Draft Initial Study/Negative Declaration

Water Distribution System High Speed Radio Upgrade

Lead Agency:

Las Virgenes Municipal Water District

4232 Las Virgenes Road

Calabasas, CA

January 2013

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CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) AUTHORITY TO PREPARE A NEGATIVE DECLARATION

The Las Virgenes Municipal Water District (LVMWD) is the managing and operational partner of the Joint Powers Agreement (JPA) and serves as the Lead Agency for purposes of this Initial Study (IS). The LVWMD, as the lead agency, is responsible for the review and approval of the proposed upgrades to the high speed radio system. Based on the findings of the IS, LVMWD has made the determination that a Negative Declaration (ND) is the appropriate environmental document to be prepared for compliance with CEQA. This ND has been prepared pursuant to Sections 15070-15075 of the *State CEQA Guidelines*. The ND documents LVMWD's finding that there are no adverse unavoidable impacts on the environment associated with the proposed project and the project does not require the preparation of an Environmental Impact Report (EIR).

PUBLIC REVIEW PROCESS

In compliance with section 15073 of the *State CEQA Guidelines*, LVMWD provided public notice of the availability of the Negative Declaration for public review and comment. LVMWD will accept written comments on the adequacy of information contained in the Draft Negative Declaration. A 30-day review and comment period has been established starting from Tuesday January 15, 2013 to Thursday February 14, 2013. Following the close of the public comment period, LVMWD will consider this Negative Declaration and comments thereto and determine whether to approve the document and project at their meeting on Tuesday March 12, 2013.

Copies of the document are available for review during the public comment period at the LVMWD offices between the hours of 8:00 AM and 5:00 PM, the LVMWD website, www.lvmwd.com, and public libraries in Calabasas, Agoura Hills, Oak Park, and Westlake Village.

Written comments on the Draft Initial Study/Negative Declaration should be sent to the following:

Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA 91302

Contact: Megan Trott, Junior Engineer
Telephone: (818) 251-2147

Initial Study/Negative Declaration

1.1 Project Data, Contact Information, and Summary of Impacts

Project Title:	Water Distribution System High Speed Radio Upgrade
Lead agency name and address:	Las Virgenes Municipal Water District 4232 Las Virgenes Road Calabasas, CA 91302
Contact person and phone number:	Megan Trott (818) 251-2100
Project Location:	The proposed project sites are located within the footprint of various existing Las Virgenes Municipal Water District facility sites within the City of Calabasas, the City of Westlake Village, the City of Agoura Hills, and in the unincorporated area of Los Angeles County.
Project sponsor's name and address:	Las Virgenes Municipal Water District 4232 Las Virgenes Road Calabasas, CA 91302
General plan designation:	Located within the Public Facility—Institutional Designation
Zoning:	Various ranges from Santa Monica Mountains North Area to Residential Agricultural (RA).
Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation.)	The project proposes to upgrade the existing Supervisory Control And Data Acquisition (SCADA) communication system from a serial radio network to an Ethernet based wireless network. Further discussion of the Project Description is located in Section 2 of this Initial Study/Negative Declaration.
Surrounding land uses and setting; briefly describe the project's surroundings:	The majority of the project sites, such as Indian Hills Tank, Kimberly Tank, Upper Oaks Tanks, and Warner Tank, are located in open space and are hidden from view of the residential areas that are at least over 1000 feet away. The Headquarters building is in the

	vicinity of a school, businesses, residential houses, and open space. LV2 Pump Station is located next to the US 101 freeway. The Tapia Water Reclamation Facility is located in Malibu Canyon adjacent to Malibu Creek and surrounded by Los Angeles County parkland (Tapia Park) to the north, the Salvation Army recreation camp to the west, and state parkland to the south and east. There are no residential uses in the immediate vicinity of the Tapia facility.
Other public agencies whose approval is required (e.g. permits, financial approval, or participation agreements):	LVMWD is a self-governing public agency. No permit from another agency is required for the proposed scope of work related to its core business of providing water and wastewater services within its service area.

1.2 Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture and Forestry	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Greenhouse Gas Emissions	☐ Hazards and Hazardous Materials	☐ Hydrology/Water Quality
☐ Land Use/Planning	☐ Mineral Resources	☐ Noise
☐ Population/Housing	☐ Public Services	☐ Recreation
☐ Transportation/Traffic	☐ Utilities/Service Systems	☐ Mandatory Findings of Significance

1.3 Determination:

On the basis of this initial evaluation:

☒ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required

David R. Lippman

Signature

Director, Facilities & Operations

1/9/13

Date

David R. Lippman

Printed Name

1.4 Explanation of Environmental Impact Evaluation:

CEQA Checklist Questions:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g. the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g. the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Potentially Significant Unless Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section 17, "Earlier Analysis," may be cross-referenced).

5) Earlier analysis may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063 (c) (3) (d). In this case, a brief discussion should identify the following:

   (a) Earlier Analysis Used. Identify and state where they are available for review.

   (b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.

   (c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g. general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The analysis of each issue should identify:

(a) The significance criteria or threshold used to evaluate each question; and
(b) The mitigation measure identified, if any, to reduce the impact to less than significance.

2.0 Environmental Setting and Project Description

2.1 Introduction

This Initial Study/Negative Declaration (IS/ND) has been prepared pursuant to the applicable provisions of the California Environmental Quality Act (CEQA) [1]and its implementing guidelines, known as the *State CEQA Guidelines*.[2] The Las Virgenes Municipal Water District (LVMWD) is the Lead Agency for this IS/ND, which examines potential physical impacts to the environment as a result of implementation of the High Speed Radio Upgrade (proposed project).

This IS/ND is intended to inform LVMWD (as the lead agency for the proposed project) and the public of the proposed project's environmental effects by publicly disclosing those impacts that may be significant and adverse, and by describing measures that would mitigate or eliminate such impacts. This section describes the proposed project, and includes a discussion of the physical setting of the project area, required discretionary actions, as well as other proposed project components and design features.

2.2 Project Locations and Description

The proposed project sites are located within LVMWD's boundaries in western Los Angeles County, California. Aerial maps of the area can be seen in Figures 4-2 and 4-3 in Appendix A.

[1] State CEQA Statute, Public Resources Code Division 13, Environmental Protection, Section 21000 et al.
[2] State CEQA Guidelines, California Code of Regulations, Title 14, Chapter 3, Section 15000 et. seq.

District Headquarters (HQ)

On the roof of building #7 there are 4 existing 10 foot pole masts on the rooftop. One mast will be removed, two masts will remain unchanged, and the fourth mast will have its antennas replaced with new PB antennas[3]. Cabling will be routed through existing conduit into building #7. Regarding the two new PB antennas, one will point to Lower Oaks Tank and the other will point to Castro Peak.

Castro Peak

On the side of the building there is an existing 32 foot Lattice mast[4] with two antennas, as shown in Figure 1. The existing antennas will be replaced with one Omni antenna at the top of the mast, two 3 foot parabolic dish antennas in the middle of the mast, and one PB antenna near the top of the mast. The Omni will provide link connections to Latigo Tank, Ramera Ridge PRS, Seminole PS, and Seminole Tank. One parabolic antenna will point to District Headquarters and the other will point to the Westlake Filtration Plant. The PB antenna will point to Seminole Pump Station. All cabling will enter the building through existing conduit. With the number of antennas and the required separation (5 feet) a new 25 foot Lattice mast and conduit may need to be installed.

Figure 1—Castro Peak

[3] PB Antenna**:** antennas that are similar in size or resemble a large pizza box.

[4] Lattice Mast: triangular in design and the entire structure is constructed by creating a series of horizontal ladders, or internal triangular structures, that secure the tower's three legs.

Westlake Filtration Plant

A 14 foot Lattice mast will be installed on the South-East corner (over the Lab) of the Filtration building, shown in Figure 2. Two PB antennas will be installed on this mast with one antenna pointing to Castro Peak and the other pointing to Kimberly Tank. New conduit will be installed through the roof and into the computer/motor control room.

Figure 2—Filtration building corner where antenna will be placed

Figure 3—Westlake Filtration Plant

Figure 4—Aerial view of Westlake Filtration Plant

Kimberly Tank

The existing 20 foot pole mast on the top of the tank, shown in Figure 5, will be replaced with a Lattice mast of lesser or equal height. On this mast will be an Omni antenna for connection to various sites to the east and a 3 foot parabolic Dish connecting Stunt Road Pump station. Existing conduit will be used for this antenna. A possible wind generator will also be installed on this mast. Additional solar panels will be installed on the roof of the tank adjacent to the existing panels. The control panel will be upgraded to include more batteries and the required equipment to support the radio and solar equipment.

A new 18 foot Lattice mast will be installed on the hillside to the west of the tank for a clear line of sight to the Westlake Filtration Plant. On this mast will be an Omni antenna for connection to the various sights to the west and a PB antenna pointing to the Westlake Filtration Plant. New Conduit will be installed from the mast to the upgraded control panel. Field testing to check the visibility of the proposed antenna was done at the hillside location with a twenty foot pole, shown in Figure 6.

Figure 5—Existing antenna location at Kimberly Tank

Figure 6—Location of new 18' Lattice mast

Figure 7—View looking down from new antenna

Figure 8—View looking up at new antenna

Warner PS, Lift Station 1, and Lift Station 2

A 20 foot pole mast will be installed on the roof of each pump station with a Yagi antenna pointing to LV2 Pump Station. New conduit will be installed through the roof and into the control panel. Warner PS is shown in Figure 9.

Figure 9—Warner Pump Station

Rancho Composting Facility

A 12 foot Lattice mast will be installed on the roof of the control building with one PB antenna pointing to Lower Oaks Tank. New conduit will be installed through the roof and into the computer room.
If a redundant link is needed, a PB antenna can be installed on the existing 32 foot Lattice mast at the Farm Building pointing to Castro Peak. This will require an additional 3 foot parabolic dish antenna at Castro. Existing conduit can be used for connection into the Farm Building.

Figure 10—Aerial view of Rancho Composting Facility facing northeast

Figure 11—Aerial view of Rancho Composting Facility facing south

Lower Oaks Tank

The antenna on the existing 12 foot pole mast next to the control panel shown in Figure 12 will be replaced with two PB antennas with one pointing to Upper Oaks Tank and the other pointing to Cordillera Tank. Two 12 foot Lattice mast antennas will be installed on the hillside to the west of the tank as seen in Figure 13. On the first mast will be two PB antennas with one pointing to the Rancho Composting Facility and the other pointing to the Tapia Water Reclamation Facility. The second mast will also contain two PB antennas with one pointing to the Headquarters Facility and the other pointing to Kimberly Tank.

Figure 12—Existing control panel with antenna

Figure 13—New location of antenna

Figure 14—View downward from new antenna site

Tapia Water Reclamation Facility (Tapia)

A repeater site will be constructed above the plant by Reservoir 1. This will consist of a 40-foot Lattice mast with two antennas. One 3 foot parabolic dish antenna will point to Lower Oaks Tank and a PB antenna will point to the Control building. Both antennas will be mounted near the top of the mast. Power will be provided via the existing conduit the fed the old air compressor.

A single PB antenna pointing to the repeater site at Reservoir 1 will be installed on the existing 40 foot Lattice Mast next to the Control building, existing conduit will provide pathway to the computer room.

Figure 15—Tapia Antenna Tower from back of control building (wide angle)

Figure 16—Tapia Antenna Tower from back of control building (close up)

Figure 17—Tapia Antenna Tower from front of control building (wide angle)

Figure 18—Tapia Antenna Tower from front of control building (close up)

Figure 19—Tapia Repeater Tower location by Reservoir 1 air compressor

Figure 20—Reservoir 1 air compressor

Figure 21—Reservoir 1 air compressor electrical outlets. Will use to power the Tapia repeater

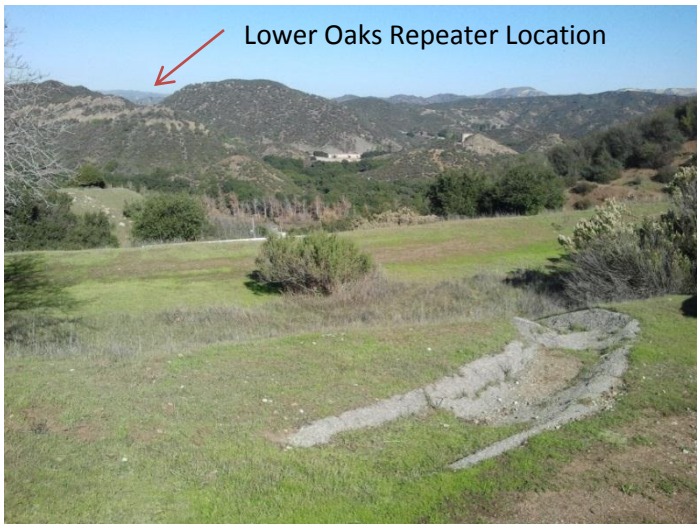

Figure 22—Tapia Repeater location. View to Lower Oaks tank Repeater location

East Sites - Cornell PS, JBR PS, Kimberly PS, Morrison Tank, Morrison PS, Oak Park PS, and Argos Valve. Cornell PS will have its 32 foot pole mast replaced with a Lattice mast of equal height and use existing antenna. Morrison Tank will use the existing 10 foot pole mast existing antenna. All other sites will use existing masts and antennas. Argos Valve will have a 12 foot pole mast installed on the top of the control cabinet with a Yagi antenna connected to the top of the mast.

West Sites – County Line PRV, Saddle Tree PS, Saddle Tree Tank, Westlake Wells, and Equestrian Tank. County Line PRV will have its existing 12 foot pole mast increased to 20 foot and will have one Yagi antenna mounted on the top. Saddle Tree PS will have its pole mast height increased by 12 feet for a total height of 20 feet and use existing antenna; this pump station sits in the middle of a residential street. All other sites will use existing masts and antennas.

005 outfall, Calabasas Tank, Conduit PS, Dardeene PS, Mulwood PS, Mulwood Tank, and Oak Ridge PS. Conduit PS will have a 20 foot pole mast installed on the roof of the Pump Station with a Yagi antenna that will point to Warner Tank. New conduit will be installed through the roof and into the Control panel. The remaining sites will use existing masts and antennas.

Latigo Tank, Ramera Ridge PRS, Seminole Tank, and Seminole PS
Latigo Tank's 20 foot pole mast will remain on top of the tank and use existing antennas and cabling, as shown in Figure 23.

Figure 23—Latigo Tank

Ramera Ridge PRS pole mast will increase in height by 8 feet for a total height of 20 feet and use existing antennas and cabling.

Seminole Tank will increase pole mast height by 8 feet for a total height of 20 feet and use existing antenna and cabling.

Seminole PS, shown in Figure 24, will have a 20 foot pole mast installed on the roof of the Pump Station with a Yagi antenna pointing to Castro Peak. New conduit will be installed through the roof and into the Control panel.

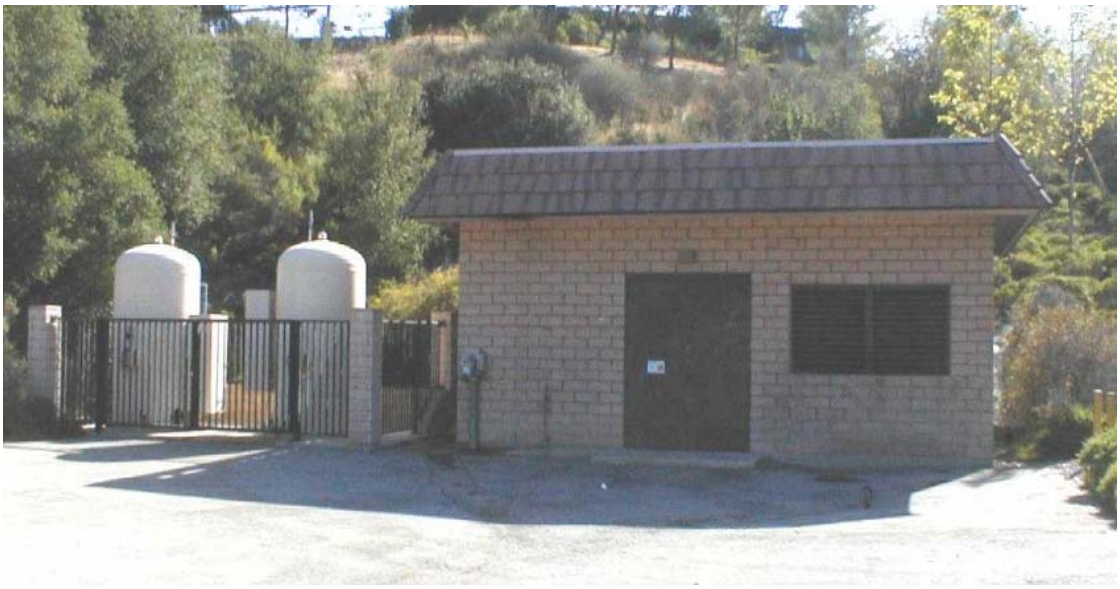

Figure 24—Seminole Pump Station

Upper Oaks Tanks

The existing 8 foot pole mast will be replaced by a 32 foot Lattice mast. This mast will have five PB antennas and a single Yagi antenna mounted. The PB antennas will point to Lower Oaks Tank, LV2 PS, Stunt Road PS, Cordillera Tank, and Warner Tank. The Yagi antenna will point to Upper/Lower Oaks PS. Existing conduit will be used for connection to the Control panel. The Control panel will be upgraded to handle the radio equipment.

Upper/Lower Oaks PS

These sites will use existing 8 foot pole mast and antenna.

Warner Tanks

The existing 12 foot pole mast will be replaced with a 20 foot Lattice mast. This mast will have two PB antennas, one 3 foot parabolic dish antenna, and one Omni antenna. The PB antennas will point to Upper Oaks Tank and LV2 Pump Station. The Parabolic dish will point to Twin Lakes Tank; the Omni will

connect to 005 outfall, Calabasas Tank, Conduit PS, Dardeene PS, Mulwood PS, Mulwood Tank, and Oak Ridge PS.

Existing conduit will be used for connection to the Control panel. The Control panel will need to be upgraded to handle the radio equipment. Some of the trees around the tank will need trimming to provide line of site to the other locations.

Cordillera Tank

The existing mast will be replaced with a 24 foot Lattice mast and have three PB antennas, one Omni antenna, and one Yagi antenna. The PB antennas will point to Lower Oaks Tank, Upper Oaks Tank, and Stunt Road PS. The Omni will connect to Reservoir 3, Mountain Gate PS, Jed Smith PS, Jed Smith Tanks, McCoy PS, and Ranchview PS. these sites will use existing masts and antennas. The Yagi antenna will connect to Indian Hills Tank. Existing conduit will be used for connection to the Control panel. The Control panel will need to be upgraded to handle the radio equipment.

Stunt Road Pump Station

The existing 40 foot Lattice mast, shown in Figure 25, will have its antennas replaced by two PB antennas, one Omni antenna, and one 3 foot parabolic dish antenna. The first PB antennas will point to Cordillera Tank and the second PB antenna will point to Upper Oaks Tank. The Omni will connect to Cold Canyon PS and Saddle Peak Tank. These sites will use existing masts and antennas. The parabolic dish will connect to Kimberly Tank. Existing conduit will be used for connection to the Control panel. The Control panel will need to be upgraded to handle the radio equipment.

Figure 25—Stunt Road Pump Station

Indian Hills Tank

Indian Hills Tank, shown in Figure 26, will have a 20 foot pole mast installed on the top of it with two Yagi antennas; one will point to Cordillera Tank and the other will point to Agoura PS.

Existing conduit will be extended and used for connection to the Control panel.

Figure 26—Indian Hills Tank

LV2 Pump Station

A 20 foot Lattice mast will be installed on the roof of the Pump Station with two PB antennas and one Omni antenna. The first PB antenna will point to Upper Oaks Tank and the second PB antenna will point to Warner Tank; the Omni antenna will connect to Lift Station 1, Lift Station 2, and Warner PS.
New conduit will be installed through the roof and into the control panel.

Agoura PS

A 20 foot pole mast will be installed on the roof of the Pump Station with a Yagi antenna pointing to Indian Hills Tank.

New conduit will be installed through the roof and into the Control panel.

Cold Canyon PS and Saddle Peak Tank

These sites will have their 8 foot pole masts increased to a total height of 20 feet and use existing antennas. The existing mast at Cold Canyon PS is shown in Figure 27.

Figure 27—Cold Canyon Pump Station

LV3 PRV, LV1 Flow Meter, and Upper Twin Lakes PS

An 18 foot pole mast will be installed with a Yagi antenna pointing to Twin Lakes Tank.
New conduit will be installed into the control panel.

Reservoir 3, Mountain Gate PS, Jed Smith PS, Jed Smith Tanks, McCoy PS, and Ranchview PS

These sites will use existing masts and antennas.

Twin Lakes Tank

A 12 foot pole mast will be installed on the top of the tank with one 3 foot parabolic dish antenna pointing to Warner Tank; one Omni antenna connecting LV3 PRV, LV1 Flow Meter, and Upper Twin Lakes PS.

New conduit will be installed to the Control panel. The Control panel will need to be upgraded to handle the radio equipment. The existing tank is shown below in Figure 28.

Figure 28—Twin Lakes Tank Site

Surrounding Land Uses

The majority of the project sites, such as Indian Hills Tank, Kimberly Tank, Upper Oaks Tanks, and Warner Tank, are located in open space and are hidden from view of the residential areas that are at least over 1000 feet away. Examples can be seen in Figures 11-14. The Headquarters building is in the vicinity of a school, businesses, residential houses, and open space. LV2 Pump Station is located next to the US 101 freeway. The Tapia Water Reclamation Facility is located in Malibu Canyon adjacent to Malibu Creek and surrounded by Los Angeles County parkland (Tapia Park) to the north, the Salvation Army recreation camp to the west, and state parkland to the south and east. There are no residential uses in the immediate vicinity of the Tapia facility.

Figure 29—Castro Peak Surrounding Area

Figure 30—Indian Hills Tank Surrounding Area

Figure 31—Latigo Tank Surrounding Area

Figure 32—Stunt Road PS Surrounding Area

Construction Process and Timeline

The proposed project will have a phased construction over a 4 year period. It will start with the East side, then the Central Area, and finish with the West side. Phase 1 will occur during the fiscal year of 2012-2013 and will include construction at Headquarters, Lower Oaks Tank, Upper Oaks Tank, Warner Tank, LV2 Pump Station, and Twin Lakes Tank. Phase 2 will occur during the fiscal year of 2013-2014 and will include construction at Indian Hills Tank, Cordillera Tank, Warner Tank, and Stunt Road PS. Phase 2a will connect the Phase 2 project sites to Phase 1 sites. Phase 3 will occur during the fiscal year of 2014-2015 and will include Rancho Las Virgenes Composting Facility, Castro Peak, Westlake Filtration Plant, Kimberly Tank, and Cornell PS. Phase 4 will occur during the fiscal year of 2015-2016 and will connect Westlake Filtration Plant, Kimberly Tank, Stunt Road PS, and Cordillera Tank. The proposed project will finish with Phase 4a when all of the stations are properly connected.

Project Objectives

This project would improve communication between various LVMWD facilities in order to provide reliable water, wastewater, and recycled water services to customers.

Project Approvals

LVWMD is a self governing public agency. No permit from another agency is required for the proposed scope of work related to its core business of providing water and wastewater services to its service area.

3.0 Initial Study Checklist

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
I. Aesthetics: Would the project:				
a) Have a substantial adverse effect on a scenic vista	☐	☐	☒	☐
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway	☐	☐	☒	☐
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☒	☐
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒

Discussion

a-c) **Less than Significant Impact**. There are existing antennas and masts at the project sites and the proposed project will replace them with taller antennas at most sites. The aesthetics will remain the same except for increased antenna height up to 20 feet, although antennas at multiple sites will not change. The project sites at water tanks are located on hills and range from 400 feet to 1500 feet from the nearest residential areas, and therefore will have less than significant impact. Examples of field testing with a 20 foot pole at two tank sites in residential areas can be seen below in Figures 33-37

The project will not substantially damage scenic resources including rock outcroppings and historic buildings within a state scenic highway. Trees around Warner Tank would need to be trimmed but would not be substantially damaged. The project would not substantially degrade the existing visual character or quality of the site and its surroundings and would have a less than significant impact.

d) **No Impact.** The proposed project will not create any substantial glare or light which would adversely affect day or nighttime views in the area.

Figure 33—Twenty foot pole at proposed antenna location, facing northwest at Lower Oaks Tank

Figure 34— Twenty foot pole at proposed antenna location, facing northwest at Lower Oaks Tank

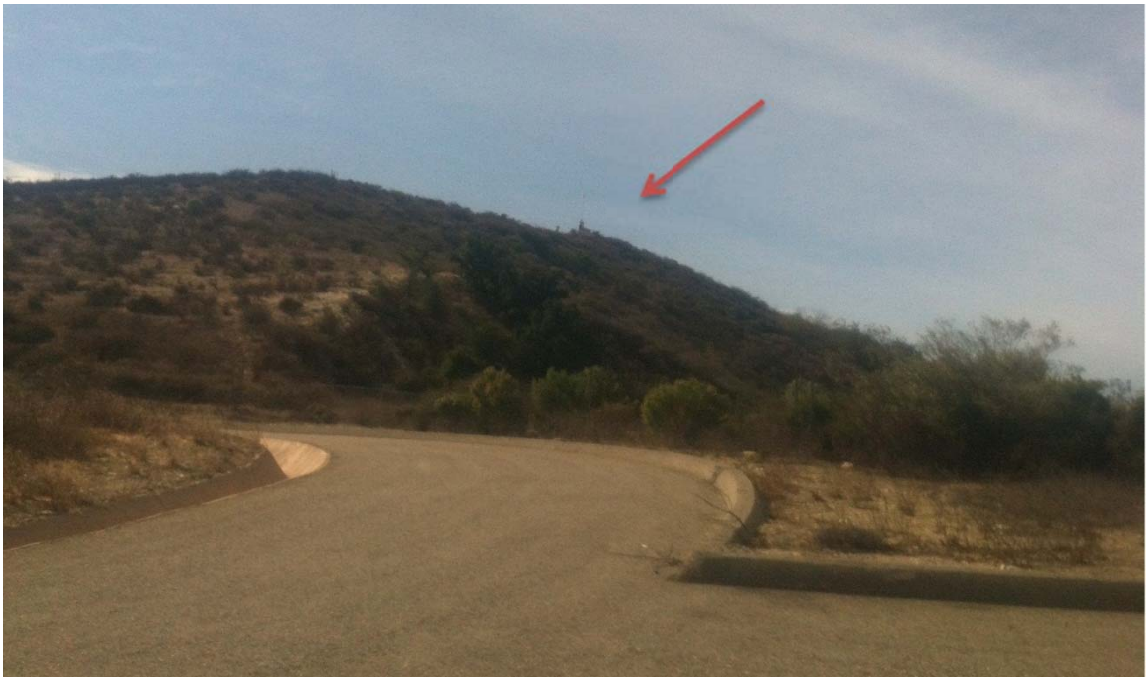

Figure 35—View of 20 foot pole from the driveway leading up to Lower Oaks Tank

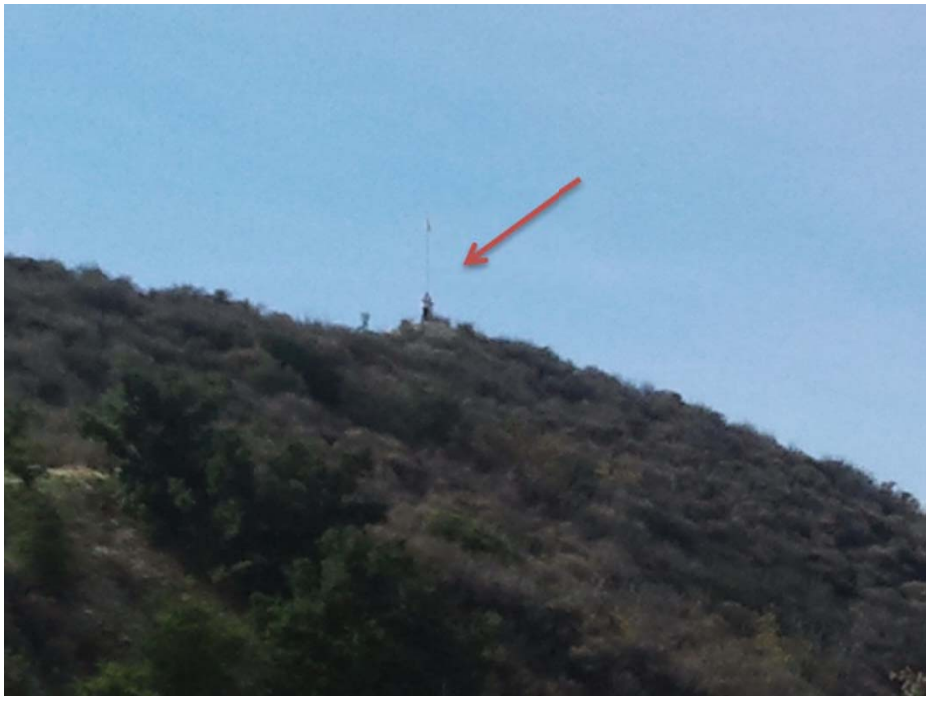

Figure 36—Close up of 20 foot pole from the driveway leading up to Lower Oaks Tank

Figure 37—Looking east at 20 foot pole at Kimberly Tank antenna location from the residential street closest to the project site

II. Agriculture and Forest Resources: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project; and the forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?	☐	☐	☐	☒
d) Result in the loss of forest land or conversion of forest land to non-forest use?	☐	☐	☐	☒
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?	☐	☐	☐	☒

Discussion

a-e) **No Impact.** The project sites and surrounding areas do not contain farming operations or designations as farmland. Because there is no designated farmland there would be no conversion of farmland to a non-agricultural use on or around the project sites. There are no Williamson Act contracts located within Los Angeles County. [5] There would be no conflicts with existing zoning, rezoning, loss, or conversion of forestland, timberland, or timberland zoned Timberland Production. Implementation of the project would not impact agricultural or forestry resources.

[5] California Department of Conservation, Division of Land Resource Protection, "Williamson Act Program," http://www.conservation.ca.gov/dlrp/lca/Pages/Index.aspx. Assessed October 2011.)

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
III. Air Quality: Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☐	☒
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☒
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Discussion

a-e) **No Impact.** During construction and under normal operating conditions, the project would not result in emissions of air pollutants or odors, and would not violate any air quality plans or standards.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
IV. Biological Resources: Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☐	☒
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☐	☐	☒
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☐	☒
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	☒
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒

Discussion

a-f) **No Impact.** All work would be done on existing structures or within existing improvements. There would be no work in any riparian area, wetland, or other area that may contain sensitive or endangered species. Some of the trees around the Warner Tank site will need trimming to provide a line of site to other locations, but because they are not designated as an oak species this will not conflict with Los Angeles County's Oak Tree Permit ordinance.[6] Based on the project sites' location, the project would not conflict with provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other habitat conservation plan.

[6] County of Los Angeles, County Code, Chapter 22.56.2060, "Oak Tree Permit.".

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
V. Cultural Resources: Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	☒
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☐	☐	☒
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☒
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	☒

Discussion

a-d) **No Impact.** There are no designated historical, archaeological, or paleontological resources located on any of the project sites because installation of the project equipment would be on existing structures.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
VI. Geology and Soils: Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42?	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☒
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒

Discussion

a-e) The project sites are not within a designated Alquist-Priolo Earthquake Fault Zone. The antennas and masts can withstand shaking and would not expose people or structures to adverse effects due to seismic ground shaking, liquefaction, or landslides. The radio equipment would be installed on the roofs of existing structures and would not result in soil erosion or loss of topsoil. The proposed project would therefore also not be located on expansive soil, unstable soil, or soil that would become unstable. The proposed project would not generate or dispose waste water. The project would have no impact on soils needed for adequately supporting the use of septic tanks or alternative wastewater disposal systems.

	Potentially Significant Impact	Less than Significant with Mitigation	Less than Significant Impact	No Impact
VII. Greenhouse Gas Emissions: Would the project:				
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	☐	☐	☒	☐
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	☐	☐	☒	☐

Discussion

a,b) **Less than Significant Impact.** There would be minimal greenhouse gas (GHG) emissions during construction resulting from the trucks driving to each site. Once construction is completed there would be no GHG emissions of any significance at the project sites. GHG emissions will have a minimal effect on the environment and will not conflict with any plan, policy, or regulation for reducing GHG emissions.

	Potentially Significant Impact	Less than Significant with Mitigantion	Less than Significant Impact	No Impact
VIII. Hazards and Hazardous Materials: Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	☒
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☒
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☒	☐

Discussion

a-g) **No Impact.** This project does not include any hazardous materials and therefore will not harm the public or environment through the transportation, disposal, or emission of any materials. The project is not within 0.25 miles of an existing or proposed school, airport, or private airstrip. Thus it will not emit hazardous emissions or handle hazardous material in the vicinity of a school, airport, or private airstrip. The project site is not located on any emergency or evacuation routes.

h) **Less than Significant Impact.** With the high rated equipment, there is a less than significant chance of an electrical fire that could expose surrounding areas to wild land fires. Because this is unlikely with the equipment proposed for this project, impacts would be less than significant with enclosures and UL rated electrical equipment.

	Potentially Significant Impact	Less than Significant with Mitigation	Less than Significant Impact	No Impact
IX. Hydrology and Water Quality: Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☐	☒
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☐	☒
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☐	☒
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow	☐	☐	☐	☒

Discussion

a-e)**No Impact.** No construction activities would impact surface water quality and no water would be used for this project. Groundwater supplies will not be used or depleted for this project. Construction activities would not alter the existing drainage pattern, create or contribute runoff water, or otherwise substantially degrade water quality.

f-j) **No Impact.** The proposed project does not include housing, and there is no 100-year flood hazard area in the vicinity of the project sites. The sites are not located downstream of a dam or levee and therefore there is no significant risk of loss, injury, or death due to the failure of a dam or levee. Due to the elevation of the project sites and distance from the ocean the project would not be impacted by a tsunami. The project sites are not located near a large body of water and as a result would not be impacted by a seiche. Because of the elevation of the project sites, there would not be risk of a mudslide.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
X. Land Use and Planning: Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b)Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒

Discussion

a-c) **No Impact.** The project sites are located on existing LVMWD property and would not divide an established community or conflict with any habitat conservation plan or natural community conservation plan. Installation of the proposed radio equipment would not conflict with any existing land use plan.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
XI. Mineral Resources: Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒

Discussion

a,b) **No Impact.** There would be no impact to the loss of a known mineral resource that would be of future value to the region and the residents of the state on any of the project sites. There are no locally important mineral resource recovery sites delineated on the Los Angeles County General Plan located near the project sites. Therefore, there would be no impact to the loss of a locally important mineral resource.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
XII. Noise: Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☒	☐
b) Exposure of persons to or generation of excessive ground borne vibration or ground borne noise levels?	☐	☐	☒	☐
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Discussion

a,b,d) **Less than Significant Impact.** The proposed project will upgrade the radio system and install new antennas and masts. Construction would involve hauling the equipment to the sites and installing it, which would temporarily increase ground borne vibration and noise levels. Due to the distance of the project sites to residential areas, noise levels and ground borne vibration impacts would be less than significant.

c) **No Impact.** Once the construction phase ends, there would be no impact on noise levels from the radio system.

e,f) **No Impact.** The project is not located near an airport land use plan or within the vicinity of a public or private airstrip. As a result, the project would not expose people residing or working in the project area to excessive noise levels. No impact would occur.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
XIII. Population and Housing: Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

Discussion

a-c) **No Impact.** The project would not result in any supplies or incentives for the population growth in the area of the project sites. The project sites are located on sites already used by radio equipment and would not result in the displacement of existing housing or people, and would not necessitate the construction of replacement housing elsewhere. No impacts on population and housing would occur.

XIV. Public Services:

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒

Discussion

a.i., ii., iii., iv., v.) **No Impact.** The proposed project would not result in adverse physical impacts associated with the provision of new or physically altered governmental facilities, the construction of which would cause significant environmental impacts to acceptable service radios or response times of the Los Angeles County Fire Department, the Los Angeles County Sheriff Department, the Las Virgenes School District, local parks, or Los Angeles County libraries.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
XV. Recreation:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Discussion

a,b) **No Impact.** The proposed project would improve radios for District use only. Therefore the project would not increase the use of or require expansion of existing neighborhood and regional parks or other recreational facilities.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
XVI. Transportation/Traffic: Would the project:				
a) Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?	☐	☐	☒	☐
b) Conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Conflict with adopted policies, plans or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?	☐	☐	☒	☐

Discussion

a,b,f) **Less than Significant Impact.** The proposed project would generate at least one construction trip to each site. The amount of trips would be negligible when compared to the traffic along the surrounding roads. The increase in traffic due to construction would have a negligible effect on general traffic conditions and would cease once the project was completed. The radio system would not conflict with any adopted policies, plans, or programs regarding the performance or safety of public transit, bicycle, or pedestrian facilities.

c,d,e) **No Impact.** There is no airport in the vicinity of the project sites so the proposed project would not result in a change in air traffic patterns resulting in substantial safety risks. There are no design features on the radio equipment that would increase hazards. Emergency access would not be affected.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
XVII. Utilities and Service Systems:: Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	☒
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Discussion

a-e) **No Impact.** The proposed project is a high speed radio upgrade and will not exceed wastewater treatment requirements or result in the construction of new wastewater treatment facilities. The proposed project would also not result in the construction or expansion of storm water drainage facilities. There would be no need to use available water supplies.

f) **No Impact.** The proposed project would generate minimal amounts of solid waste disposal during construction only.

g) **Less than Significant Impact.** The proposed project would comply with federal, state, and local statutes and regulations related to solid waste disposal. The proposed project would not result in a significant impact on solid waste management and would be served by a landfill with sufficient permitted capacity. Impact would be less than significant.

	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
XVIII. Mandatory Findings of Significance:				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☒	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☐	☒
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

Discussion

a) **Less than Significant Impact.** The proposed project would not impact biological resources or threaten to reduce the habitat of fish or wildlife species, a plant or animal community, or important examples of the major periods of California history or prehistory. Aesthetics would be affected because the proposed project includes non-natural structures. Overall impacts would be less than significant.

b) **No Impact.** All impacts analyzed for the proposed project would follow existing federal, state, and local regulations regarding hydrologic, hazardous, air quality, and GHG emission regulations. The proposed project would not result in any potentially significant impacts and would therefore not have significant cumulative impacts.

c) **Less than Significant.** The proposed project is not anticipated to have substantial direct or indirect effects on humans.

Appendix A—SCADA Communication System Review Preliminary Engineering Report

Las Virgenes Municipal Water District

SCADA Communication System Review

Preliminary Engineering Report

June 15, 2012

MSO Technologies Inc. 2985 E Hillcrest Dr Suite 101, Thousand Oaks, CA 91362 (805) 379-8668
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0.90	January 25, 2012	MSO	Draft release to LVMWD
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Table of Contents

Table of Figures

1. About This Document

The purpose of this document is to provide Las Virgenes Municipal Water District (District) a preliminary engineering report outlining potential benefits derived from upgrading the existing SCADA communication system to currently available wired and wireless networking technologies. Additionally the document investigates the potential for a backhaul network providing major sites with two radio paths. The existing system provides communication to the District's potable, reclaimed, and composting facilities. The overall focus is migration of the existing system from a serial radio network to an Ethernet based wireless network. The document outlines options for the communication system architecture, radio, and network equipment. Limited field testing of select radio paths was conducted to verify their potential however more work will be required in the final design. While options for Ethernet to serial protocol conversion are covered, PLC replacement options are outside the scope of this document.

2. EXISTING SYSTEMS

The existing system consists of spread spectrum radios, leased line modems, and data trunk lines between main sites.

In 1998, MSO worked with the District to develop the potable communication system upgrade for the Y2K replacement project. The project was initiated to replace the BIF control system which used tone telemetry over telephone lines. The BIF equipment was obsolete and communication over the telephone lines failed regularly.

The District already had some sites using Modicon PLCs so it was a natural choice to continue using the same manufacturer. Modicon (now Schneider Electric) uses a simple industry standard serial communications protocol (Modbus) that was well suited for distributed communications systems of the day. Although antiquated by today's standards, equipment existed to transport the Modbus protocol from serial to Ethernet networks and back to serial again providing the backbone of the existing communications system. This equipment included Modicon's serial bridge multiplexor and NR&D's MEB serial to Ethernet Bridge which was relatively new at the time.

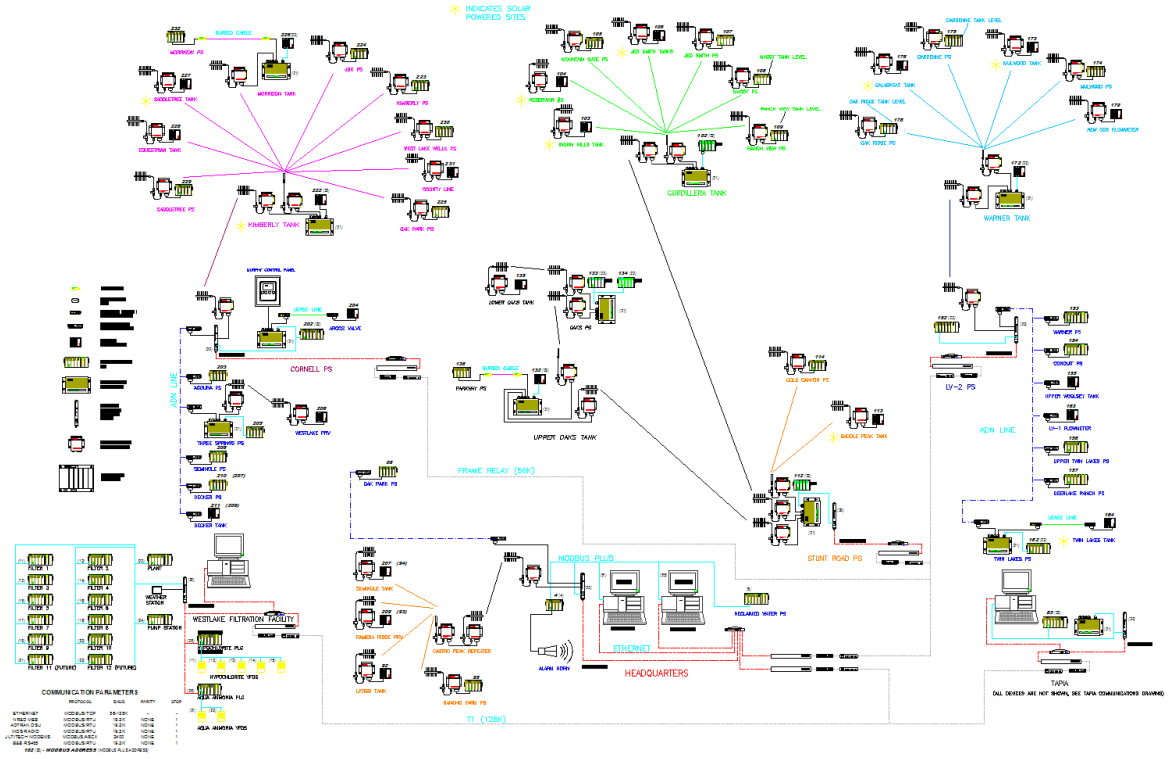


Figure 2-1 Existing SCADA Communication Layout

2.1 Radio Sites

The existing system uses MDS 9810 unlicensed spread spectrum radios at most of the sites. Water distribution facilities are predisposed to typical radio system architectures – the District is no exception. Tanks on hills were prime locations for radio repeaters while pump stations at lower elevations in the valleys could typically see their tank repeater site. Certain sites were selected as major repeaters since they had a commanding view to multiple surrounding sites.

Figure 2-2 MDS 9810 Spread Spectrum Radio

The radios have a range of approximately eight miles from a directional yagi or eight miles radius from an omnidirectional antenna at a repeater site. Most of the District's sites were within the above mentioned radius from their selected repeater site. The radios were addressable to prevent cross talk from different agencies or overlapping repeaters. We've used this version of radio on other power and water projects with great success.

At 900 MHz and less than 1 Watt/m radiated power output, the radio signals need a direct or near direct line of sight between the sites. The 900 MHz radio waves do not "bend" around obstacles like the lower 150 MHz or 450 MHz frequencies do. Therefore line of site is necessary for a radio path to be viable. Therefore sites obscured by hills or blocked by other terrain are not accessible by the radios.

2.2 Leased Line Sites

Sites not viable for radios due to line of site or other reasons were implemented using ADN leased line modems. These modems were digital modems on digital telephone lines which were supposed to be more reliable than regular analog telephone lines. The sites were multi-dropped together to reduce the cost and number of leased lines. The collector modem was at one of the communication hubs and each remote site had a modem. The modems are AC powered and require an inverter to provide power from the battery backup during power outages.

Figure 2-3 Leased Line ADN Modem

2.3 Hub Sites and Communications Backbone

Remote sites are concentrated at so-called hub sites which are in turn connected to the Frame Relay communications backbone which connects the hub sites to District headquarters. Therefore the hub sites have a considerable array of equipment including: Frame Relay termination, CSU/DSU, Ethernet router and switch, and finally an Ethernet to serial bridge. These sites also have wall mount racks for the equipment and a small uninterruptable power supply (UPS).

Figure 2-4 NR&D MEB-TCP Ethernet to Serial Bridge

2.4 Networked District Facilities

Connection to the Tapia Water Reclamation Facility (TWRF) and the Westlake Filtration Plant (WLFP) is established via dedicated T1 line with District headquarters. Each of these facilities has significant internal network infrastructure which is beyond the scope of this document. Alternatives to the T1 line need to be investigated as the District prefers to be self-reliant for all communication paths where feasible.

2.5 Data Transfer

In order to support automatic operation many of the sites share data: tank level, flow, pressure, or number of pumps running or required to run. Some tank sites utilize buried cables for transmitting analog signals to a pump station, while other tank sites have a PLC requiring radios to read the data as necessary. The existing serial protocol doesn't support peer-to-peer communications, so PLCs located at hub sites were programmed to read and write the data to other sites as necessary.

2.6 Limitations of the Existing System

The existing system, while quite fast at the time, is now limited in speed, bandwidth, and flexibility when compared with current wireless technologies. Over the years the addition of new facilities consumed additional network bandwidth. Arguably the current communication system is at or past its peak communication bandwidth.

The existing communication network requires field devices communicate via a single protocol – Modbus. The protocol requires a master which queries the data from the remote devices known as slaves. The original design allows multiple masters via Modicon bridge multiplexors and NR&D's MEB TCP Ethernet to serial bridges. While these devices provided greater flexibility they also limited access by other serial protocols because they will only route Modbus related protocols. This protocol limit precludes the use of security cameras, voice over IP (VOIP) phones and certain types of so-called smart sensors.

The existing system provides security through device-unique keying, slave device addressing, and the Modbus protocol. However Modbus is an open source protocol and with proper knowledge and equipment security could be compromised.

3. CURRENT TECHNOLOGIES

The SCADA industry typically lagged behind most other industries in adopting new communication technologies. The lag was often due to equipment cost and the slow speed with which vendors modified their equipment to take advantage of new technologies. While this lag still exists it is significantly less than it used to be. The near universal adoption of TCP/IP on Ethernet as the de facto standard for communication networks has had the greatest single impact.

Ethernet communication hardware in SCADA systems has become prevalent at all levels of control systems. In the past, Ethernet was only available on the largest of PLC controller platforms because it required large form factor modules for the large Ethernet interface card. Now, Ethernet communications is available on many of the smallest PLC controllers. Ethernet communication typically provides higher speed communications on all PLC platforms.

In addition, Ethernet communication supports peer-to-peer communication protocols. So if a pump station needs to read the nearby tank level, the pump station PLC can be programmed to read the tank level directly rather than relying on a repeater or hub site to relay the data to the pump station PLC. Arguably this adds traffic to the network but the network support significantly greater bandwidth and it also eliminates the need for the intermediate device to read and write the data.

Typically most industrial Ethernet networks use TCP/IP to route traffic from source to destination. This allows multiple protocols to coexist on the network thereby allowing PLCs from multiple vendors on the same network. Further this allows other devices such as IP security cameras, VOIP phones, and other smart networked equipment and sensors to benefit from one common network.

Figure 3-1 Schneider Electric and Allen Bradley Ethernet PLCs

3.1 Ethernet Radio Options

In the last decade, Ethernet radios have significantly improved with reasonably fast data rates, good security, high reliability, and much lower cost. Industrial grade Ethernet radios are now available in a wide range of frequencies and data rates.

Frequency	Data Rate
450 MHz (licensed)	19 Kbps
900 MHz (unlicensed)	256 to 1024 Kbps
2.4 GHz (unlicensed, similar to 802.11b, g, n)	11 to 54 Mbps

5.X GHz (unlicensed, similar to 802.11a)	54 to 300 Mbps
6 GHz and up (licensed)	100 to 1000+ Mbps

Table 1 Radio Frequency and Data Rates

Most of these radios are similar to commercial grade wireless access points for home or office – they require a unique network name and some form of secure code for the remote sites to connect to the master or access point. Other security functions include encryption and a white list of remote radios that are allowed to connect to the master radio.

3.1.1 Backhaul Radios

The options for the backhaul or trunk radios are in the higher frequencies of 2.4 GHz and above. These provide higher data rates and are generally referred to as broadband radios. The 2.4 GHz unlicensed band has been in use for over 10 years and is fairly congested. The 5 GHz unlicensed band has been in use for over 5 years and is getting congested. However with careful planning and fine tuning of the configuration it can be a very cost effective option, especially with the newer technology.

There are two bands within the 5GHz band: the UNII band (5.255-5.325, 5.495-5.705 GHz) and the ISM band (5.725 - 5.875GHz). The UNII band has a lower output power than the ISM band and is therefore used less often due to its reduced range. Many of these radios can be set for different channel bandwidths, the wider channels provide higher data rates but also increase the chances for interference. For example a radio capable of 300 Mbps with a 40 MHz channel would be reduced to 30 Mbps with a 5 MHz channel. Most of the radios can automatically adjust their data rates depending on how strong the signal is. As the signal gets weaker the radio keeps a connection working by reducing the data rate which reduces the receive sensitivity.

The power output of these radios is much less than the 900 MHz radios and therefore require higher gain antennas to achieve similar distances. As a result omnidirectional antennas are more suited for single plant applications and not for the District's needs. Additionally as the antenna gain increases the beam of the antenna becomes much narrower. To achieve longer links especially ones where there could be many other radios, a higher gain antenna may be desirable as the narrower beam will reduce the chance for interference and reduce the area of interference cause by the radio. It becomes very important that the antenna mast not only handle the higher wind loading brought on by the dish antenna but also remain rigid enough to prevent antenna deflection and loss of signal. The installation of the 5GHz radios is more challenging as the antennas take more effort to align and frequency or channel selection requires more planning and tuning to optimize the system for reliability and speed.

Most of the 5 GHz radios provide enhanced features that add to the RF performance of the radios. As an example the radios provide for 2 or 3 coax connections to the antennas for different polarizations which can be set manually by a web-interface or automatically by the radio. Some of the radios are able to use the multiple signal paths to achieve high performance even when the signal is being distorted by buildings or other obstructions.

In addition to the much higher bandwidth, these radios provide very short latency from 5 to 10 ms compared to 100 to 200 ms with 900 MHz radios. Less latency makes it feel like you're on the wired network.

Cost for these radios varies widely depending on the desired bandwidth and age of the technology. Some of the radios we have used have older technology and maximum bandwidth of 54Mbps. These cost from $2,500 to $3,500 (radio and antenna only) for a pair of radios depending on the antennas. Newer radios with higher bandwidth, latest technology, and maximum bandwidth of 300Mbps cost from $6,000 to $8,000 (radio and antenna only) depending on antennas.

All of the 5 GHz radios utilize power over Ethernet (POE), most manufactures use Mode B, which use extra conductors in the Ethernet cable, 4,5,7 and 8, to provide power to the radio. Mode A puts the power on the data pairs 1,2,3 and 6. Unfortunately not all radio vendors meet the POE 48VDC standard and some require proprietary POE equipment to provide 12 or 24 VDC.

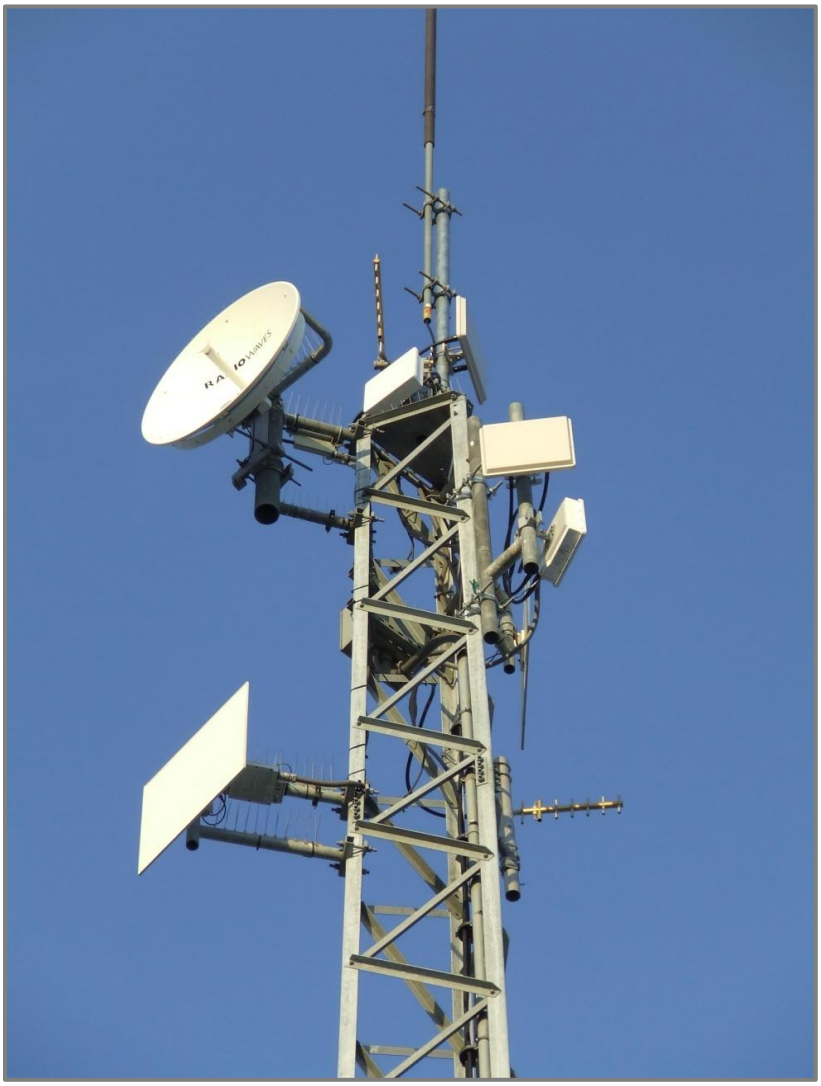


Figure 3-2 Different Types of Backhaul Radio Antennas

Many of the broadband radios combine the transceiver and antenna into one package that mounts on the radio mast resembling a pizza box. These integrated radios have limited antenna gain and while they may work for shorter distances of three to five miles, they also have a wide beam and generate and pickup more interference.

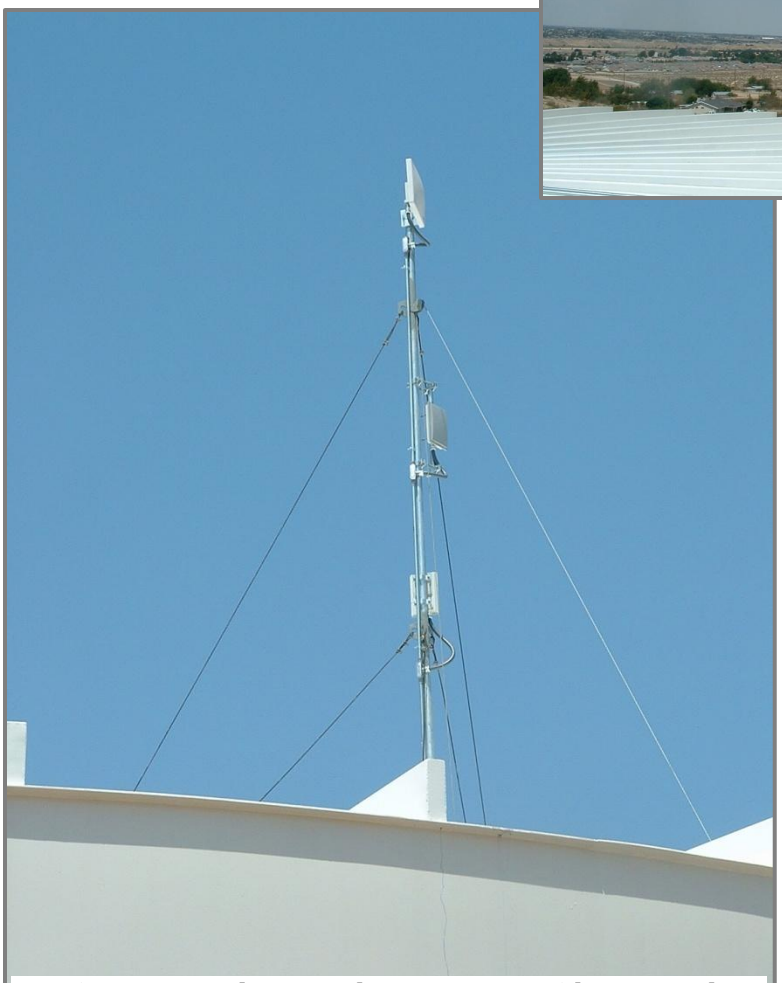


Figure 3-3 Tank Mounted Antenna Mast with Integrated Transceiver and Antenna

Another option is to use semi-licensed 4.9 GHz radios. These radios are a little more costly than the 5 GHz radios and are designated for public-safety use. An FCC application is required to use these radios. The FCC will determine if the District qualifies and if there are other existing users of this band in the District's area. If there are other users it will require the District work with that agency or agencies to determine if sharing of the frequency band is possible. If there are no existing users in the area the District will become the frequency coordinator for the area.

A final option is to use licensed broadband radios. These operate in the 6 to 23 GHz and higher frequencies. The bandwidth goes up into the multi-gigabit range but so does the price with a pair of radios costing $15,000 to $25,000 (radio and antenna only). These radios are often two part units with an outdoor unit and an indoor unit. They also require larger antennas which are also more expensive to install than the other options.

3.1.2 Point to Multipoint Radios

The backhaul network connects to the field sites via point-to-multipoint radios. MDS has three 900MHz Ethernet radio models: iNET, iNET II, and Mercury. All three use the 902-928 spread

spectrum frequencies but they are not compatible products. The iNET II uses a wider channel than the iNET, and the Mercury uses an even wider channel. The iNET 900 operates at 256/512 Kbps, iNET II operates at 512/1024 Kbps, and the Mercury supports up to 5Mbps. The higher bandwidth of the Ethernet iNET and iNET II require a stronger radio signal with an RSSI of better than -75. The Mercury requires even stronger strong signal strength and with its very wide channels has very limited range for most SCADA applications.

Figure 3-4 MDS iNET II 900 MHz Spread Spectrum Ethernet Radio

The 900 MHz Ethernet iNET radios use the same radio antenna, cables, and surge protectors as the existing 900 MHz serial spread spectrum radios. The Mercury radio requires an additional GPS antenna. While the iNET radios can be a direct replacement of the MDS 9810 serial radios, the iNET radios will not work as well at sites with weak radio links. Weak links are more pronounced with Ethernet as the sites will no longer need to be polled in rotation. Instead Ethernet will support multiple connections to a single site with multiple sites being polled simultaneously. This faster polling rate will make the communication errors more pronounced as more retries will be required.

Another option for a 900 MHz radio is the Trio J Series which costs about $500 less than the MDS iNET radio. However while MSO has significant practical experience with iNET radios we have little practical experience with the Trio radios and therefore should further test the Trio radios before considering them as an alternate to the iNETs.

Figure 3-5 Trio J Series 900 MHz Spread Spectrum Ethernet Radio

3.2 Ethernet to Serial Conversion

Even though the radio network and PLCs are both in need of being upgraded the radio network is being upgraded first to support any future PLC upgrade. This means the field sites will require an interim solution to convert the Ethernet ModbusTCP protocol to serial Modbus. Two options exist for this interim need: dedicated Ethernet to serial conversion hardware or configure the iNET radio as an Ethernet to serial bridge. Some sites may be better served by one or the other.

3.2.1 Dedicated Ethernet to Serial Converter

In the original design there are several large Ethernet to serial converters installed at the communications hubs. These serial to Ethernet converters were expensive (approx. $4,000) and have large form factors. The converters were too large to put in small tank or PRV site panels and were too expensive for thirty plus sites.

Smaller less expensive Ethernet to serial converters have since been developed. Current day converters bridge between Ethernet and serial communication media as well as provide protocol

conversion, e.g. ABCIP to Modbus. There are some limitations to the protocol conversion but it does provide an easy and inexpensive way to bridge protocols. In this scenario the Ethernet port of the radio would be plugged into an Ethernet switch or directly into the converter. The inclusion of an Ethernet switch would allow service personnel to connect locally to the PLC without disconnecting the network.

Figure 3-6 Digi One IAP Protocol Bridge and Lantronix Ethernet to Serial Bridges

The Ethernet to serial converters are typically DIN rail mountable and are DC powered which works well with the existing back up power at the sites. These bridges can be added to existing sites with minor wiring modification and power demand.

Sites that require multiple serial devices to be bridged to the Ethernet network can utilize a multiple port bridge. These devices provide the bridging described above but not the protocol conversion. The single and multiple port devices can be configured through the Ethernet network and provide valuable diagnostics over the network.

Figure 3-7 Digi One Port Server TS
Multiple Port Ethernet to Serial Bridge

3.2.2 iNET as Serial Radio

The iNET radios can be configured to operate as a serial radio and convert ModbusTCP to serial Modbus. In this scenario the serial port of the radio would be connected directly to the serial port of the PLC. However this option would not work by itself at a site with multiple Modbus devices needing conversion and would require service personnel to disconnect the PLC from the network in order to connect directly to it.

3.3 Security Cameras (IP Cameras)

Security cameras have evolved from co-axial closed-loop cable systems to live streaming on Ethernet networks. However, IP cameras do require significant bandwidth on a network and a few high resolution cameras streaming constantly can decimate even a hardwired network. Newer cameras have the ability to limit the data or can be activated by motion. However the cameras can be needlessly triggered by animals and on windy days. Our experience is it's best to break up the radio network into several smaller sub networks to separately handle the camera traffic. However this method requires additional radios at the main repeater sites and additional networking equipment.

The topic of security cameras must be discussed during the network design if the District seriously expects to implement IP cameras or other network devices in the future. This discussion should include SNMP monitoring software also.

4. PROPOSED SYSTEM

Advances in communication equipment provide the potential for a reliable, high speed, fault tolerant, and flexible Ethernet SCADA communication network. The SCADA network needs to be built and sized from the control center at District headquarters (HQ) out to the sites since all the data must come back to this location. District headquarters currently has Ethernet connectivity to some sites. Low speed frame relay (56 Kbps) is used to connect to the Cornell and LV2 pump stations while higher speed T1 (1.5Mbps) circuits connect to the Rancho Las Virgenes Composting Facility (Rancho), Tapia Water Reclamation Facility (Tapia) and Westlake Filtration Plant (WLFP). With proper planning these paths can be retained and incorporated into the new system to serve as a backup if desired. However these links, especially the frame relay links, are bandwidth limited, so their performance as backup links will be significantly limited compared with the backhaul radio's potential data rate of 20 Mbps.

One of the District's spoken desires is to eliminate or at least reduce their dependence on outside agencies for communication links. Doing so will provide annual cost savings based on the number of lines replaced but it will also mean the District will be responsible for maintaining critical portions of their communication network. Our approach is to design a backhaul radio network with multiple paths between nodes making up the backhaul network. This will require two or possibly three pairs of radios at some sites, as opposed to the current one pair, as well as multiple port routers to support the routed network design. If a radio or path obstruction problem occurs the network will route to a backup path to seamlessly restore communications. Recognize it may not be feasible or economical to have a backup path for all backhaul sites.

4.1 Proposed Backhaul Radio Network

The main data collection facilities are HQ, WLFP, Tapia, and Rancho. Unfortunately these sites are all in valleys which limit the radio path options. MSO has developed a preliminary network plan for the backhaul sites. This was developed based on our experience with the District's existing system and our topographic mapping software. The proposed plan was reviewed with District staff prior to MSO conducting any field testing in case the District's review altered the proposed paths. Field testing was conducted the week of May 7, 2012. Results of the testing are shown in the logical network diagram shown below.

The purpose of the field work was to test segments of the proposed backhaul network that are not part of the existing communication system in order to verify the topographic paper study. While not all backhaul paths were tested, paths with questionable line of sight were given priority and alternate paths tested as time allowed. One major result from the field work is recognition of Lower Oaks Tank as a major site in the new communication network. The Lower Oaks Tank site is proving to be the key site in terms of providing the critical second network path to HQ, paths to Rancho and Tapia facilities, and connecting the eastern portion of the communication network with the western portion. Additionally Lower Oaks Tank provided the alternate backhaul segment when a path from Cornell PS to Kimberly Tank proved to be unachievable. The antenna location is outside the Lower Oaks Tank fence line but mostly hidden from the homes to the east.

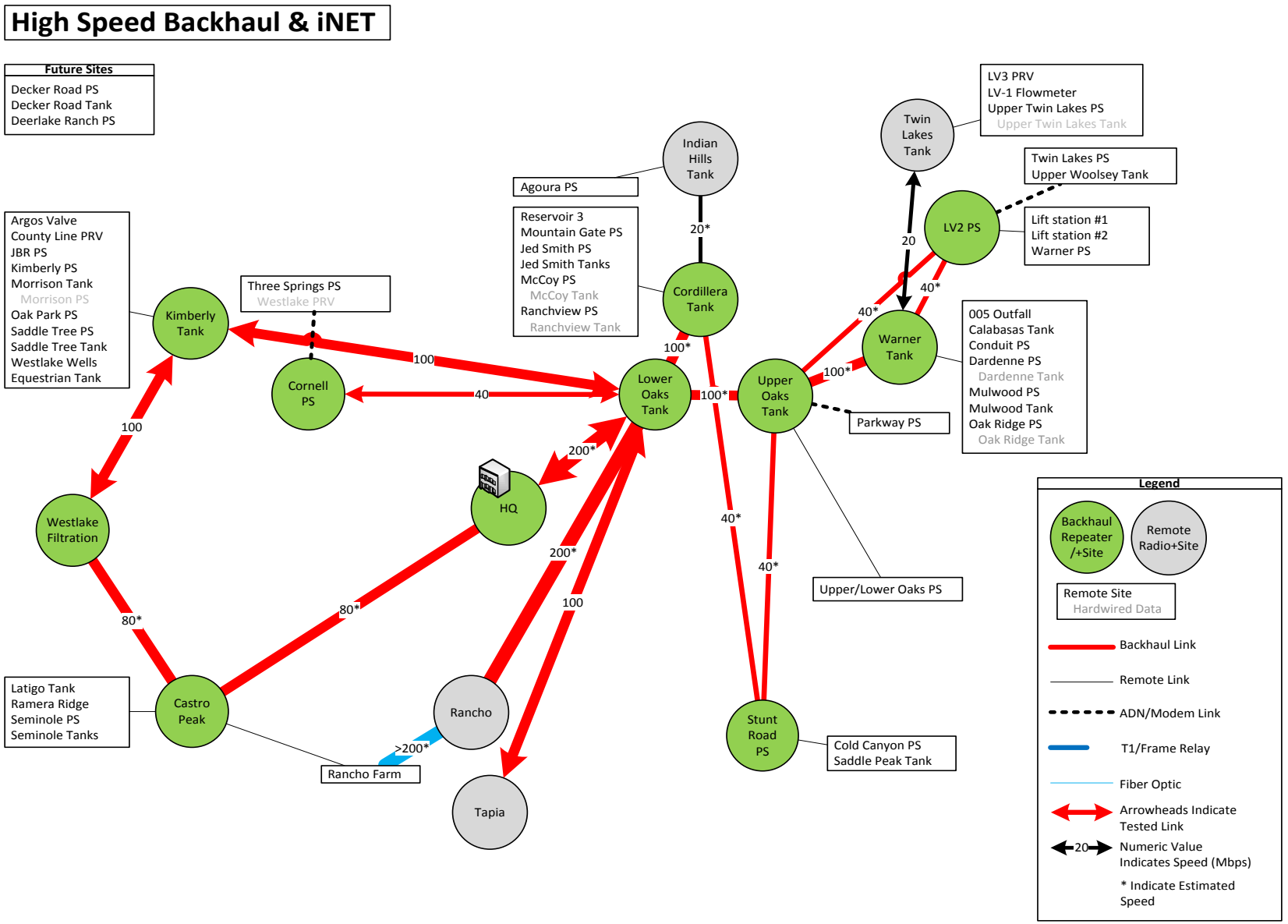


Figure 4-1 Logical Network Diagram

4.1.1 Backhaul Network West Side

The western portion of the backhaul network consists of the following paths: HQ to Castro Peak, Castro Peak to WLFP, WLFP to Kimberly Tank, Kimberly Tank to Lower Oaks Tank, and Lower Oaks Tank to HQ. Castro Peak to Kimberly Tank is an alternate backup path for future consideration but may not be currently justifiable. Unfortunately Cornell PS is unable to be a major connection point in the backhaul network as two high bandwidth paths were not achievable. Currently the proposed network reaches Cornell PS via Lower Oaks Tank. Given the import of Cornell PS, a backup connection is highly recommended. This can be accomplished via lower bandwidth wireless or leased line connection.

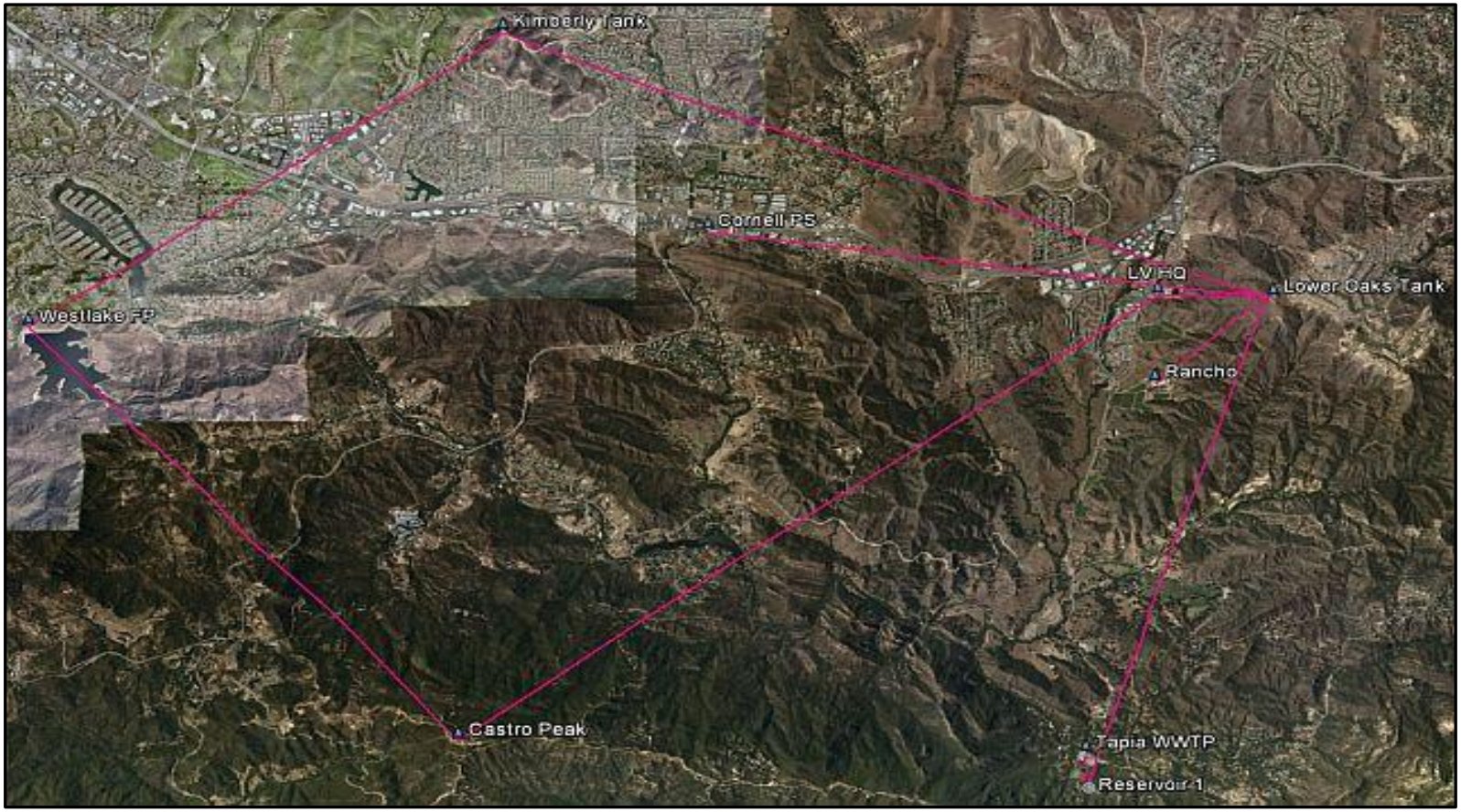


Figure 4-2 Backhaul Network West Side

4.1.2 Backhaul Network East Side

The eastern portion of the backhaul network consists of the following paths: Lower Oaks Tank to Cordillera Tank, Cordillera Tank to Stunt Road PS, Stunt Road PS to Upper Oaks Tank, Upper Oaks Tank to Warner Tank, Warner Tank to LV2 PS, LV2 PS to Upper Oaks Tank, and Upper Oaks Tank to Lower Oaks Tank. A possible but untested path between Stunt Road PS and Kimberly Tank is a future consideration but may not be currently justifiable.

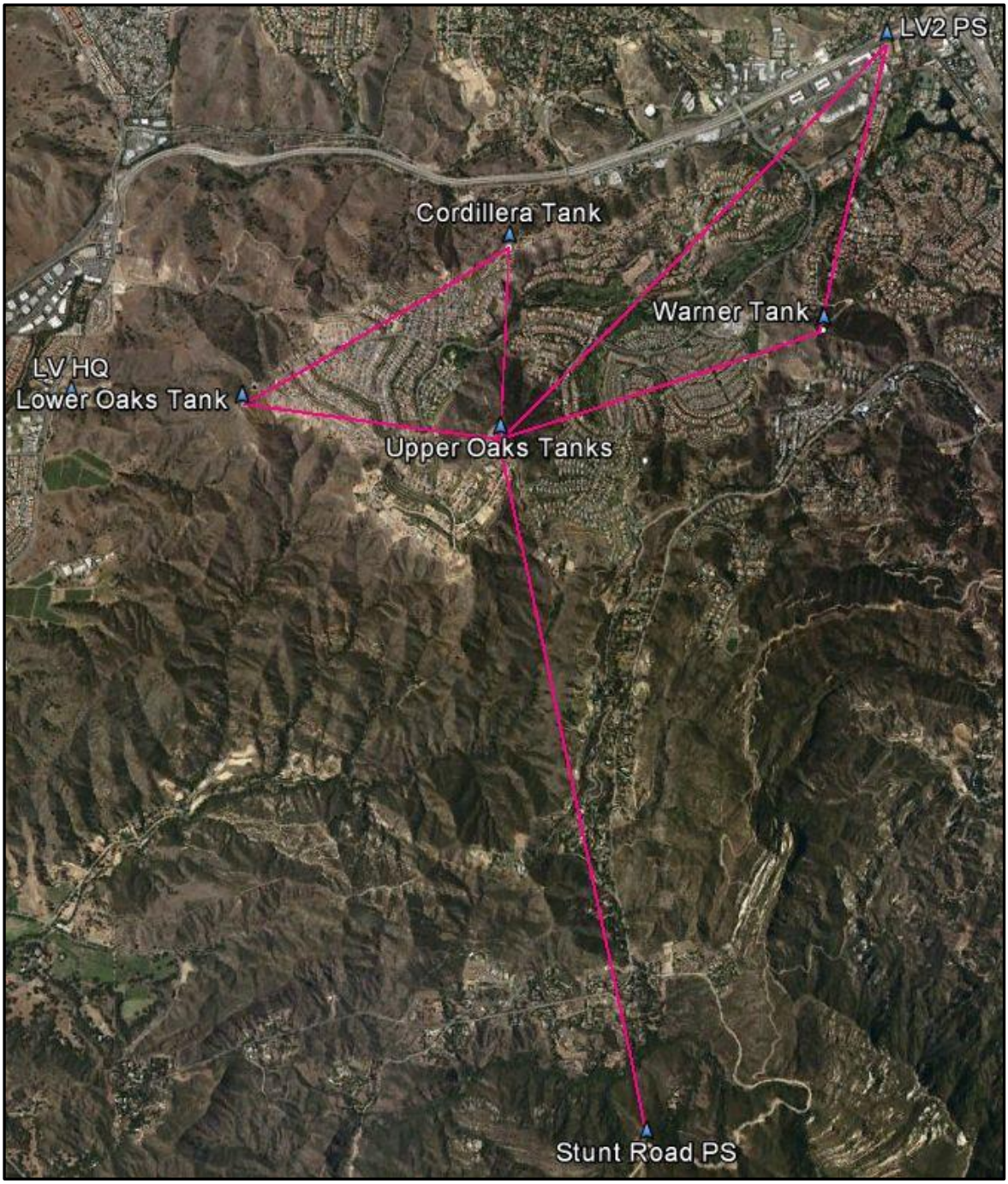


Figure 4-3 Backhaul Network East Side

4.1.3 District Headquarters

The District's headquarters is a campus like facility with several office buildings presenting itself to the street as more of an office environment. Adding radios and large profile antennas will be a challenge aesthetically. The antenna mast needs to be substantial enough to support the larger antennas and tall enough to establish the necessary links with other sites. The south hill behind the headquarters building limits where a mast can be located to establish the path to Castro Peak.

Figure 4-4 View From Hose Drying Rack to Castro Peak

Figure 4-5 View From Hose Drying Rack to Lower Oaks Tank

4.1.4 Castro Peak

Castro Peak is one of the highest elevations in the District and is visible to HQ, Rancho, and WLFP. It is currently a repeater site collecting data at HQ from Ramera Ridge, Latigo Tank, and Seminole Tank. Two problems exist with this site: it is a leased site and the dirt road leading to the site may not be passable during rainy weather. The proposed backhaul network's equipment requirements (antenna, routers, rack, etc.) may require lease negotiations in order to install the additional equipment. The existing tower will need to be evaluated to determine if it can handle the wind loading for multiple panel or dish antennas. There are multiple towers and users of this site so additional testing will be required to determine if there are other 5 GHz radios installed on the adjacent towers that could interfere with the proposed District radios. Time did not allow testing at Castro Peak. These issues will need to be addressed in the detailed design.

Figure 4-7 View From Castro Peak to Headquarters

Figure 4-6 Castro Peak Radio Building (circa 1998)

4.1.5 Headquarters to Castro Peak

This is an existing proven radio path that has worked well with the 900 MHz radios. At just over six miles the proposed 5 GHz radios will require higher gain antennas at least at one end of the path. We plan to test the path with an integrated (transceiver and antenna) radio at HQ and a two foot dish or two foot square panel antenna at Castro Peak. This path was not tested due to limited time with tower crew.

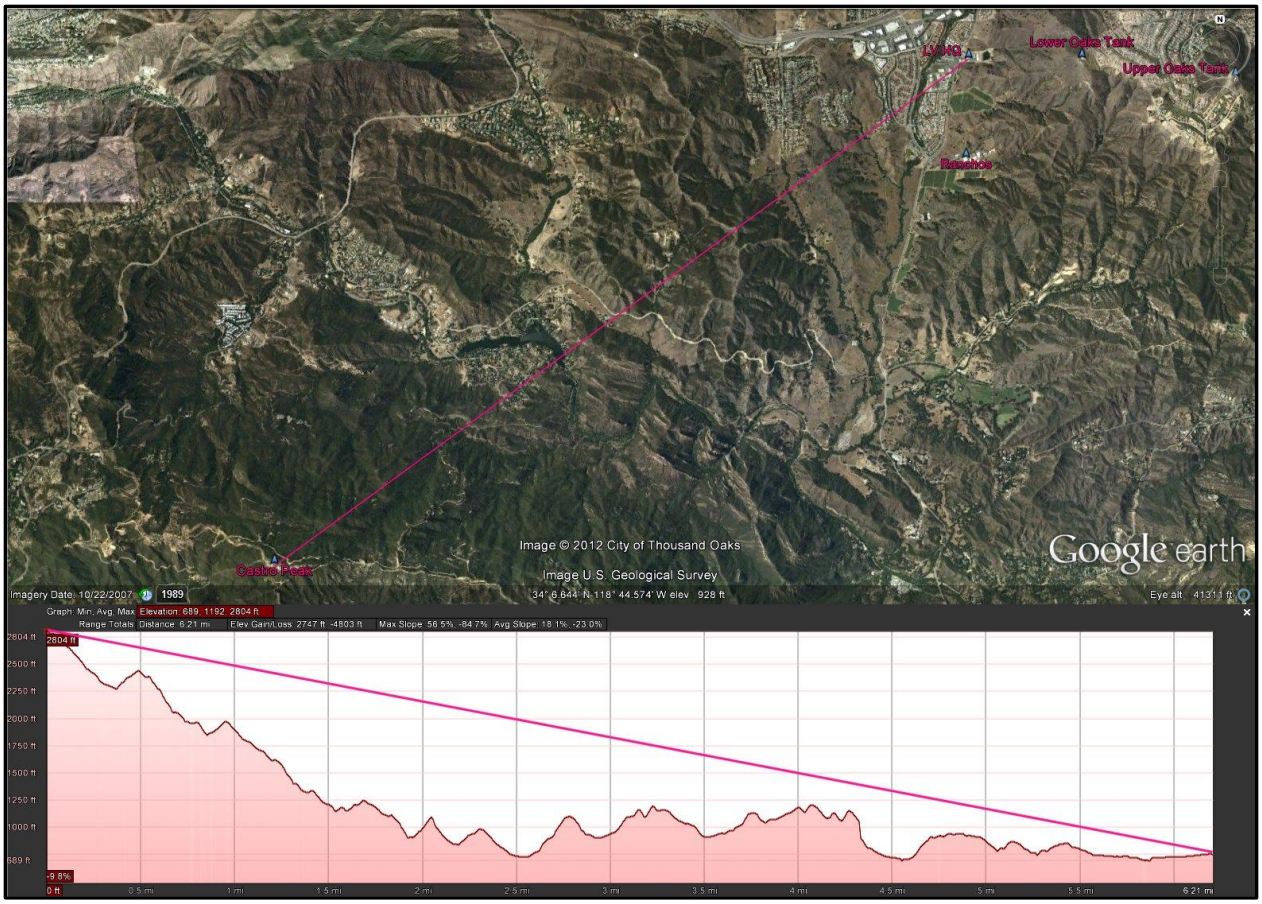


Figure 4-8 Castro Peak to HQ Path and Profile

4.1.6 Castro Peak to Rancho

This path is nearly identical to the HQ to Castro Peak path only slightly shorter. Since Rancho is so close to HQ and the paths are very similar it is probably not required to test this path unless the field testing of the HQ to Castro Peak suggests otherwise. If tested the same radio and antenna configuration will be used as for the HQ to Castro Peak link. This path is not a requirement since a path exists from Lower Oaks Tank to Rancho. However this path could be considered as a backup path into Rancho in the future.

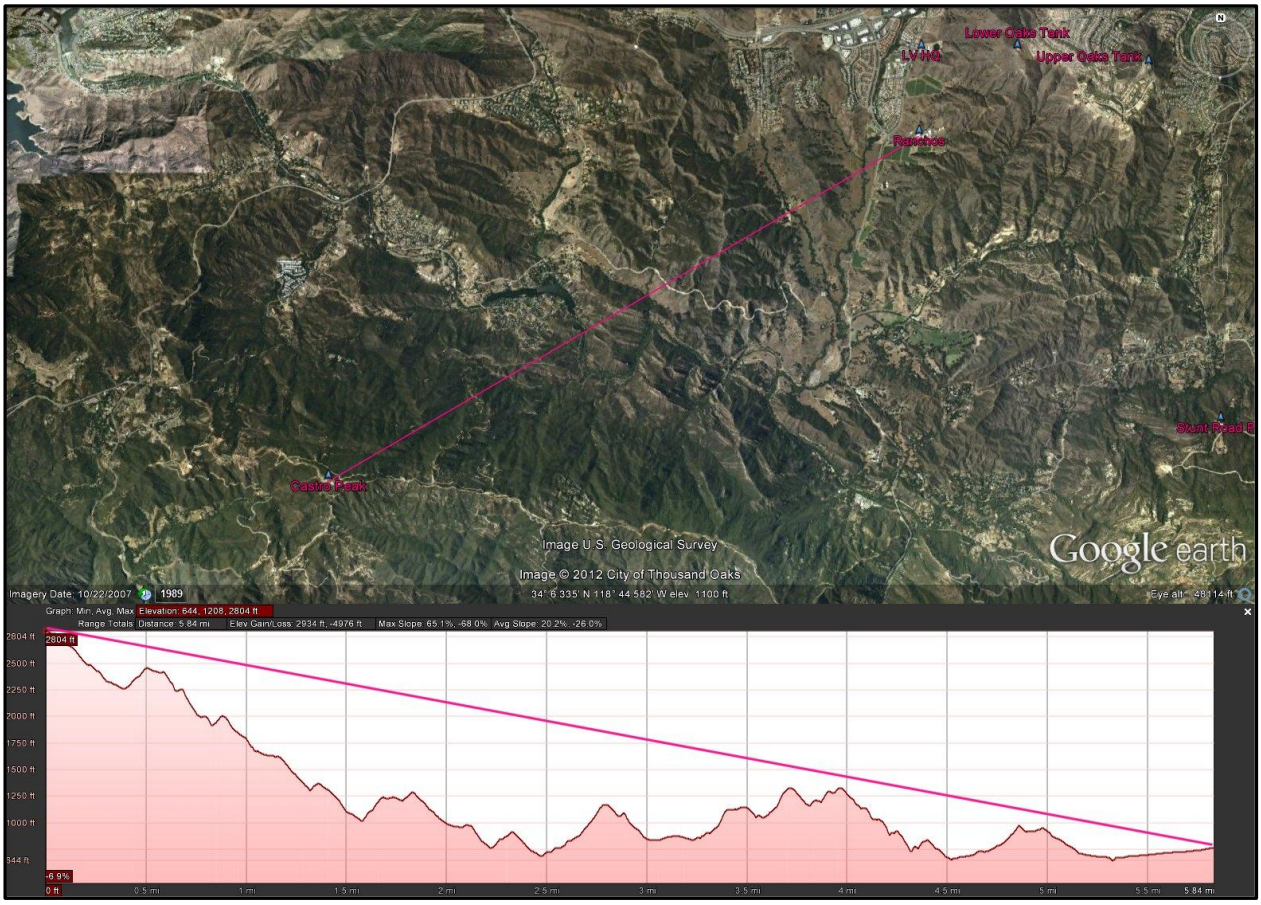


Figure 4-9 Castro Peak to Rancho Path and Profile

4.1.7 Castro Peak to WLFP

This radio path is just less than five miles in length and looks good topographically. For this path test we will use a two foot dish or two foot square panel antenna and integral radio at Castro Peak and an integral radio at WLFP. During testing we will need to determine where the radio and antenna mast should be mounted. The antennas for the two links (Castro Peak and Kimberly) will require five feet of separation on the mast. Due to time constraints with the tower crew this path was not tested. While the path looks good topographically the tower issues need to be further investigated during detailed design.

Figure 4-10 View From WLFP to Castro Peak

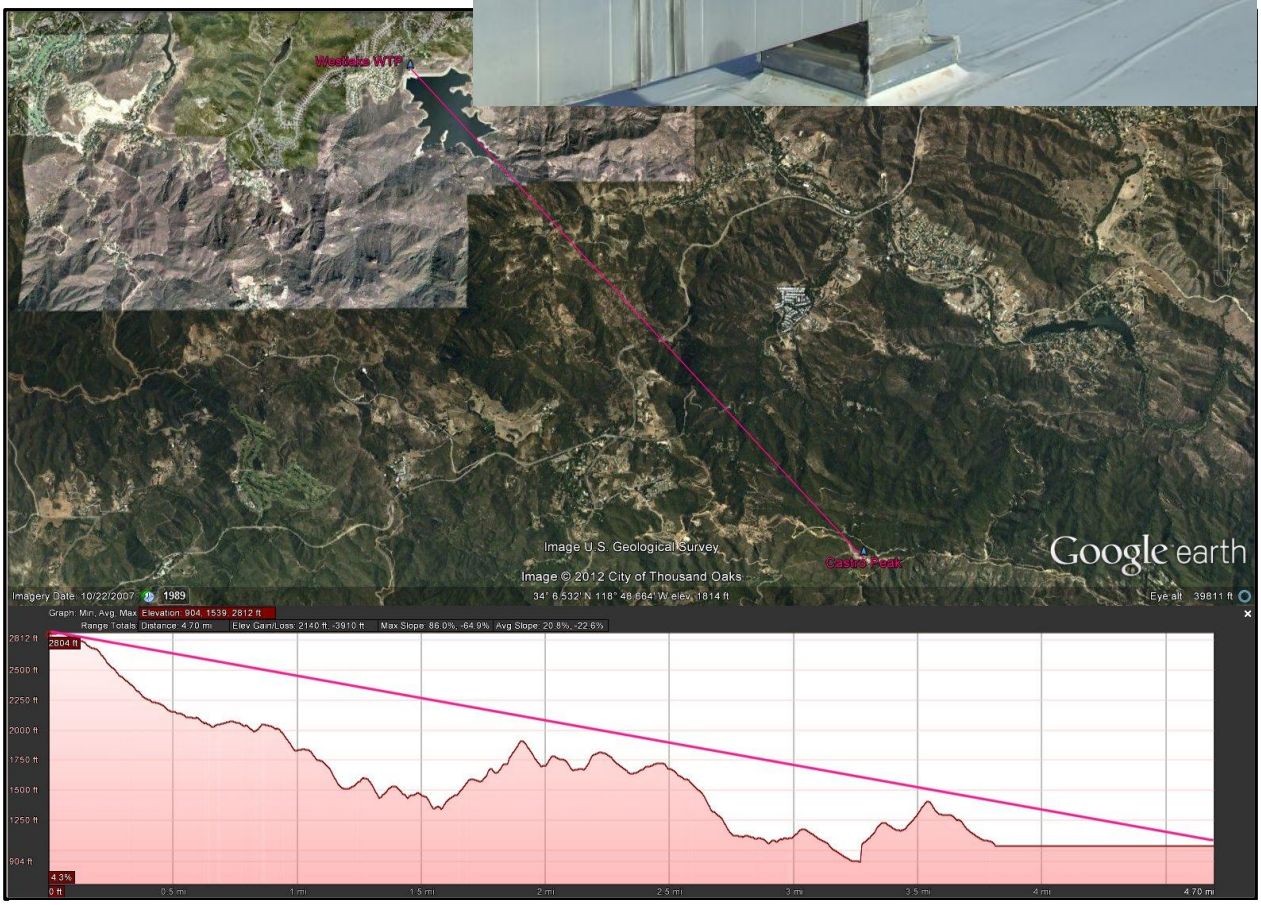


Figure 4-11 Castro Peak to WLFP Path and Profile

4.1.8 WLFP to Kimberly Tank

This path is just over four miles. Field testing verified it is a solid path for one of the northwest segments of the backhaul network. For testing the WLFP antenna was located on the northeast portion of the roof. If one mast is used the mast for WLFP will need to provide five feet of separation between the Kimberly Tank and Castro Peak antennas.

Kimberly Tank is recessed into its hill and is mostly hidden from view. A substantial radio mast is required to support the two 5 GHz antennas and the multiple 900 MHz antennas required for the numerous field sites Kimberly Tank serves. The site is solar powered and will need extensive additions to its solar panels and batteries to support the proposed equipment.

Figure 4-12 View From WLFP to Kimberly Tank

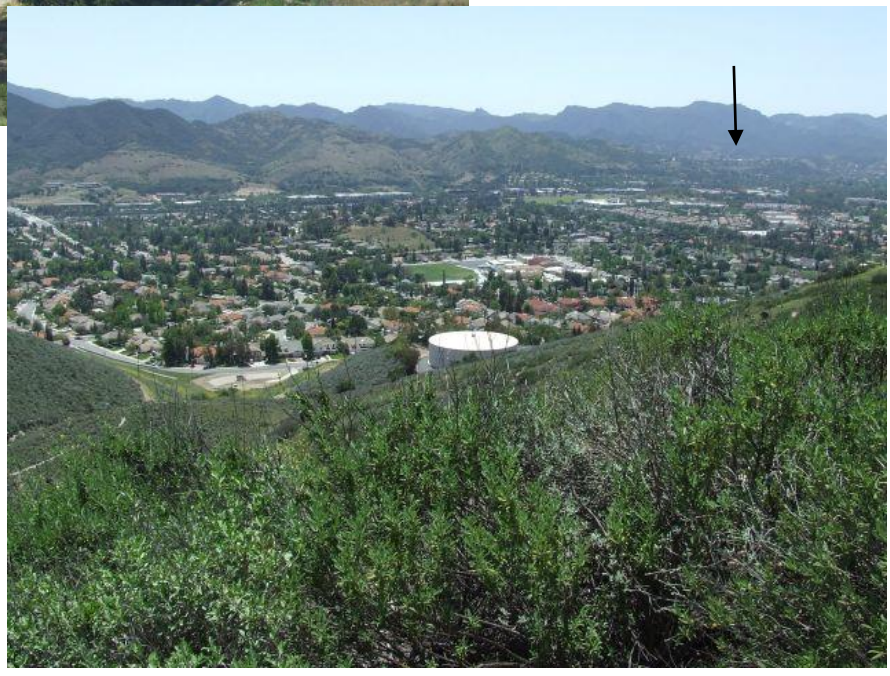


Figure 4-13 View From Kimberly Tank to WLFP

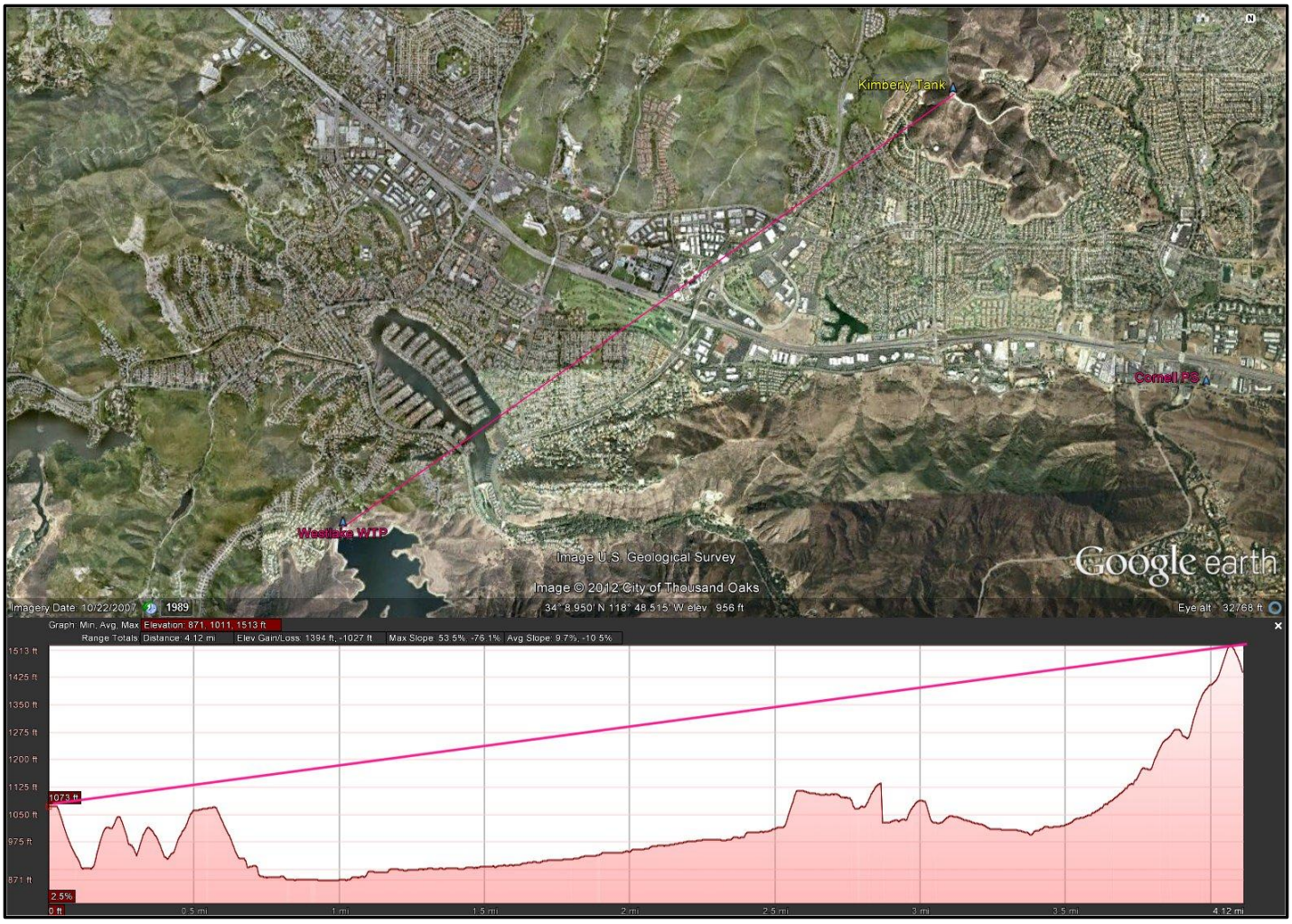


Figure 4-15 WLFP to Kimberly Tank Path and Profile

4.1.9 Kimberly Tank to Cornell PS

This path is currently used by the 900 MHz radios and works well albeit without clear line of sight which the topographic profile confirms. The 5 GHz radios require line of sight. Testing proved this to be the case and this path was deemed unachievable with the target 5GHz radios. However it was replaced via the Kimberly Tank to Lower Oaks Tank path segment.

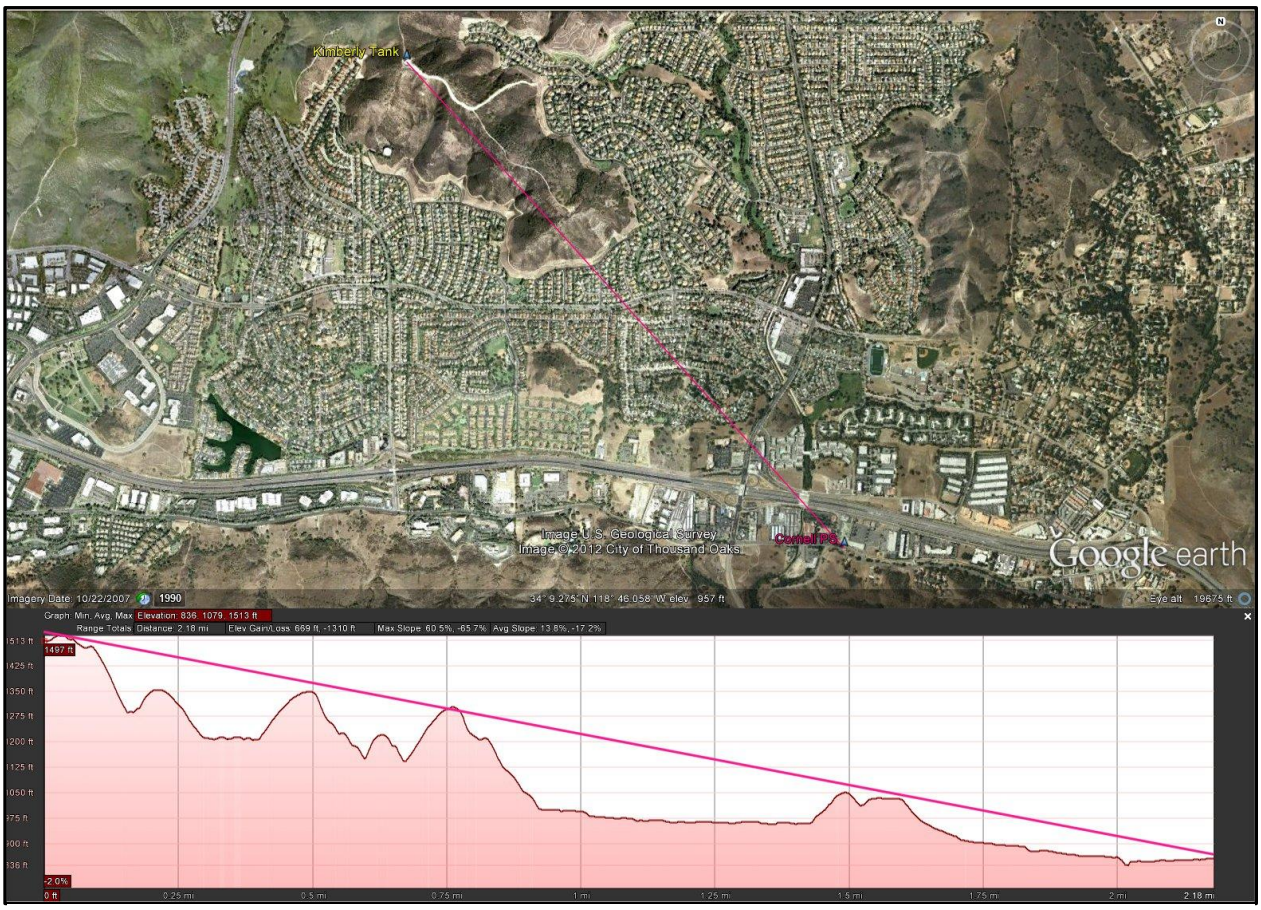


Figure 4-16 Kimberly Tank to Cornell PS Path and Profile

4.1.10 Cornell PS to Lower Oaks Tank

Cornell PS is an important facility within the District's distribution system and therefore justifies redundant paths if possible. Unfortunately a path to Kimberly Tank is not possible with the 5GHz radios. However a path from Cornell PS to Lower Oaks Tank does exist. This path was tested successfully but will require a forty to sixty foot antenna height for best results. Tree growth may be an issue in the long term for this path. A second path into Cornell PS may require maintaining leased circuits into the site. Another option exists via a tower across the freeway which will be further investigated during detailed design.

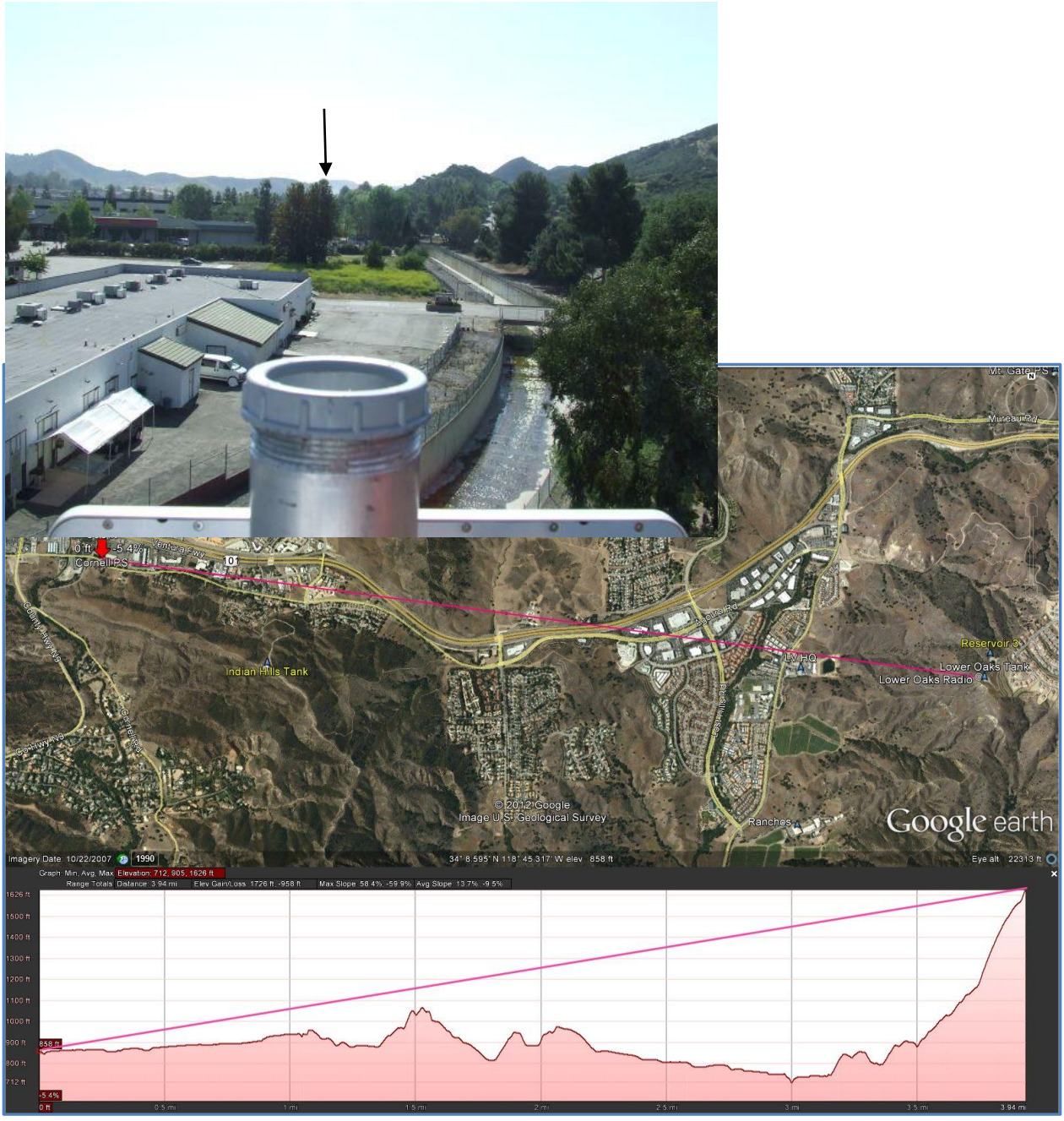


Figure 4-17 Cornell PS to Lower Oaks Tank Path and Profile

4.1.11 Headquarters to Lower Oaks Tank

This path is critical to the proposed backhaul network. Not only for connection with the east side of the network but also for links to Rancho, Tapia, and other facilities. The path was successfully tested and at under a mile in length the integral radios will work for both ends. The tank site is cut into the hill with the highest point approximately twenty five feet higher than the tank. The possibility exists to extend the existing mast for east facing antennas allowing for a shorter radio mast on the hill for the HQ, Rancho, Tapia, Cornell PS, and Kimberly Tank links.

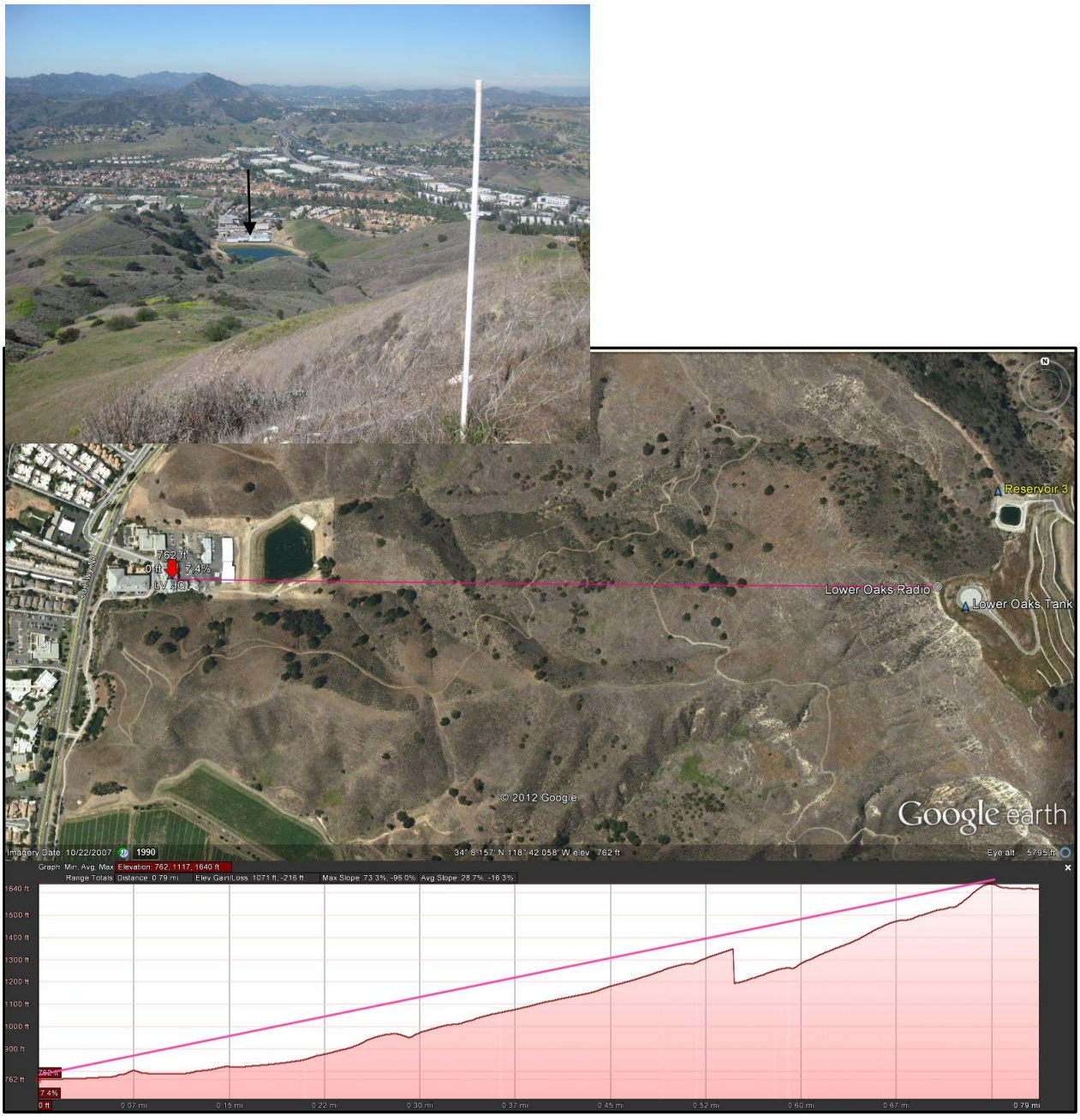


Figure 4-18 Headquarters to Lower Oaks Tank Path and Profile

4.1.12 Lower Oaks Tank to Rancho

The distance from Lower Oaks Tank to Rancho is also under a mile long in length so the integral radios will work for both ends. While the profile shows a small hill in the path, further testing demonstrate if the Rancho rooftop provides sufficient height to eliminate or reduce additional antenna height requirements at the Lower Oaks Tank site.

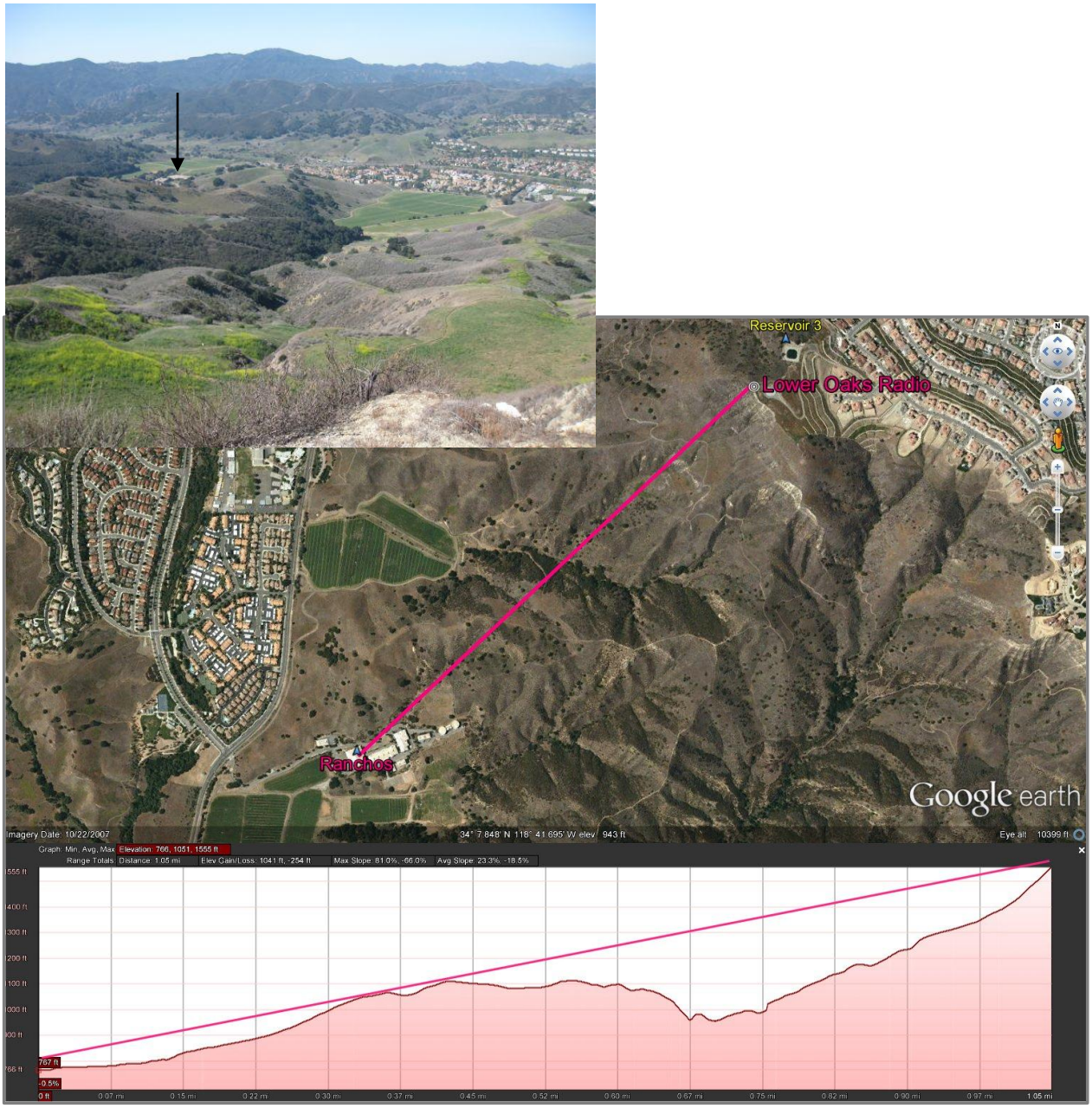


Figure 4-19 Rancho to Lower Oaks Tank Path and Profile

4.1.13 Lower Oaks Tank to Tapia

Tapia Plant is located in a small valley at one of the lowest elevations in the District. Even though Castro Peak and Stunt Road are over 2000 feet higher neither of them provide a radio path into Tapia. The best radio path we have identified is from Lower Oaks Tank to a repeater site located above the plant near Reservoir 1. Utility power was run to Reservoir One for a compressor and instruments but it's not clear if the circuit is still energized. Therefore the proposed repeater site may need to be solar powered, or a hybrid solar and wind powered site. The path from Lower Oaks Tank to the repeater is just over 4 miles should work very well based on the profile information.

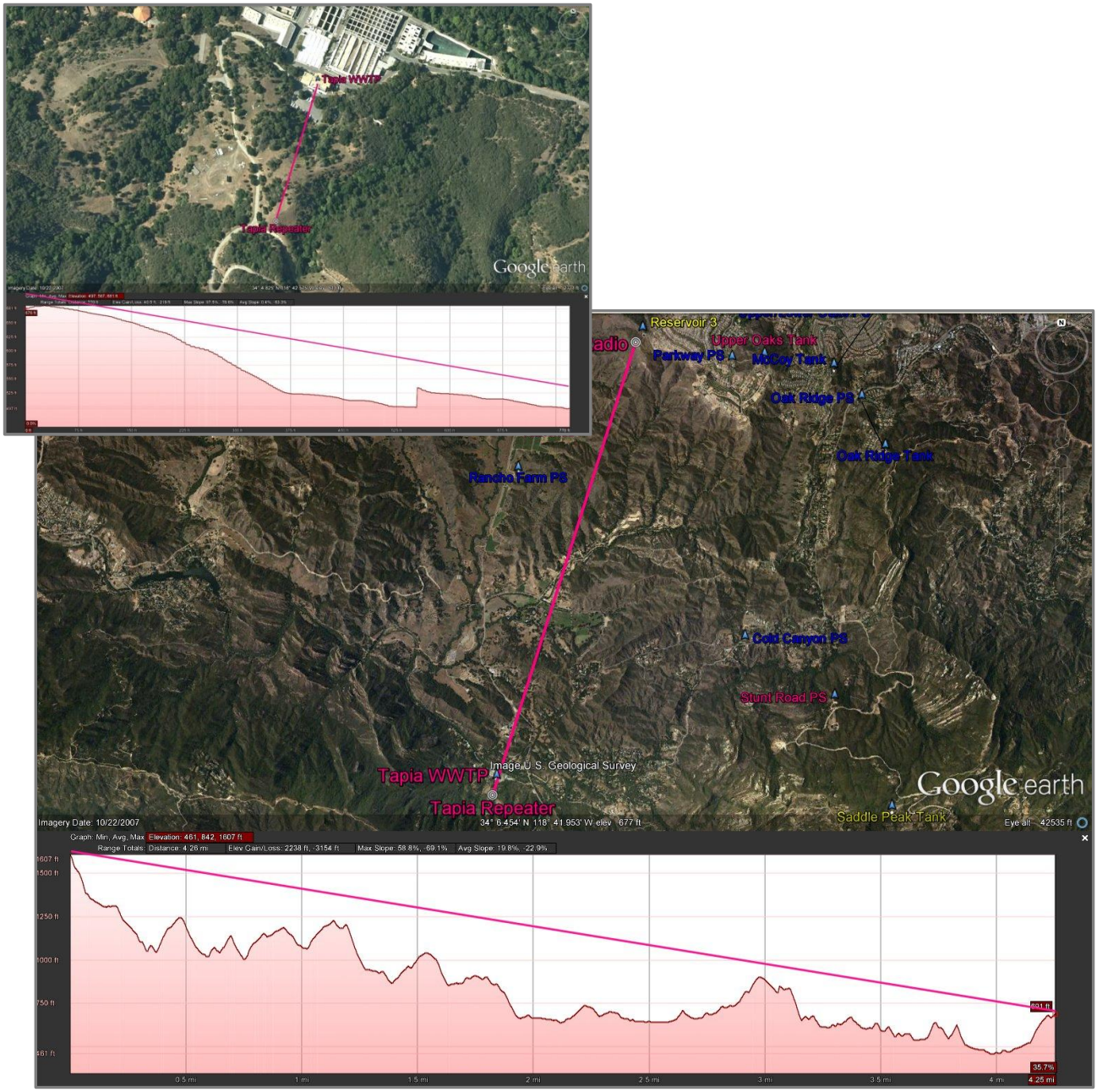
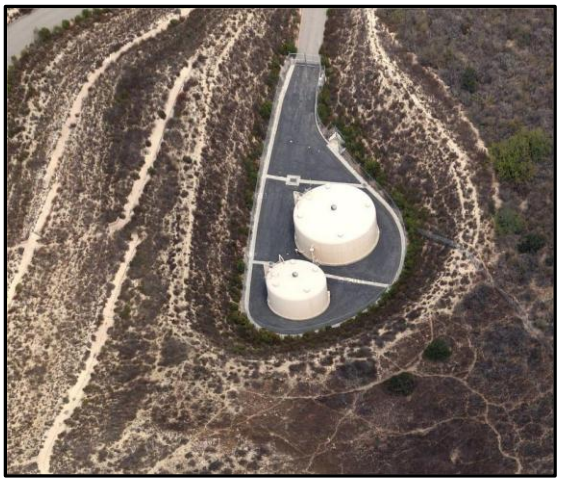


Figure 4-17 Lower Oaks Tank to Tapia Repeater Path and Profile

4.1.14 Lower Oaks Tank to Upper Oaks Tanks

Upper Oaks Tanks are above ground tanks but the site is cut into a hill and the tanks are mostly hidden from view. The tanks were built after the previous SCADA communications upgrade so the tanks were not part of that communication plan.



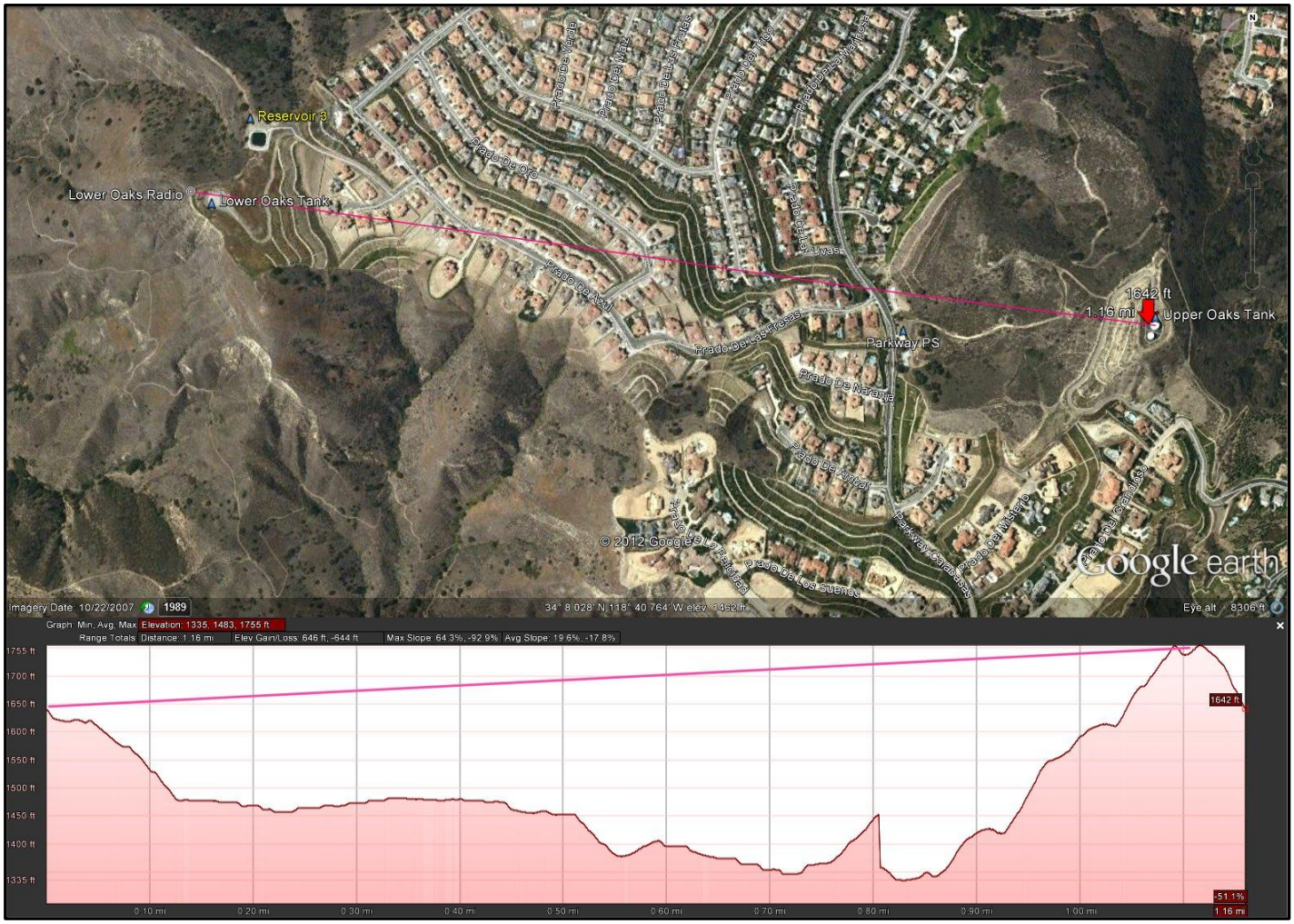


Figure 4-18 Lower Oaks Tank to Upper Oaks Tanks Path and Profile

4.1.15 Upper Oaks Tanks to Warner Tank

This path is a short distance and looks good topographically. There should be no problems getting this path to work except for the trees that mostly surround Warner Tank. Warner Tank is also an important site both for backhaul and for gathering data from local sites. It will need a taller radio mast to accommodate the additional proposed radios. No testing was performed at this site.

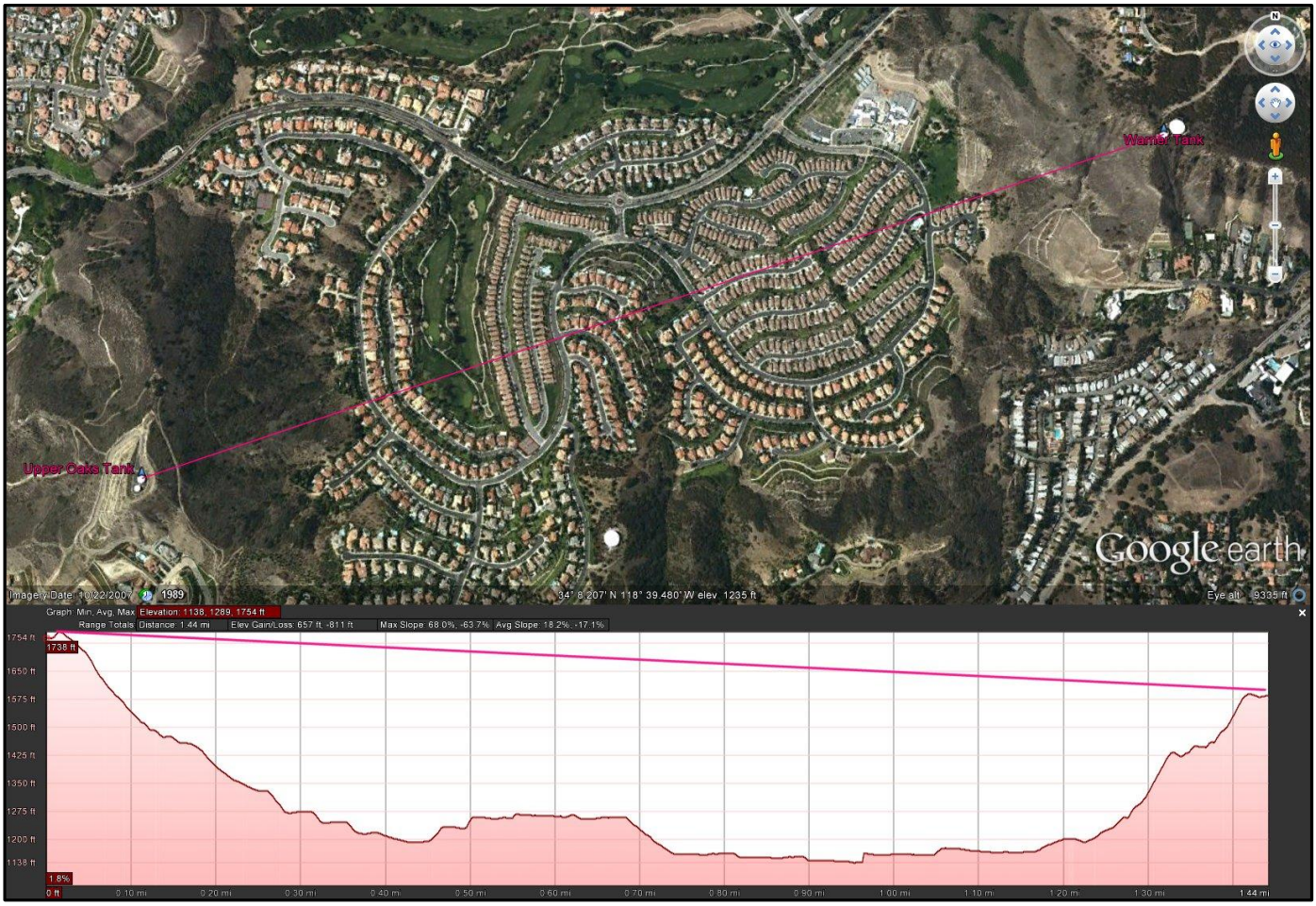
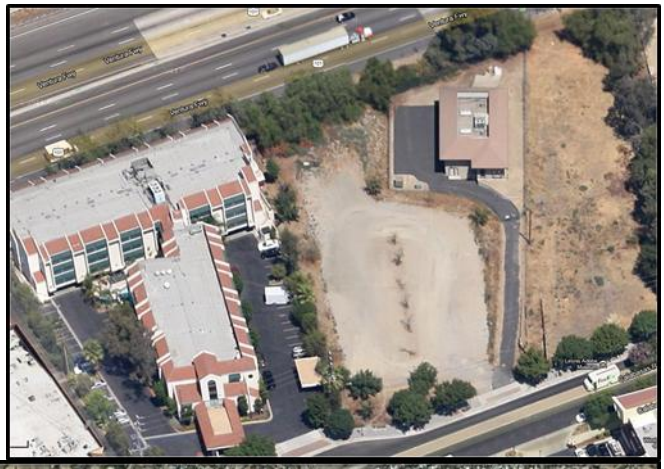
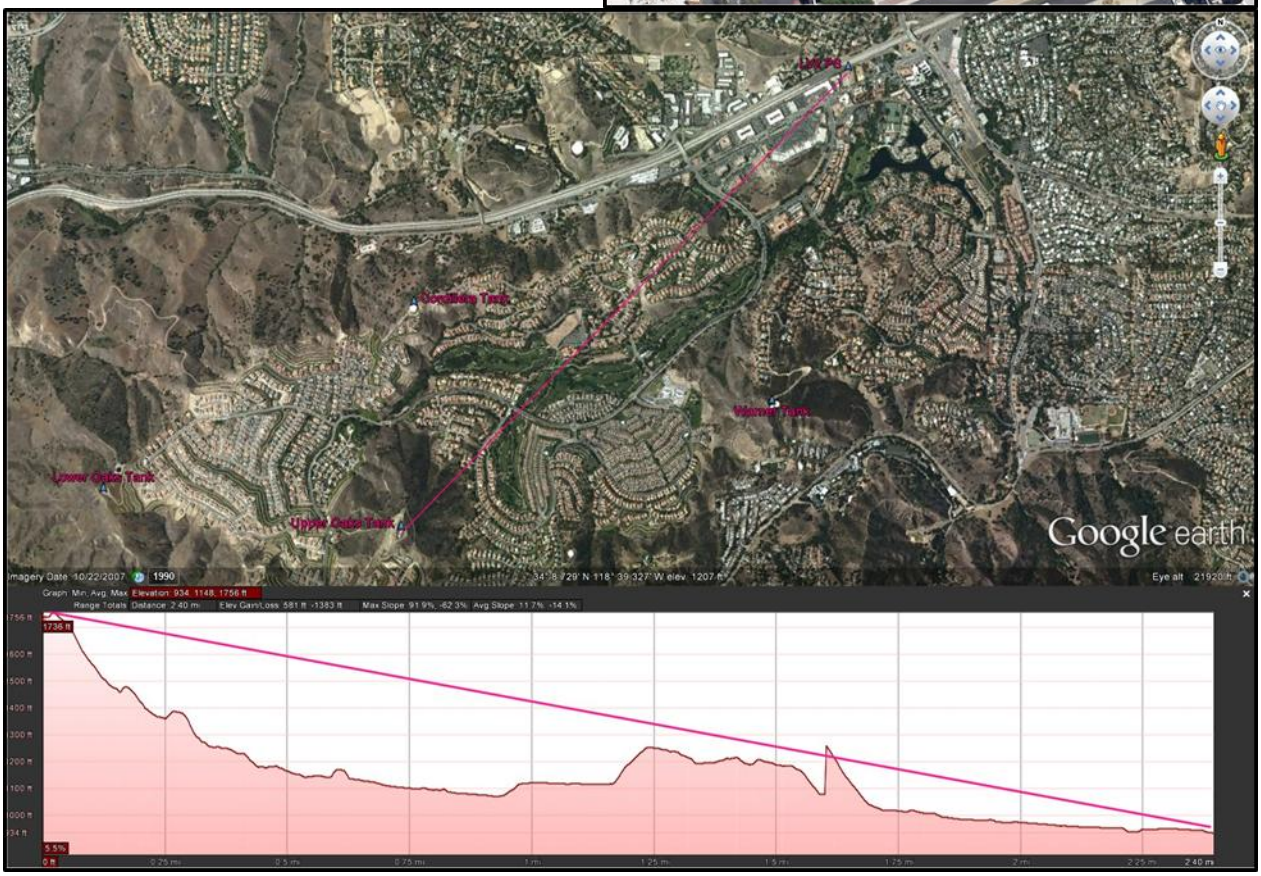


Figure 4-19 Upper Oaks Tank to Warner Tanks Path and Profile

4.1.16 Upper Oaks Tanks to LV2 PS

This path is only 2.5 miles long and looks good except for the odd spike in the profile image which appears to be an artifact in the topography data. This link will be a backup path to the Warner Tank to LV2 path which is an existing path that works well. No testing was perfomed at this site.





4.1.17 Warner Tank to Twin Lakes Tanks

This profile is good with the path being one of the longer paths at ten miles in length. Higher gain antennas will be required for this path with a three foot dish at one end and a two foot dish or square panel antenna at the other end. This link was successfully tested.

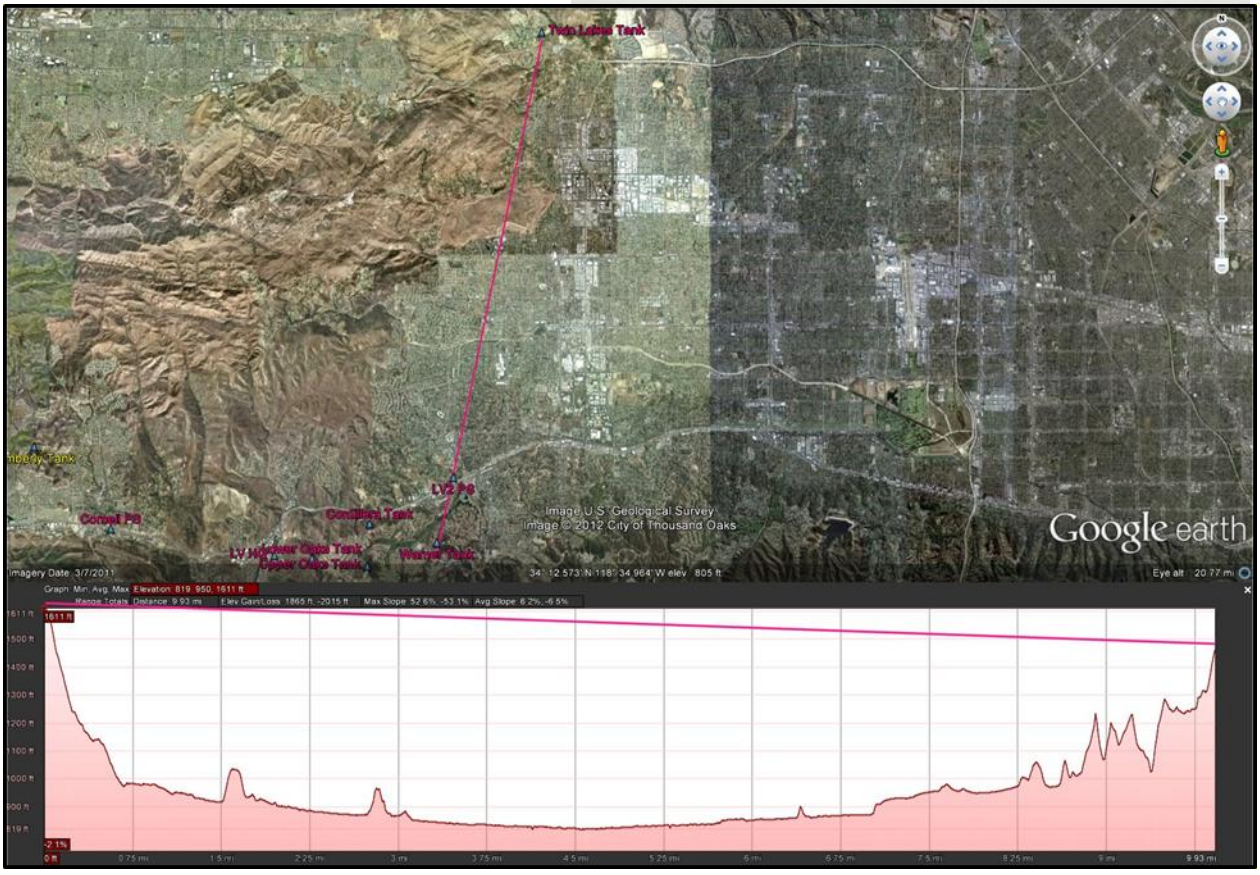


Figure 4-20 Warner Tank to Twin Lakes Tanks Path and Profile

4.1.18 Upper Oaks Tanks to Stunt Road PS

Other paths considered part of the backhaul network include Cordillera Tank and Stunt Road PS. Cordillera Tank can easily be connected to Upper Oaks Tank which is only 1.5 miles away. Stunt Road PS currently picks up the Upper Oaks Tanks with a very strong link at three miles in length which should also work well as a 5 GHz path.

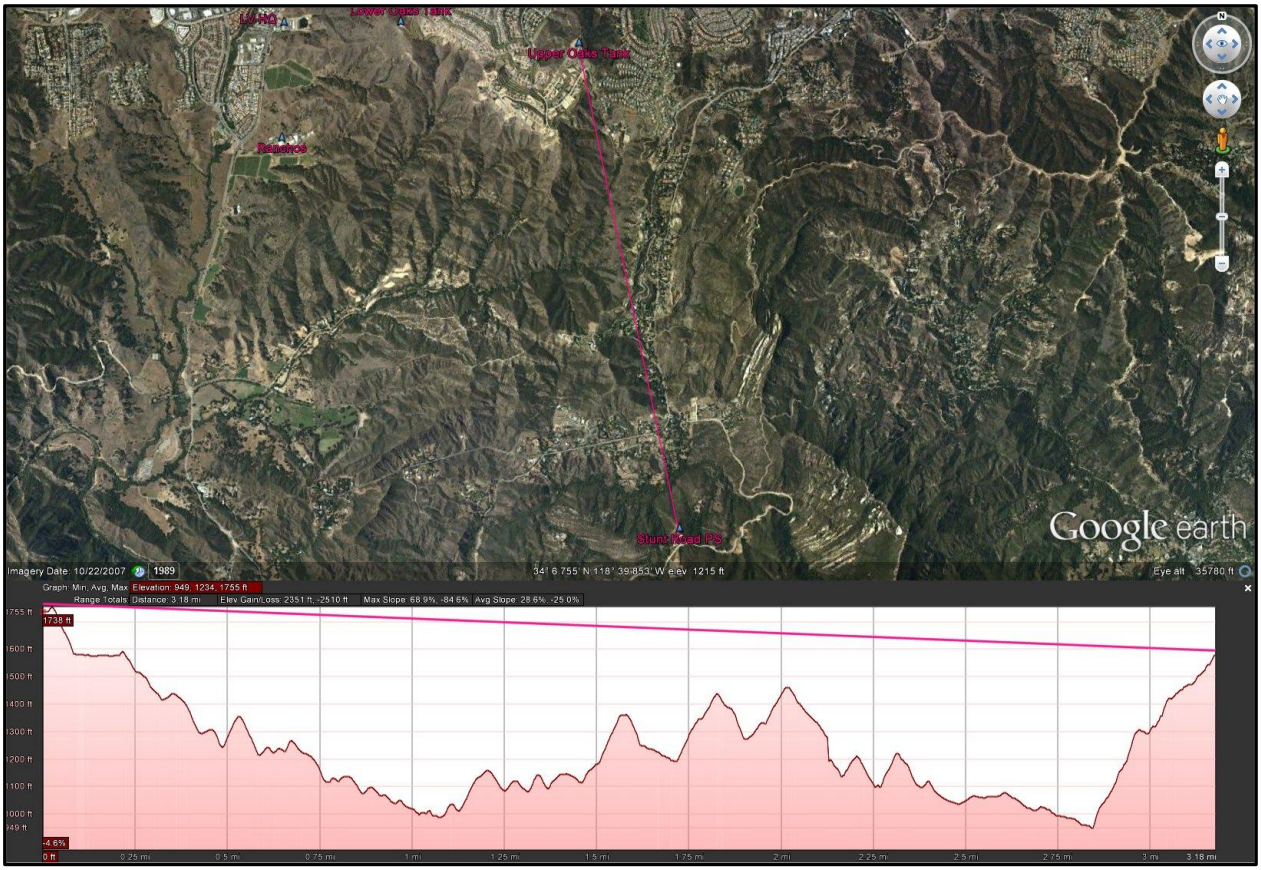


Figure 4-21 Upper Oaks Tanks to Stunt Road PS Path and Profile

4.1.19 Kimberly Tank to Stunt Road PS

This is an optional backup path. The profile appears good but the distance is nearly nine miles requiring high gain antennas. The concern being the tower at Stunt Road PS is lighter duty and may not be suitable for mounting larger antennas.

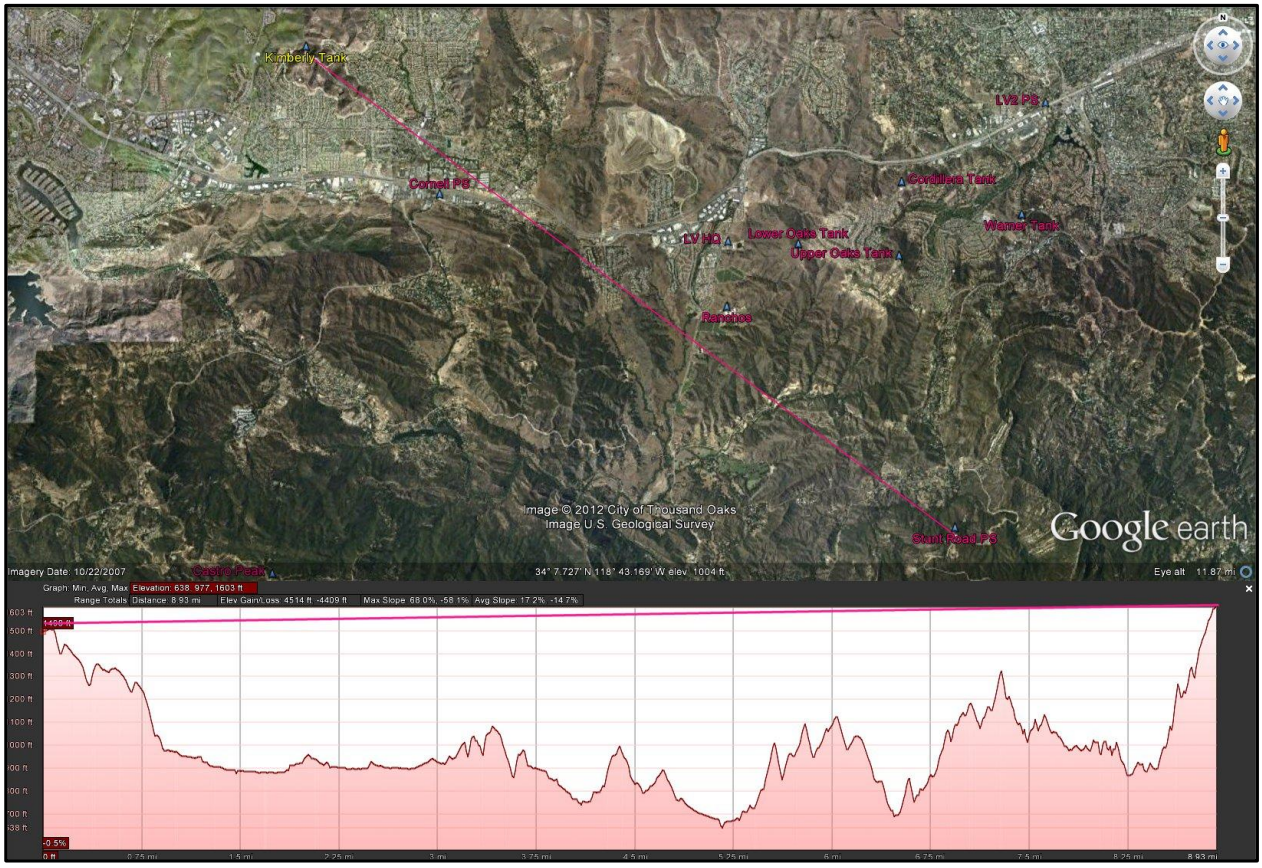


Figure 4-22 Kimberly Tank to Stunt Road PS Path and Profile

5. BUDGETARY COST ESTIMATE

Service	Description			
Professional Services	**Detailed Design Phase**			$40,000
	Network Design and Component Specification			
	Design Drawings (wiring, backup power, enclosure)			
	Commissioning (2 eng x 2.5 weeks/phase)			$108,000
	Assumes four phases @ $27,000 each			
			Services Estimate	**$148,000**

Site Name	Description	Qty.	Cost	Extended
Castro Peak Repeater				
	Trunk Radio	2	$3,000	$6,000
	Antennas, mounts and jumpers	2	$1,000	$2,000
	900 Mhz AP Radio and antenna	2	$2,000	$4,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	0	$400	$0
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$15,000	$15,000
			Subtotal	**$42,200**
Cordillera Tank Repeater				
	Trunk Radio	3	$3,000	$9,000
	Antennas, mounts and jumpers	3	$700	$2,100
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	0	$700	$0
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$2,000	$2,000
			Subtotal	**$30,000**
Cornell Pump Station Repeater				
	Trunk Radio	1	$3,000	$3,000
	Antennas, mounts and jumpers	1	$700	$700
	900 Mhz AP Radio and antenna	0	$2,000	$0
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$10,000	$10,000
			Subtotal	**$28,900**

Equestrian Tank Repeater				
	Trunk Radio	0	$3,000	$0
	Antennas, mounts and jumpers	0	$700	$0
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	0	$7,000	$0
	Industrial Network Switch, Managed	0	$700	$0
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$5,000	$5,000
			Subtotal	**$14,900**
Headquarters				
	Trunk Radio	2	$3,000	$6,000
	Antennas, mounts and jumpers	2	$700	$1,400
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	0	$400	$0
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$10,000	$10,000
			Subtotal	**$32,600**
Indian Hills Tank Repeater				
	Trunk Radio	0	$3,000	$0
	Antennas, mounts and jumpers	0	$700	$0
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	0	$7,000	$0
	Industrial Network Switch, Managed	0	$700	$0
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$2,000	$2,000
			Subtotal	**$11,900**
Kimberly Tank Repeater				
	Trunk Radio	2	$3,000	$6,000
	Antennas, mounts and jumpers	2	$700	$1,400
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$5,000	$5,000
			Subtotal	**$30,000**
Lower Oaks Tank Repeator				
	Trunk Radio	7	$3,000	$21,000
	Antennas, mounts and jumpers	7	$700	$4,900

	900 Mhz AP Radio and antenna	0	$2,000	$0
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	3	$10,000	$30,000
			Subtotal	**$71,500**
LV2 Pump Station Repeater				
	Trunk Radio	2	$3,000	$6,000
	Antennas, mounts and jumpers	2	$700	$1,400
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$10,000	$10,000
			Subtotal	**$35,000**
Rancho Las Virgenes				
	Trunk Radio	1	$3,000	$3,000
	Antennas, mounts and jumpers	1	$700	$700
	Router	0	$7,000	$0
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	0	$400	$0
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$5,000	$5,000
			Subtotal	**$16,900**
Stunt Road PS Repeater				
	Trunk Radio	2	$3,000	$6,000
	Antennas, mounts and jumpers	2	$700	$1,400
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$5,000	$5,000
			Subtotal	**$30,000**
Tapia Water Reclamation Facility				
	Trunk Radio	1	$3,000	$3,000
	Antennas, mounts and jumpers	1	$700	$700
	900 Mhz AP Radio and antenna	0	$2,000	$0
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	0	$700	$0

	Ethernet to Serial Bridge	0	$400	$0
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$5,000	$5,000
			Subtotal	**$23,200**
Reservoir 1 Repeater (Tapia)				
	Trunk Radio	2	$3,000	$6,000
	Antennas, mounts and jumpers	2	$1,000	$2,000
	900 Mhz AP Radio and antenna	0	$2,000	$0
	Router	0	$7,000	$0
	Industrial Network Switch, Managed	0	$700	$0
	Ethernet to Serial Bridge	0	$400	$0
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$10,000	$10,000
			Subtotal	**$25,500**
Twin Lakes Tank Repeater				
	Trunk Radio	1	$3,000	$3,000
	Antennas, mounts and jumpers	1	$1,000	$1,000
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	0	$700	$0
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$5,000	$5,000
			Subtotal	**$25,900**
Upper Oaks Tank Repeator				
	Trunk Radio	4	$3,000	$12,000
	Antennas, mounts and jumpers	4	$700	$2,800
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$5,000	$5,000
			Subtotal	**$37,400**
Warner Tank Repeater				
	Trunk Radio	3	$3,000	$9,000
	Antennas, mounts and jumpers	3	$1,000	$3,000
	900 Mhz AP Radio and antenna	1	$2,000	$2,000
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	1	$700	$700
	Ethernet to Serial Bridge	1	$400	$400
	Radio Enclosure with backup power	1	$7,500	$7,500

	Mast and installation	1	$10,000	$10,000
			Subtotal	**$39,600**
Westlake Filtration Facility				
	Trunk Radio	2	$3,000	$6,000
	Antennas, mounts and jumpers	2	$700	$1,400
	Router	1	$7,000	$7,000
	Industrial Network Switch, Managed	0	$700	$0
	Ethernet to Serial Bridge	0	$400	$0
	Radio Enclosure with backup power	1	$7,500	$7,500
	Mast and installation	1	$10,000	$10,000
			Subtotal	**$31,900**
Remote Radio Sites	Radio Site	38	$2,530	$96,140
ADN Modem Sites	Modem Site	4	$2,050	$8,200

Professional Services	**$148,000**
Hardware & Installation Estimate	**$631,740**
Contingency (15%)	**$79,760**
Total (w/o tax)	**$859,500**

6. SUMMARY

A fault tolerant, high bandwidth wireless Ethernet backhaul network is not only desirable but achievable. This backhaul network will act as the backbone of the replacement system for the District's existing SCADA communication system. Being an Ethernet network will allow the District to use it for other-than-SCADA purposes assuming implementation of bandwidth utilization controls to ensure passage of critical SCADA data.

The proposed network finds a major tie point between the western and eastern portions of the network at Lower Oaks Tank. The importance of this site cannot be overstated. Not only in terms of establishing the long-sought-after second link into District headquarters but also for establishing wireless links to Rancho Composting Facility, Tapia Water Reclamation Facility, not to mention completing the western backhaul network from Kimberly Tank.

This report lays the groundwork for the more substantial detailed design phase. The design phase will investigate site specific issues pertaining to providing adequate main and backup power, as well as specifying all equipment necessary for successfully installing and implementing the network. The installation is expected to be done in multiple phases due to cost and number of sites involved. The logistics of phasing the installation will also be planned during the design phase.

As with any budgetary estimate assumptions were made that negatively and positively impact the final cost estimate figure. We will investigate and present lower cost alternatives as appropriate during the design phase.

Appendix A Field Testing

Site	Equipment	Lat deg min N	Long deg min W	Elev ~ feet	Azimuth degrees (T)	Distance miles	Elev. diff.	Degrees up/down	RSSI ave.	SNR ave.	Bandwidth Mbps	Remarks field notes
LV HQ		34 8.154	118 42.060	760								24dBi flat panel, 8 degree beam, on hose stand about 30 feet above ground
Lower Oaks Tank		34 8.146	118 41.308	1640	91	0.8	880	12.0				24dBi flat panel, 8 degree beam, on tripod, 10 feet above ground, high point west of fence
	TrangoLINK-45								-65/-64		43.84	channels mostly clear, ch 1H 5.265Ghz, 54Mbps, no errors
Westlake Filtration		34 7.934	118 50.239	1070								24dBi flat panel, 8 degree beam, 10 foot pipe on top of roof
Kimberly Tank		34 9.953	118 46.800	1500	55	4.1	430	1.1				24dBi flat panel, 8 degree beam, on lift about 12 feet above the tank
	TrangoLINK-45								-62/-62		39.4	Couple active channels, rest clear, ch 21H 5.835Ghz, 54Mbps, 2/3% errors
	Proxim QB8100								-60/-70	31/39	65/130	Tested at 5.805 Ghz, 20Mhz, H&V
	Proxim QB8100								-69/-74	26/29	108/162	Tested at 5.805 Ghz, 40Mhz, H&V
Kimberly Tank		34 9.953	118 46.800	1500								
Cornell Pump Station		34 8.596	118 45.316	860	138	2.1	-640	-3.3				not tested, no line of sight even from lift at Cornell at 60 feet
Stunt Road PS		34 5.498	118 39.538	1550	126	8.6	50	0.1				not tested
Cornell Pump Station		34 8.596	118 45.316	860								24dBi flat panel, 8 degree beam, on lift 30 to 58 feet above ground, 48 feet put us just above trees
Lower Oaks Tank		34 8.146	118 41.308	1640	98	3.9	780	2.2				24dBi flat panel, 8 degree beam, on tripod, 10 feet above ground, high point west of fence
	TrangoLINK-45								-63/-64		40.76	Lift at 48 Feet, couple active channels, rest clear, ch 20H 5.815Mhz, 54Mbps, 0/1% errors
	TrangoLINK-45								-62/-62		40.22	Lift at 58 Feet, couple active channels, rest clear, ch 20H 5.815Mhz, 54Mbps, 0/0% errors
	Proxim QB8100								-74/-85	15/21	54/54	Lift at 38 feet, tested at 5.815 Ghz, 40Mhz, H&V
	Proxim QB8100								-61/-72	30/34	216/216	Lift at 48 feet, tested at 5.815 Ghz, 40Mhz, H&V
	Proxim QB8100								-60/-70	32/35	243/135	Lift at 58 feet, tested at 5.815 Ghz, 40Mhz, H&V
Lower Oaks Tank		34 8.144	118 41.310	1637								24dBi flat panel, 8 degree beam, on tripod, 10 feet above ground, high point west of fence
Tapia Repeater (Reservoir 1)		34 4.773	118 42.593	675	198	4.1	-962	-2.5				24dBi flat panel, 8 degree beam, on Tripod, 10 feet above ground, on top of dam
	TrangoLINK-45								-59/-60		40.29	Channels all clear, ch 20H 5.815Mhz, 54Mbps, 0/0% errors
	Proxim QB8100								-60/-68	33/35	65/130	Tested at 5.805 Ghz, 20Mhz, H&V
	Proxim QB8100								-58/-71	29/38	135/108	Tested at 5.805 Ghz, 40Mhz, H&V

Warner Tanks		34 8.397	118 38.793	1635							3 foot dish, 31.2dBi, 4 degree beam, near center of tank only about 6 feet above tank
Twin Lakes Tanks		34 16.749	118 36.716	1585	12	9.8	-50	-0.1			2 foot dish, 28.3dBi, 6 degree beam, tree near tank partially in path
	TrangoLINK-45								-56/-55	5.65	Couple active channels, rest clear, ch 21H 5.835Mhz, 6Mbps, 0/1% errors
	TrangoLINK-45								-61/-59	39.4	Couple active channels, rest clear, ch 21H 5.835Mhz, 54Mbps, 3/4% errors