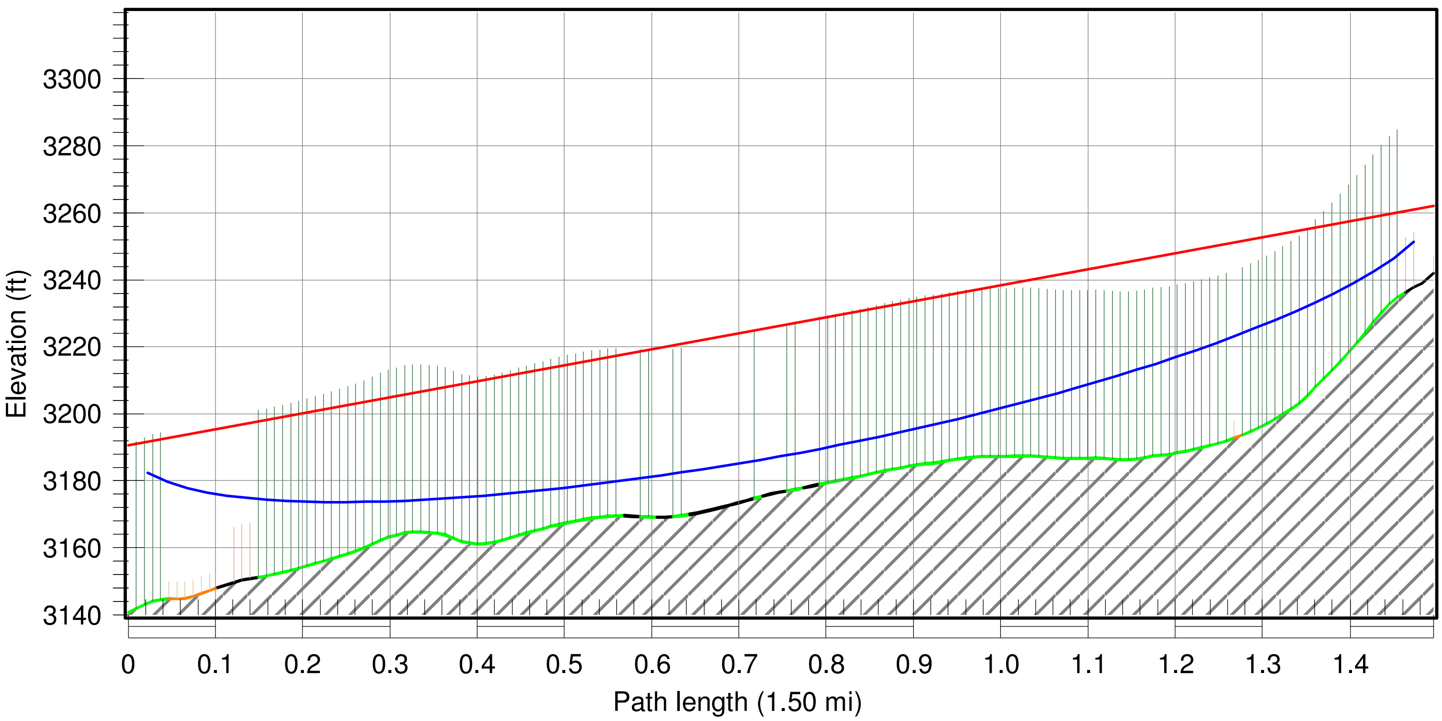
Transmission summary (WWTP-Main Lift Stn (460).pl5)



F = 460.00 MHz K = 1.33 %F1 = 60.0, 60.0

	WWTP		Main Lift Stn
Latitude	40 54 11.82 N		40 54 11.67 N
Longitude	121 38 34.35 W		121 39 14.98 W
True azimuth (°)	269.72		89.72
Vertical angle (°)	-1.40		1.40
Elevation (ft)	3140.73		3104.46
Antenna gain (dBd)	5.00		9.00
Antenna height (ft)	50.00		10.00
TX line model	LMR-400		LMR-400
TX line length (ft)	75.00		25.00
TX loss (dB)	3.09		1.68
RX loss (dB)	3.09		1.68
Frequency (MHz)		460.00	
Path length (mi)		0.59	
Free space loss (dB)		85.29	
Diffraction loss		9.13	
Net path loss (dB)	80.89		80.89
Radio model	Trio FCC Qx450 12.5k 55.4kbps		Trio FCC Qx450 12.5k 55.4kbps
TX power (dBm)	34.00		34.00
ERP (dbm)	35.95		41.32
ERP (watts)	3.94		13.55
Receive signal (dBm)	-46.89		-46.89
Receive signal (µv)	1011.31		1011.31
Thermal fade margin (dB)	53.11		53.11

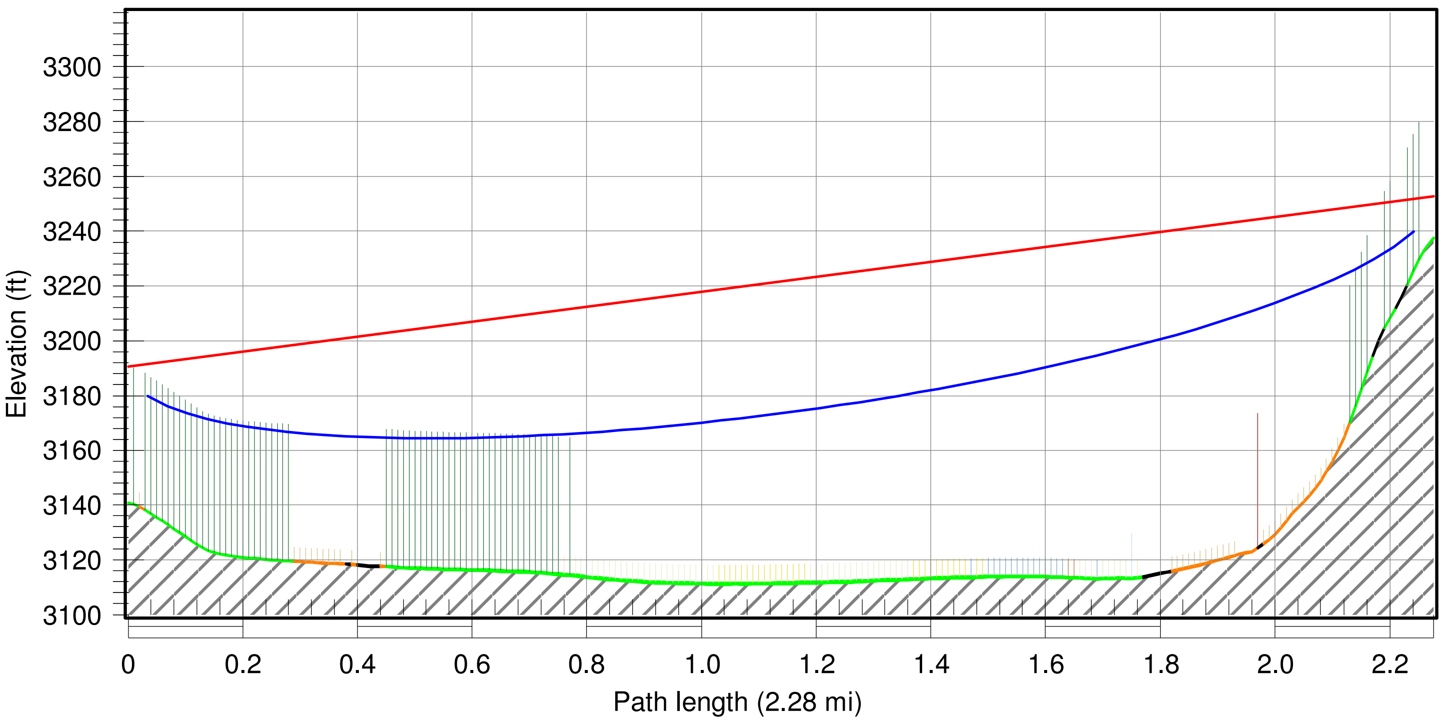
Transmission summary (WWTP-Mtn View Tank.pl5)



F = 460.00 MHz K = 1.33 %F1 = 60.0, 60.0

	WWTP		Mtn View Tank
Latitude	40 54 11.82 N		40 53 00.09 N
Longitude	121 38 34.35 W		121 37 53.97 W
True azimuth (°)	156.86		336.87
Vertical angle (°)	0.51		-0.53
Elevation (ft)	3140.73		3242.02
Antenna gain (dBd)	5.00		9.00
Antenna height (ft)	50.00		20.00
TX line model	LMR-400		LMR-400
TX line length (ft)	75.00		25.00
TX loss (dB)	3.05		1.69
RX loss (dB)	3.05		1.69
Frequency (MHz)		460.00	
Path length (mi)		1.50	
Free space loss (dB)		93.35	
Diffraction loss		31.01	
Net path loss (dB)	110.80		110.80
Radio model	Trio FCC Qx450 12.5k 55.4kbps		Trio FCC Qx450 12.5k 55.4kbps
TX power (dBm)	34.00		34.00
ERP (dbm)	35.95		41.32
ERP (watts)	3.94		13.55
Receive signal (dBm)	-76.80		-76.80
Receive signal (µv)	32.33		32.33
Thermal fade margin (dB)	23.20		23.20

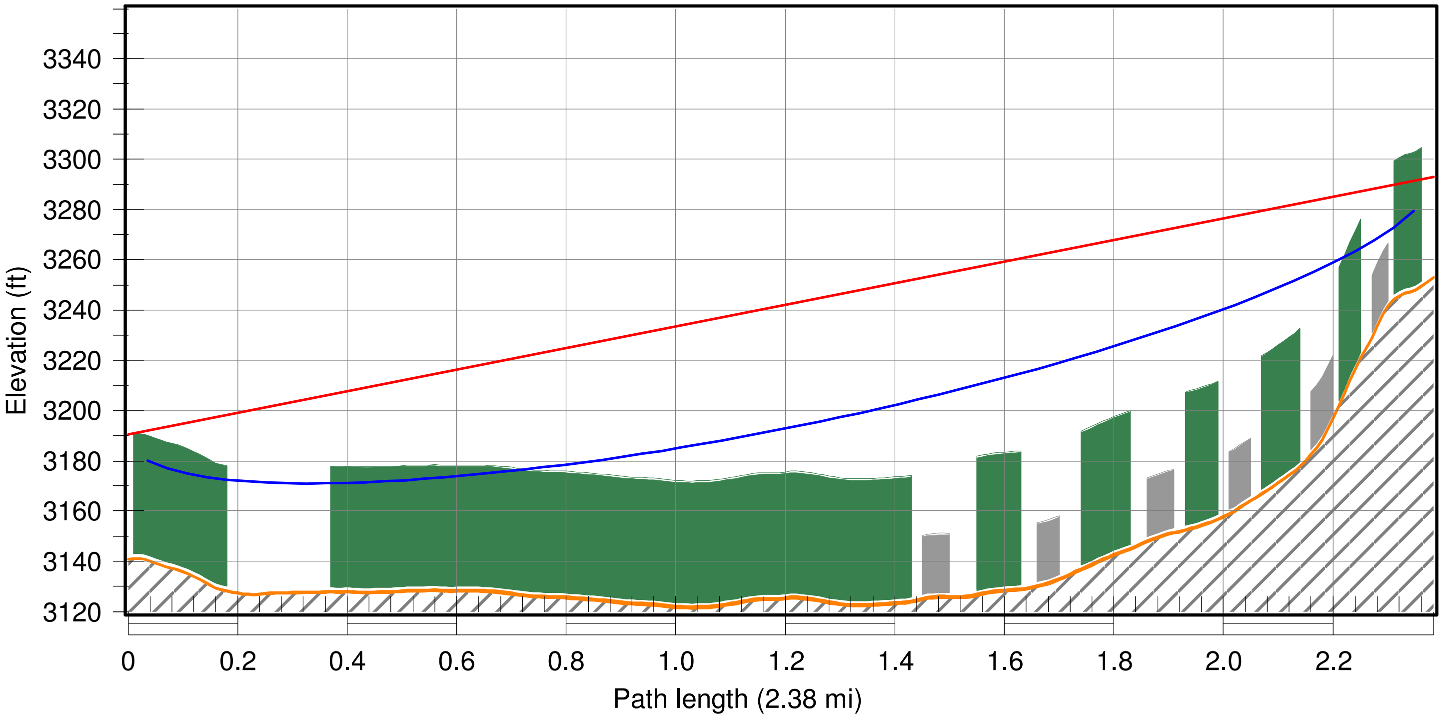
Transmission summary (WWTP-Timber Tank.pl5)



F = 460.00 MHz K = 1.33 %F1 = 60.0, 60.0

	WWTP		Timber Tank
Latitude	40 54 11.82 N		40 52 55.39 N
Longitude	121 38 34.35 W		121 40 34.04 W
True azimuth (°)	229.93		49.91
Vertical angle (°)	0.28		-0.31
Elevation (ft)	3140.73		3237.61
Antenna gain (dBd)	5.00		9.00
Antenna height (ft)	50.00		15.00
TX line model	LMR-400		LMR-400
TX line length (ft)	75.00		25.00
TX loss (dB)	3.05		1.68
RX loss (dB)	3.05		1.68
Frequency (MHz)		460.00	
Path length (mi)		2.28	
Free space loss (dB)		97.00	
Diffraction loss		21.48	
Net path loss (dB)	104.91		104.91
Radio model	Trio FCC Qx450 12.5k 55.4kbps		Trio FCC Qx450 12.5k 55.4kbps
TX power (dBm)	34.00		34.00
ERP (dbm)	35.95		41.32
ERP (watts)	3.94		13.55
Receive signal (dBm)	-70.91		-70.91
Receive signal (µv)	63.67		63.67
Thermal fade margin (dB)	29.09		29.09

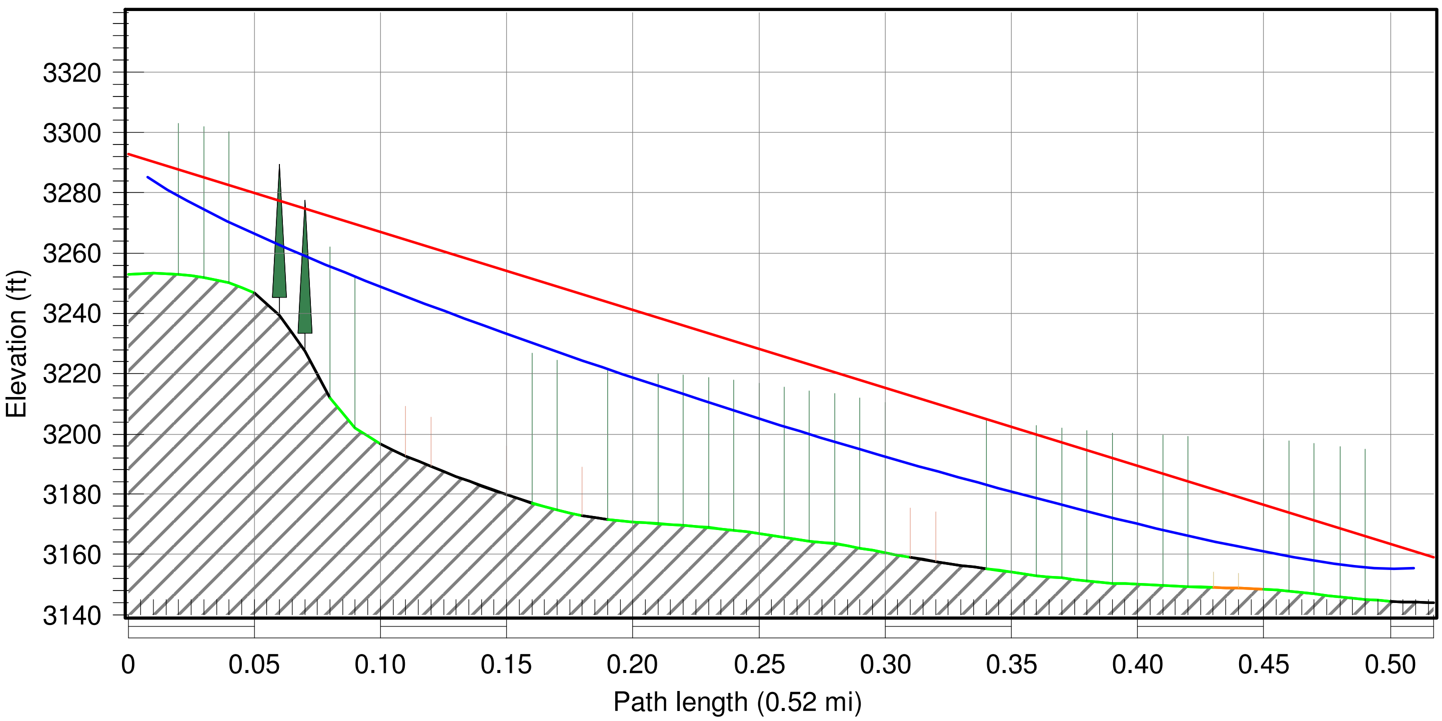
Transmission summary (WWTP-Well #7 (460).pl5)



F = 460.00 MHz K = 1.33 %F1 = 60.0, 60.0

	WWTP		Well #7
Latitude	40 54 11.82 N		40 52 17.00 N
Longitude	121 38 34.35 W		121 39 37.00 W
True azimuth (°)	202.50		22.49
Vertical angle (°)	0.45		-0.48
Elevation (ft)	3140.73		3252.90
Antenna gain (dBd)	5.00		5.00
Antenna height (ft)	50.00		40.00
TX line model	LMR-400		LMR-400
TX line length (ft)	75.00		75.00
TX loss (dB)	3.05		3.05
RX loss (dB)	3.05		3.05
Frequency (MHz)		460.00	
Path length (mi)		2.38	
Free space loss (dB)		97.40	
Diffraction loss		15.00	
Net path loss (dB)	104.20		104.20
Radio model	Trio FCC Qx450 12.5k 55.4kbps		Trio FCC Qx450 12.5k 55.4kbps
TX power (dBm)	34.00		34.00
ERP (dbm)	35.95		35.95
ERP (watts)	3.94		3.94
Receive signal (dBm)	-70.20		-70.20
Receive signal (µv)	69.09		69.09
Thermal fade margin (dB)	29.80		29.80

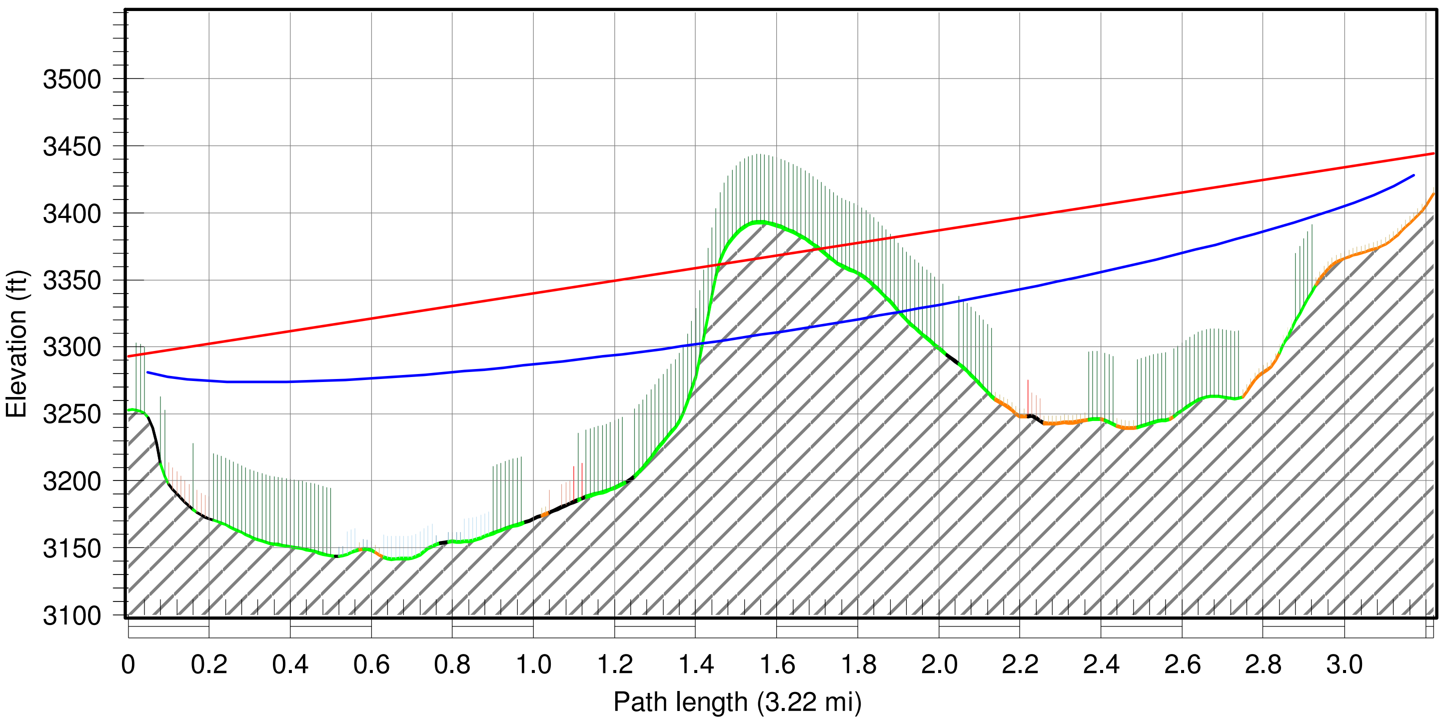
Transmission summary (Well #7-Bartel Lift Stn.pl5)



F = 460.00 MHz K = 1.33 %F1 = 60.0, 60.0

	Well #7		Bartel Lift Stn
Latitude	40 52 17.00 N		40 52 25.41 N
Longitude	121 39 37.00 W		121 40 10.76 W
True azimuth (°)	288.17		108.17
Vertical angle (°)	-2.81		2.81
Elevation (ft)	3252.90		3143.92
Antenna gain (dBd)	5.00		9.00
Antenna height (ft)	40.00		15.00
TX line model	LMR-400		LMR-400
TX line length (ft)	75.00		25.00
TX loss (dB)	3.31		1.78
RX loss (dB)	3.31		1.78
Frequency (MHz)		460.00	
Path length (mi)		0.52	
Free space loss (dB)		84.14	
Diffraction loss		36.91	
Net path loss (dB)	107.84		107.84
Radio model	Trio FCC Qx450 12.5k 55.4kbps		Trio FCC Qx450 12.5k 55.4kbps
TX power (dBm)	34.00		34.00
ERP (dbm)	35.95		41.32
ERP (watts)	3.94		13.55
Receive signal (dBm)	-73.84		-73.84
Receive signal (µv)	45.43		45.43
Thermal fade margin (dB)	26.16		26.16

Transmission summary (Well #7-Ivan Marx Tank.pl5)



F = 460.00 MHz K = 1.33 %F1 = 60.0, 60.0

	Well #7		Ivan Marx Tank
Latitude	40 52 17.00 N		40 53 03.27 N
Longitude	121 39 37.00 W		121 43 09.64 W
True azimuth (°)	286.02		105.98
Vertical angle (°)	0.69		-0.35
Elevation (ft)	3252.90		3414.14
Antenna gain (dBd)	5.00		9.00
Antenna height (ft)	40.00		30.00
TX line model	LMR-400		LMR-400
TX line length (ft)	75.00		50.00
TX loss (dB)	3.05		2.36
RX loss (dB)	3.05		2.36
Frequency (MHz)		460.00	
Path length (mi)		3.22	
Free space loss (dB)		100.01	
Diffraction loss		30.19	
Net path loss (dB)	117.32		117.32
Radio model	Trio FCC Qx450 12.5k 55.4kbps		Trio FCC Qx450 12.5k 55.4kbps
TX power (dBm)	34.00		34.00
ERP (dbm)	35.95		40.64
ERP (watts)	3.94		11.58
Receive signal (dBm)	-83.32		-83.32
Receive signal (µv)	15.25		15.25
Thermal fade margin (dB)	16.68		16.68