Tucson Electric Power

# 138 Kilovolt Transmission Line Underground Cost Analysis

**Report SL-015392**

**Revision 7**

**Final Report**

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# ISSUE SUMMARY AND APPROVAL PAGE

This is to certify that this document has been prepared, reviewed and approved in accordance with Sargent & Lundy's Standard Operating Procedure SOP-0405, which is based on ANSI/ISO/ASSQC Q9001 Quality Management Systems.

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# ACRONYMS AND ABBREVIATIONS

| Acronym/Abbreviation | Definition/Clarification |
|---|---|
| AC | Alternating Current |
| DC | Direct Current |
| DTS | Distributed Temperature Sensing |
| ft | Foot |
| GCC | Ground Continuity Conductor |
| HDD | Horizontal Directional Drill |
| HDPE | High Density Polyethylene |
| HVED | High Voltage Extruded Dielectric |
| HV | High Voltage |
| Kcmil | 1000 circular mils |
| kV | Kilovolt |
| mil | Thousandth of an inch |
| PVC | Polyvinyl Chloride |
| ROW | Right of Way |
| XLPE | Cross-linked polyethylene |

# SUMMARY OF REVISIONS

**Revision 0**:

Initial issue. Represents a 1.5 mile section of the proposed Kino – DeMoss Petrie 138kV Transmission Line. Initial studies were performed based off standard cable rating in optimal condition.

**Revision 1:**

Removal of trenchless installation under major arterial roadways.

**Revision 2**:

Updated cost estimate to increase length of underground estimate from 1.5 miles to 5.5 miles, and break out 5.5 mile route into 7 sections. Sections are defined between major east west running roads. Electrical calculations were performed based off regional data from TEP including but not limited to soil thermal resistivity reports, loading requirements, and publicly available soil temperatures. Due to this calculation to maintain the preferred ampacity on the line it was determined that 2 cables per phase where required. This required updates to duct bank design and the associated costs with this adjustment. In addition, trenchless installation was added back into the cost estimate for the crossing of Aviation Pkwy and Union Pacific Railroad.

**Revision 3:**

Addition of GIS map as appendix for 5.5 mile route

**Revision 4:**

Removal of installed spare conductor in cost estimate

**Revision 5**:

Updated cost of cable and other material effected by unexpected increased inflation rates. Addition of revision summary.

**Revision 6**:

Added clarification that the estimate does not cover the total cost of the project. The study does not account for the remainder of transmission line that would be required to connect the existing DeMoss-Petrie Substation to the Planned Vine Substation.

**Revision 6**:

Added clarification that the estimate does not cover the total cost of the project. The study does not account for the remainder of transmission line that would be required to connect the existing DeMoss-Petrie Substation to the Planned Vine Substation.

**Revision 7**:

Updated cost estimate to reflect current 2022 costs.

# EXECUTIVE SUMMARY

## SCOPE OF WORK

Tucson Electric Power (TEP) is proposing to install a new overhead single circuit 138 kilovolt (kV) alternating current (AC) transmission line from the Kino Substation (currently under construction) extending approximately 7 miles northwest to the existing DeMoss-Petrie Substation with a new proposed intermediate substation north of the University of Arizona. The line is being developed to help satisfy growing energy needs and strengthen reliability for TEP customers within the project area. During preliminary community meetings, TEP has received multiple questions regarding the cost of undergrounding the proposed transmission line. In response to those questions, TEP has enlisted Sargent and Lundy (S&L) to evaluate and prepare estimated costs to place portions of the proposed 138kV transmission line underground. The material and construction costs in this report represents multiple sections equaling a total of 5.5 miles of underground 138-kV transmission circuit in urban, central Tucson. The estimates provided do not account for the total cost of the Project. The study does not account for the remainder of the transmission line that would be required to connect the existing DeMoss-Petrie Substation to the planned Vine Substation. In addition, this report provides an overview of a 138kV cross-linked polyethylene cable (XLPE) underground transmission line along with information on operation, maintenance and potential repairs.

## OVERVIEW OF PROJECT DESIGN

For the purposes of this study, preliminary calculations show that a two cable per phase installation is required to meet the preferred ampacity of 2264 A. The expected ampacity value calculated with 2 cables per phase and a 0.75 load factor assumed is governed by the trenchless installation at a depth of 15', which is determined to be 2275 A with the preliminary inputs as a part of this report. Final data will be necessary to confirm the ampacity for the line to ensure the proper operation of the line. See preliminary modeling performed by S&L as described in section 3.2.1. The duct banks would be installed via open-cut trench and then backfilled with thermally corrective fill to improve cable operating performance. The investigation of the proposed route evaluates the crossing of a Union Pacific railroad as well as major arterials within the City of Tucson. Due to the railroad sensitivity and the high traffic volume of Aviation Parkway a jack and bore has been assumed in this area. At the current time only preliminary underground utility data is known, which consists of preliminary water and sewer line locations. A grade A utility location is recommended to verify all utilities along the route once a route is finalized, this would discover all other utilities that may be buried in the area such as communications, gas, and other potential utilities. ASCE 38 Grade A or daylighting would determine exact location and depth of each utility which will help determine the required depth and installation complications that may come with the route. It will also help determine if utility relocation would be required in any area of the project. The cost estimate utilized anticipated construction methods and expected geological and environmental conditions based upon preliminary known data from TEP database. Detailed assumptions are provided in Section 4 of this report.

## SUMMARY

This study should be considered a class 4 estimate from Association of the Advancement of Cost Engineering (AACE) 18R-97 Cost Estimate Classification System. The information provided in this report is preliminary in nature and is for the purposes of a feasibility assessment and is based off preliminary information. Values utilized in the cost estimate are calculated and estimated for this specific project to the best of the ability of engineers at the time of the estimate.

Underground transmission line installation, although feasible, is significantly more expensive compared to overhead alternatives. Per estimates provided in this document, the cost of undergrounding could be up to approximately 16.3 times greater than a comparable overhead installation dependent on the section

evaluated. The comparison is based off a 1 million per mile cost of overhead transmission lines which does not include any land acquisition costs, which at this preliminary stage are unknown for the purposes of this report. The overall cost of the transmission line would vary depending on the length of the undergrounding, the construction methods used, and the obstructions encountered. These costs do not include permitting, right of way acquisition, or environmental cost at this early stage. This report is prepared to evaluate the feasibility and preliminary cost of undergrounding portions of the proposed transmission line. The estimate may increase based upon permitting and right of way acquisition. In addition to the initial installation cost, there are operational, power transfer capabilities, maintenance, and reliability concerns when compared to overhead construction.

- Operational and Reliability Concerns – With the installation of the transmission line cables in a concrete-encased duct bank, repairs to damaged installations are required less often than their overhead counterparts. However, when repairs are required, they are lengthy and costly.

- Power Transfer Capability - Due to underground transmission lines inherent issues with heat dissipation, typically underground transmission lines cannot transfer as much power as overhead with similar conductor sizes. In regions such as the southwest where dry warm conditions are prevalent, power transfer capability of underground transmission is significantly less than that of overhead transmission. In addition, it is expected based off of preliminary data that the soils have poor thermal resistivity characteristics that effect heat dissipation and therefore power transfer capability. Due to heat dissipation concerns, S&L and TEP evaluated the underground section of the transmission line with a load factor of 0.75 as described later in this document.

# 1. STUDY DESCRIPTION

## 1.1. OVERVIEW

The purpose of this document is to generate an indicative cost estimate to inform TEP and interested parties of the estimated construction costs for underground 138kV construction. It also provides information on operation, maintenance, and repair concerns for underground transmission lines. S&L developed the cost estimate for multiple segments of 138kV underground transmission line along a 5.5 mile long route based on an urban environment in central Tucson and assumed the crossing of a railroad and restricted access highway via trenchless installations. The estimate provided does not account for the remainder of transmission line that would be required to connect the existing DeMoss-Petrie Substation to the planned Vine Substation.

# 2. UNDERGROUND CABLE SYSTEMS

XLPE Cable is the most common type of cable used for underground transmission lines being installed at transmission level voltages. XLPE cable systems have become the preferred underground cable system for underground cable installations in the United States. Therefore, XLPE has been selected as the cable system for this study.

## 2.1. SYSTEM AMPACITY RATINGS

When designing underground transmission lines, one of the most important concepts to consider is the ampacity of the cable. The largest impact to the ampacity is the thermal performance of the underground system as whole. The calculation for determining the allowable ampacity of the underground cable is complicated with many design factors that have effects on the thermal performance of the cable. These factors include items such as soil thermal resistivity, cable size, cable depth, and cable separation. At this early stage, S&L has performed preliminary calculations to determine a conceptual ampacity to understand potential cost and planning of the project.

### 2.1.1. Soil Thermal Resistivity

Soil thermal resistivity has a large impact on the allowable cable ampacity. The thermal resistivity is an important factor for design of underground electric cable systems. It is a measure of how a soil resists heat flow away from the cable. Due to this, thermal properties of the soils/backfill installed around the cable have a direct impact on cable ampacity. The entire area surrounding the cable can affect the ampacity, including changes in layers and materials around the cable. Concrete and asphalt placed on top of the cable would affect the rating of the cable, most likely in a negative way, dependent on their thermal resistivity.

### 2.1.2. Cable Size

The conductor size of the cable has the most obvious impact to the ampacity of the cable. An increase in the conductor size has a direct correlation to an increase in ampacity. There is a limit to the allowable cable size. At present, 6000 kcmil is the largest conductor size used for XLPE type cables.

### 2.1.3. Cable Depth

Depth of the cables has an impact on the ratings of the cable. The deeper the cable is buried in the soil; the

more soil heat must move through to dissipate away from the cable. Typically, larger cables are required for deeper installations. By the requirements of the NESC (National Electric Safety Code) which has been adopted by the State of Arizona as law, requires a minimum depth of the cables to ensure safety for the general public. This minimum depth, though most desirable to support a higher allowable ampacity of the cable cannot always be maintained. Existing underground infrastructure such as water lines, sewer lines, gas lines, communications line, and potentially other electrical lines all could affect the depth of the transmission line pushing the cable deeper affecting ampacity.

### 2.1.4. Cable Separation

Other cables in proximity can also generate heat and adversely affect the cable ampacity. This condition is called mutual heating. This can be reduced by increasing the separation of the cables. Optimal separation is determined by weighing the separation distance against the amount of excavation required. Increasing the separation too much would require larger excavation which in turn drives up project cost.

## 2.2. INSTALLATION METHODS

There are multiple types of installations for an underground transmission line. These include:

1. Use of open trenches with installation of a duct bank
2. Use of open trenches for direct embedment
3. Trenchless type such as Horizontal Directional Drill (HDD) or jack and bore.

The most common method in the U.S. is duct bank-type installations. Duct banks are installed to provide mechanical protection for the cable, and to easily allow a cable to be upgraded in the future. Short lengths of a couple hundred feet of trench are opened at a time. For this project, S&L would recommend the duct bank installations where open trench is feasible and a jack and bore installation for the short distances under highways and railroad crossings.

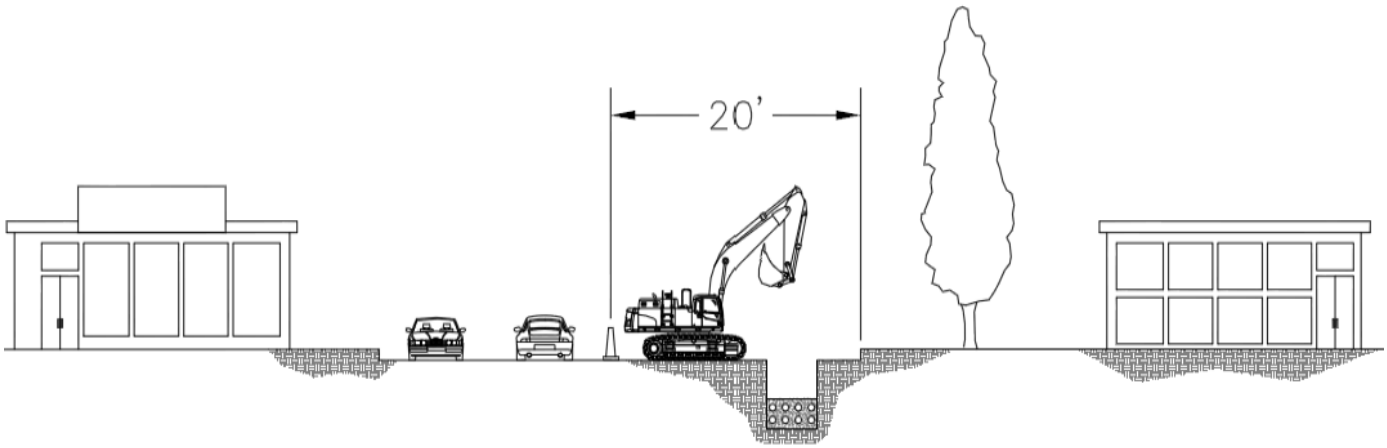
There are multiple steps for installation of an underground transmission line. First, all necessary information should be acquired such as geotechnical studies which should include thermal analysis of the soil, existing underground utility locations and acquiring all permits required for the project. Secondly, the civil installation includes the excavation of the soil for the duct bank, installation of the duct bank described later, installation of the man vaults, backfilling the excavations with thermally corrective fill to the desired compaction and restoring the ground surface around the duct bank. Next contractors would mandrel the duct bank to ensure proper installation with no obstructions. Finally, the electrical construction includes the installation of all cables (electrical and communications), splicing, and grounding of the cables and other equipment. After the civil and electrical installations are complete, the system is tested before it is placed in operation.

### 2.2.1. Open Trench

Open trench construction would consist of cutting the asphalt road or concrete sidewalk and utilizing excavation equipment to remove any sub-grade material and soil to the desired depth of the proposed duct bank. The excavated material would be removed for disposal or stockpiled for use as backfill after completion of the duct bank (provided the properties of the soil meet the design criteria). Excavations usually happen in sections to limit the amount of open trench; this would be determined during detailed design. In urban environments, which is the basis for this cost estimate, shoring would be utilized to keep excavations open and limit the width of the excavation. The expected construction width in urban areas is approximately 20 feet (Figure 2.1) for the trench, excavation and working space. The construction contractor would be required to provide traffic control devices such has jersey barriers, signage, and potentially flagman to ensure safety for workers and the public. When construction isn't present trench should be covered by

steel plates.

**Figure 2-1 — Typical Urban Open Trench Construction**




Once a portion of the trench is excavated and clear to the proper depth, polyvinyl chloride (PVC) duct would be placed into the open trench. Individual PVC ducts would be used to house each cable and/or communication wires to be installed. The ducts would be held in place utilizing plastic duct spacers to ensure all the required separation per the design are met (see figure 2.2). In an urban environment, utilities that cannot be relocated prior to the construction of the duct bank would increase construction cost and time. Existing utilities that must remain in the Right of Way (ROW) would be required to be supported during the open excavation and avoided by re-routing the duct bank or changing duct configuration to accommodate the existing infrastructure. These types of details would be determined during detailed design. Duct bank spacers are placed three to five feet apart to keep the PVC ducts in the desired configurations. The area would then be framed and filled with high strength thermally corrective concrete (see figure 2.3), with the top portion having a red dye added to identify danger during future excavation. After the concrete has hardened the trench is backfilled and the surface returned to pre-construction conditions.

**Figure 2-2 — Open Trench Spacers**

**Figure 2-3— Open Trench Concrete**

### 2.2.2. Trenchless Installation

There are two types of trenchless methods that are commonly utilized when open trenching may not be allowed. Horizontal Directional Drill (HDD) and jack and bore. Trenchless type installations are used in areas were open trench is not allowed such as highways, railroads, bodies of water, and other environmentally sensitive areas. For the urban environment in this estimate, jack and bore was used to cross under railroad and highway due to the short crossings, approximately 400 feet. Jack and bore installations consist of installing a non-metallic casing such as high-density polyethylene (HDPE) , fiberglass or reinforced concrete pipe, and then installing the smaller ducts within the larger casing. Jack and bore can only be installed in a straight path.

Jack and bore must be installed via a send and receive pit excavated on either side of the crossing. Send pits are typically 30’ to 40’ long x10’ wide to the required depth of the bore plus 3’ for the placement of equipment, approximately 16-18’ deep. Depth may vary based upon existing utilities and any requirements of other entities such has ADOT or railroad owners. This size is required for the boring equipment and for placing the casings which are approximately 20’ sections but vary dependent on send pit sizes. Receive pits are commonly smaller in size averaging 10’ long x 10’ wide to the same depth as the send pit. Due to the depth of the excavation shoring would be required to maintain the safety of all workers in the pit based on the assumption there would not be enough room to bench the excavation. The excavated material must also be considered for storage during the jack and bore process. In urban environments where construction area is restricted, excavated material is typically transported outside the construction area to be stored or disposed of while duct banks are installed. This can lead to an even larger area required for the jack and bore process. Casings can vary in size from 14 to 80+ inches in diameter, depending on project requirements.

**Figure 2-4 — Jack and Bore – Send Pit**

**Figure 2-5 — Jack and Bore – Equipment**

### 2.2.3. Vaults

Man-vaults would be required along the route for cable installation, splicing, inspection, maintenance requirements and access for future repairs. Man-vault spacing, and location are determined by maximum cable reel length, cable pulling tensions, and side wall pressures. Typical distance between vaults is expected to be 1,500 to 2,500 feet for the XLPE cable. The size of man-vaults is based on the type of cable system installed. Typical dimensions for man vaults are between 25-35 feet long by 7-10 feet wide by 10-12 feet tall dependent on voltage. Excavations are expected to 37 feet long by 12 feet wide by 12 - 16 feet deep dependent on existing infrastructure. Typically, man vaults are pre-cast and delivered to the site for installation. After installation, the over excavation is backfilled. A man vault typically houses cable and splices on one side of the vault allowing open space on the other side to work, cables are typically stacked 3-4 high dependent on system design. If the design of the underground line requires multiple cables per phase to maintain ampacity requirements multiple vaults per splice location would be required. These vaults will be placed in line, slightly offset, to minimize easement impacts. One phase cable set would enter the first vault while the second set would by-pass the first vault, then enter the second vault while the first phase cable set would by-pass the second vault. This would occur at every vault location.

**Figure 2-6 – Man Vault Placement**


**Figure 2-7 – Man Vault Backfill**

### 2.2.4. Cable Installation and Testing

After the civil portion of the underground installation (no cables placed in ducts at this time) is complete, the duct bank would be tested and cleaned by pulling a mandrel and swab through each of the ducts. This is done to ensure all ducts are concentric with correct clearance for cable, are clean of debris and are ready for cable pulling. Once each duct is cleared the cables can be installed. The typical cable pulling setup would be to set the reel of cable at one end of the pull and place a winch truck at the opposite end. Direction of pull between man vaults would be determined based on the direction that results in the lowest pulling or sidewall tensions. Once all the cables are pulled into a man-vault from each direction, splicing of the cable could commence. This process is repeated until all the cables have been pulled and spliced or terminated.

**Figure 2-8 – XLPE Cable Reel**

**Figure 2-9 – XLPE Cable Installation**

After completion of the installation, all splices and terminations of the cable must be tested before being placed in service. Testing includes a jacket integrity test using a specified DC voltage to ensure the jacket is continuous from end to end. Historically, an AC soak test would also be performed where the cable would be connected at rated voltage without load and left to “soak” for 24 hours. This enables the insulation to be stressed prior to current flow.

## 2.3. MAINTENANCE

Underground transmission lines require routine maintenance to ensure the cables continue to operate with uninterrupted service. Maintenance is primarily visual inspection of terminations, splices, man vaults, arrestors, grounds, riser structures, and cables. This type of maintenance is dependent on the utility but is recommended every 6 to 12 months for standard maintenance and a higher intensity maintenance performed in five-year intervals. To accommodate for visual inspections, the line would have to be de-energized and lane closures maybe necessary to allow inspectors access into the vaults.

### 2.3.1. Cable Failure and Repair

Underground transmission lines, in general, are reliable. However, should a cable failure occur, the time to restore service can be lengthy. Overhead lines, utilizing standard material, can usually be placed back into service in a matter of days. On the other hand, underground transmission lines may be out of service for weeks to get qualified crews on site to repair or replace cable. If cable is not available or stored in a yard it could take months for repair as new cable would be ordered, which typically have long lead times. Accurately locating the cable failure is extremely important. Overhead line faults are relatively easy to identify and correct as visual inspections provide a quick analysis and plan for repair. Locating a failure for underground lines is much more difficult as visual inspection is nearly impossible. Therefore, other methods

are used to locate the failure(s). The most common method of locating a fault is to apply a capacitor discharge signal and detect return signal using an acoustical device.

Once the fault is located, a specialized contractor such as the cable manufacturer would need to make the repairs. Faults may be so great that the cable cannot be reused and depending on the level of failure, could fuse to the duct. In this case, if the duct has a spare, a new cable would need to be purchased, manufactured and pulled. If there is no spare position in the duct bank, then a replacement duct bank would need to be installed.

# 3. PRELIMINARY DESIGN

This assessment is based on a 5.5-mile route, broken out into multiple sections described below in table 1, in an urban location of central Tucson. Due to the location, installation of the duct bank is proposed in the road, median, road shoulder, or sidewalk area dependent on location. S&L has assumed that most of the line would be installed in road median or road shoulder to minimize impacts to the travel lanes as much as possible. It is also assumed that most of the existing storm drains would be avoided by this placement limiting the amount of existing infrastructure interactions. At this stage, no surveys or geotechnical studies within the project study area or other design support activities have been performed. A full list of assumptions is provided in section 4.

**Table 1 – Sections**

| Section | Description |
|---|---|
| 1 | 36th to Silverlake |
| 2 | Silverlake to 22nd |
| 3 | 22nd to Broadway |
| 4 | Broadway to 6th |
| 5 | 6th to Speedway |
| 6 | Speedway to North UA Substation |
| 7 | North UA Substation to Grant |

## 3.1. DESIGN INPUTS

**Table 2 – Preliminary Cable Data**

| | |
|---|---|
| **CONDUCTOR SIZE** | 6000 KCMIL |
| **CONDUCTOR MATERIAL** | COPPER, |
| **INSULATION TYPE** | CROSS LINKED POLYETHYLENE (XLPE) |
| **NUMBER OF CABLES PER PHASE** | 2 |
| **CABLE DIAMETER** | 4.86 INCHES |
| **CABLE WEIGHT** | 24.4 LB/FT |
| **MAXIMUM CABLE OPERATING TEMPERATURE** | 90°C |
| **EMERGENCY TEMPERATURE** | 105°C |

Based on the cable size, it is expected that the duct bank would require 8” ducts to supply enough space for the specified cable. No spare cable will be installed for this project. S&L would recommend a spare duct for phase cables be installed in the event that catastrophic damage occurs in a duct; TEP can install a new cable without developing an entirely new duct bank. It is assumed the permanent right of way width required for the duct bank would be approximately 30 feet wide.

For communication wires and Ground Continuity Conductor (GCC), S&L recommends the use of 2" Schedule 40 conduits. A single 2" duct would be utilized for the installation of one 96 count single mode fiber optical cable for communication support for the transmission line. Two ducts would be utilized for the installation of a fiber optic cable that would be used for distributed temperature sensing fiber (DTS). The DTS would be used to monitor the temperature of the cables in the duct bank to ensure the protection of the cable. Two ducts would house the GCC to support the cable grounding method which would be finalized during detailed design. Finally, S&L recommends two additional 2" ducts to be installed as a spare in the event that there is damage to one of the 2" ducts. A total of seven 2" ducts are proposed for the transmission line.

S&L identified, using preliminary GIS data that the underground transmission line route could cross up to 40 sewer lines and 70 water lines along the 5.5-mile route. During detailed design of the 138kV underground transmission line, it is expected to encounter storm water, communications, and gas lines., This would require changes in configuration and depth of the underground transmission line or relocation of the existing utilities which will result in higher installation cost. It is expected that these interferences will be encountered multiple time on the project due to the urban nature of the route.

## 3.2. ELECTRICAL DESIGN

### 3.2.1. AMPACITY

For the purposes of this cost estimate, a 6000 kcmil two cable per phase installation was chosen in order to meet all ampacity requirements set forth by the client. A preliminary cable ampacity calculation has been performed to determine conceptual cable ampacity characteristics. To perform this work, CYMCAP, a cable ampacity program developed by Eaton was used to model the underground transmission layout. The modeling accounts for all material placed around the cable as well as the potential depth and configuration of duct banks/bores along the route. If determined during the detailed modeling of the system that the ampacity is not met, more conductor area would be required; this may potentially require additional cables per phase and updates to the design. This could have significant impacts to the design, increasing the duct bank size and requirement of additional materials. A total of 8 unique installations were evaluated to determine ampacity, these include open trench duct bank,  and jack and bore. See Table 2 for maximum steady state ampacity results.

A preliminary native soil thermal resistivity of 2.79°C-m/W was utilized for the ampacity calculation. This value was determined per a geotechnical investigation that was conducted for a project at Irvington Yard 138kV Substation provided by TEP.  This sample investigation is located approximately 3.25 miles from the southern most edge of the study area for this project. It is critical to understand that soil characteristics change and it is recommended that these tests are performed at approximately 1500 foot intervals along the route.  If the soils thermal resistivity is higher than expected, the ampacity will decrease as described in section 1. Thermal resistivity for the duct bank concrete (duct bank encasement and red dyed) was assumed to be 0.65°C-m/W and the thermally approved backfill was assumed to be 0.90°C-m/W.

Soil temperatures for the duct bank and the jack and bore installations were determined utilizing data retrieved from the National Water and Climate Center (NWCC). The NWCC provides soil temperature data at a maximum depth of 40 inches. The worst-case annual ground temperature per the NWCC at a depth of 40 inches is 28.8°C. Soil temperature at a depth of 60 feet was determined utilizing data retrieved from "Henry's Map," which is located on the Environmental Protection Agency website. The average temperature of shallow groundwater is approximately 22.2°C. For conservatism, this value was increased to 25°C for the purposes of this calculation.

At the request of TEP the minimum required ampacity for the line will be 1584A continuous rating, but TEP

would prefer that the underground transmission line has the same capacity as TEP's standard 138kV overhead transmission line utilizing 954 ACSS conductor which is 2264A.

It is assumed there is a load factor for the cable of 0.75 per TEP. Load factor in transmission line design reflects the duration that the line is loaded to its full capacity. For underground lines the longer the line runs at high temperatures the harder it is for the soil around the cable to cool.

Table 3 below provides a summary of the preliminary ampacity calculation performed by S&L.

**Table 3 – Maximum Steady State Ampacity at Rated Temperature (90°C)**

| Installation Number | Cable Size | Description | Required Ampacity Per Phase (A) | Preferred Ampacity Per Phase (A) | Max Ampacity Per Phase at Rated Temp (A) |
|---|---|---|---|---|---|
| **1** | 6000 kcmil | Duct Bank – 1 Cable/Phase – 3ft Depth | 1584 | 2264 | 1897.2 |
| **2** | 6000 kcmil | Duct Bank – 2 Cables/Phase – 3ft Depth | 1584 | 2264 | 2998.6 |
| **3** | 6000 kcmil | Duct Bank – 1 Cable/Phase – 10ft Depth | 1584 | 2264 | 1571.2 |
| **4** | 6000 kcmil | Duct Bank – 2 Cables/Phase – 10ft Depth | 1584 | 2264 | 2275.4 |
| **5** | 6000 kcmil | Jack & Bore – 1 Cable/Phase – 15ft Depth | 1584 | 2264 | 1234.7 |
| **6** | 6000 kcmil | Jack & Bore –2 Cables/Phase –15ft Depth | 1584 | 2264 | 2275.0 |
| **7** | 5000 kcmil | Jack & Bore– 2 Cables/Phase –15ft Depth | 1584 | 2264 | 2028.6 |
| **8** | 5000 kcmil | Duct Bank – 2 Cables/Phase-10ft Depth | 1584 | 2264 | 2031.4 |

The allowable ampacity of an underground transmission line is restricted by the section of the line with the lowest allowable ampacity. Given the cable requirements set forth, a single 6000 kcmil cable per phase installation will not meet ampacity requirements for all required installation configurations, mainly when the cable is 10 plus feet deep. Therefore, it should be assumed at minimum a two cable per phase installation will be required.

S&L evaluated 2 cables per phase installations for both 5000 kcmil and 6000 kcmil cables for the most critical cases (jack and bore and deep duct bank), both installations meet the minimum required ampacity of 1584A. A 5000 kcmil two cables per phase installation will allow a maximum ampacity 2028.6A while a 6000 kcmil two cable per phase installation will allow a maximum ampacity of 2275.0A. The benefit of selecting a 6000 kcmil cable over a 5000 kcmil would be an improvement in ampacity of 246.4A and meeting the preferred ampacity. The benefit of a 5000 kcmil cable would be a lower cost as well as being more common in the industry.

If a jack and bore is not utilized on this project, a 5000 kcmil two cable per phase installation will allow a maximum ampacity of 2031.4A and a 6000 kcmil two cable per phase installation will allow a maximum ampacity of 2275.4 A.

### 3.2.2. CHARGING CURRENT

Cable charging current was calculated in order to better understand the electrical characteristics of the transmission line. Charging current is a capacitive loss that occurs due to the layer of insulation surrounding the underground cable. The charging current calculation was completed using an S&L internal design calculation. In addition, the cables were modeled in CYMCAP in a typical duct bank configuration and charging current was analyzed and compared to the S&L calculation results. See Table 4 for the results of the cable charging current calculation.

**Table 4 – Charging Current – Calculated Result**

| Description | Result (A) |
|---|---|
| S&L Calculation - Total Charging Current – Per Phase | 194.678 |
| CYMCAP - Total Charging Current – Per Phase | 194.319 |

Based on the ampacity requirements specified by the client, ampacity is either 1585 amps minimum, or 2264 amps preferred. With a result of 195 amps, the charging current makes up 12.3% – 8.6% of the total current. The full impacts of the cable's shunt capacitance and charging current must be studied from a system impact perspective to fully understand the effects on voltage regulation, system efficiency and power flow. In addition, the charging capacitance needs to be considered when developing the line protective relay settings.

### 3.2.3. MAGNETIC FIELD

In addition to ampacity and charging current, a magnetic field calculation was also performed. Magnetic field was analyzed using CYMCAP and assumes a typical installation case which provides both a conservatively result for the strength of magnetic field based of minimal depth of installation and is expected to be used for most of the route. Results are provided for both the preferred client ampacity of 2264A per phase as well as the minimum allowable ampacity of 1584A per phase. See Table 4 and Table 5 for the EMF results.

**Table 5 – 1584A Magnetic Field Results**

| Description | Distance from Center of Duct Bank (ft) | Magnetic Field (mG) |
|---|---|---|
| Maximum Magnetic Field | 0 | 208.837 |

**Figure 3-1 – 1584A Magnetic Field Results**

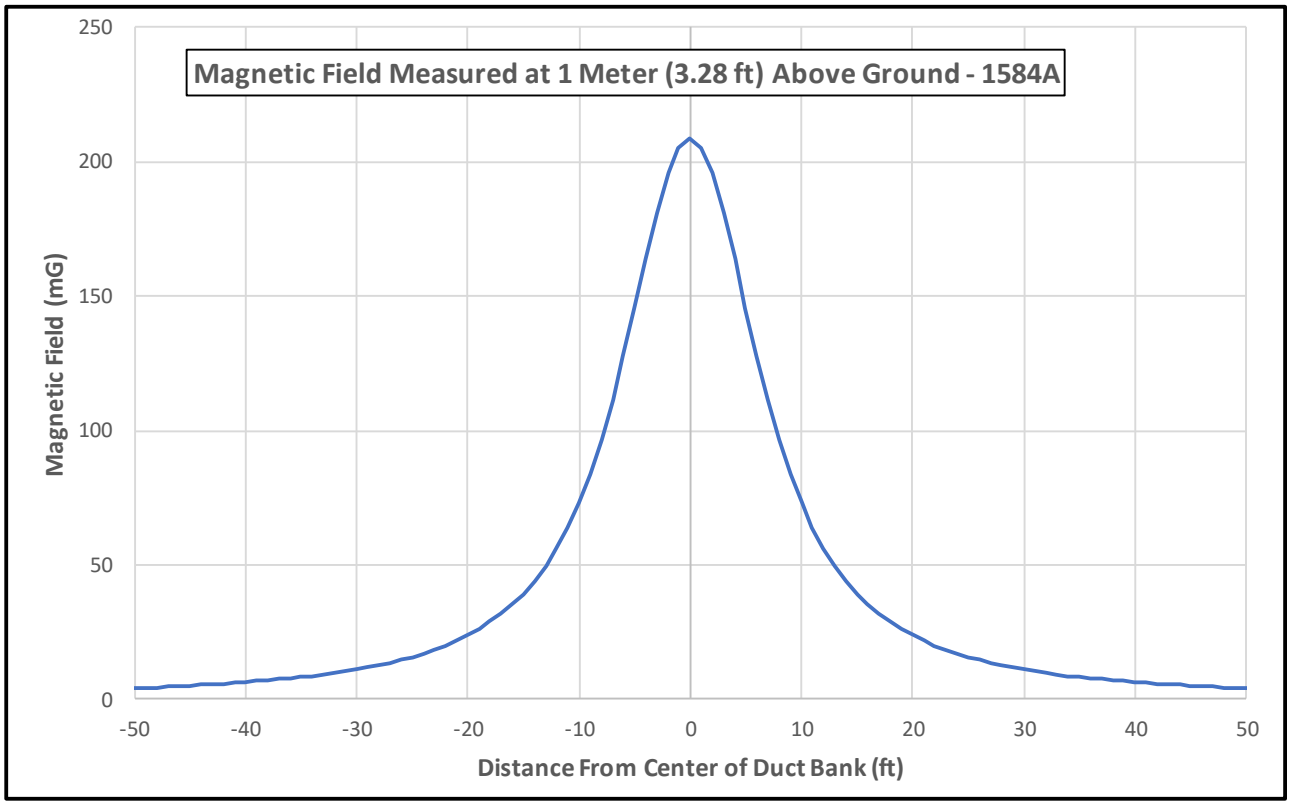
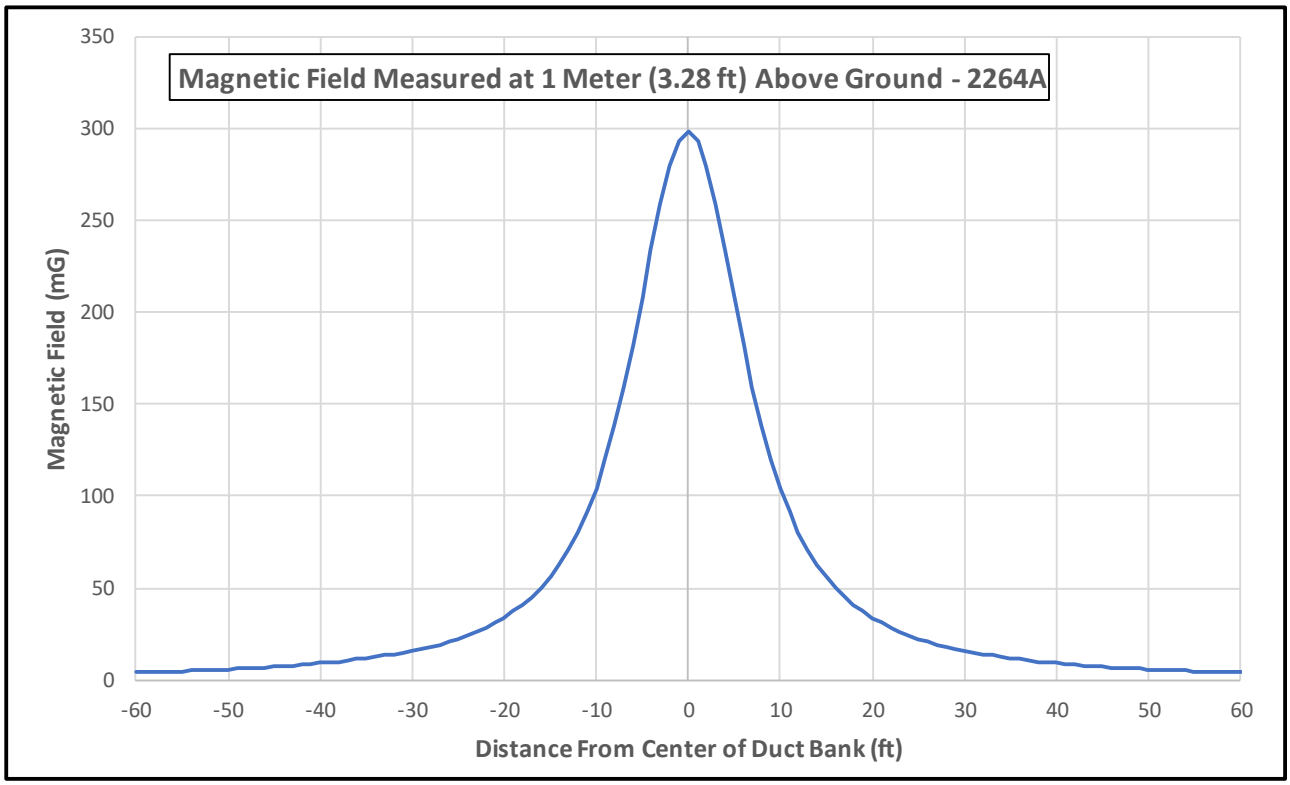


**Table 6 – 2264A Magnetic Field Results**

| Description | Distance from Center of Duct Bank (ft) | Magnetic Field (mG) |
|---|---|---|
| Maximum Magnetic Field | 0 | 298.678 |

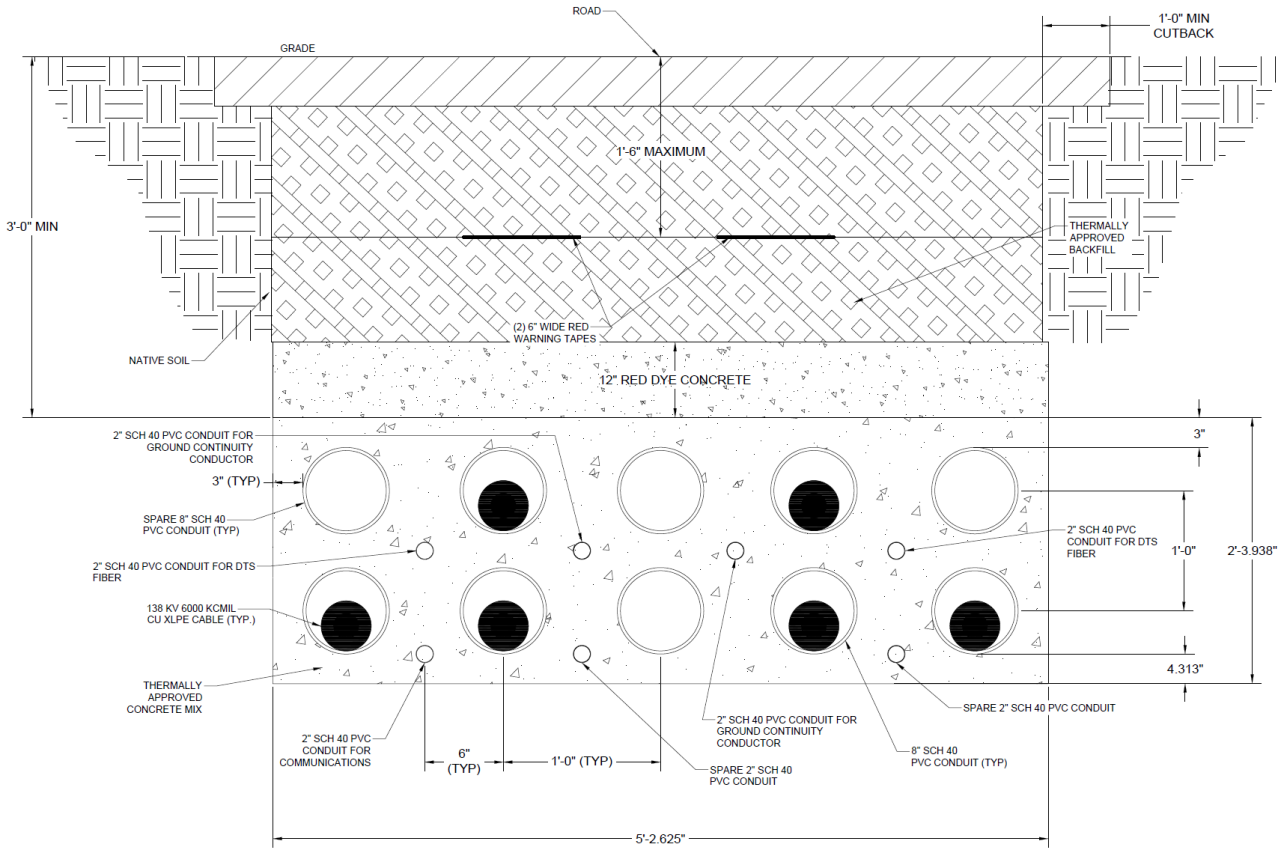
**Figure 3-2 – 2264A Magnetic Field Results**



## 3.3. OPEN CUT TRENCH PARAMETERS

Since data has not been gathered for underground infrastructure along the route, S&L assumes the average depth of the duct bank would be at minimum, 3 feet to the top of the duct bank. Most existing underground infrastructure would be crossed by open trench except when in designated road jack and bore crossings. The duct bank would have ten 8” PVC ducts for cables and four 2” PVC ducts. Below is a preliminary representation of the proposed duct bank design.

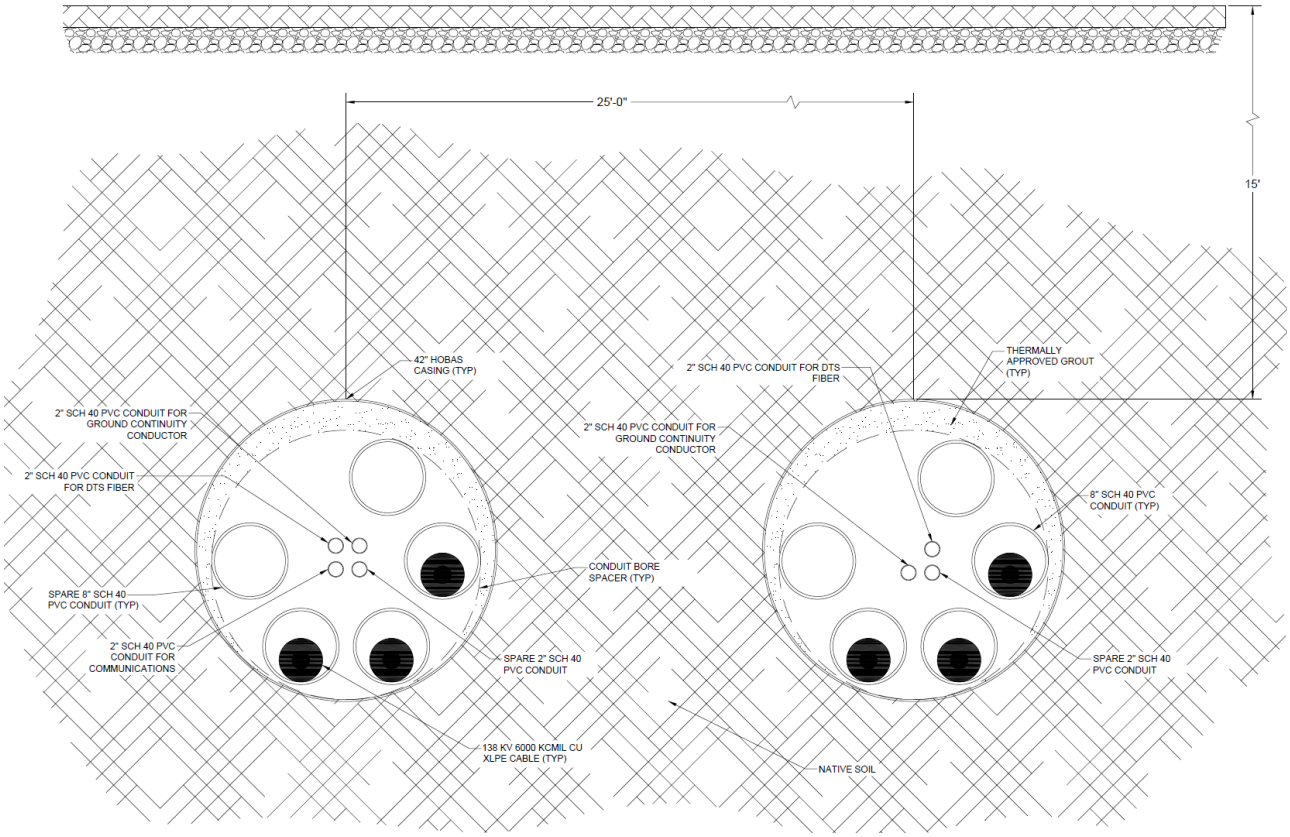
**Figure 3-3 — Preliminary Duct Bank Layout**



## 3.4. TRENCHLESS DESIGN PARAMETERS

It is expected that trenchless installations would be required under the highway and railroad crossings. For this study, it was assumed that there would be one crossing requiring a jack and bore, approximately 400-ft in length. S&L has estimated the bore casing would be 42” in diameter to support the duct installation. Due to the requirement of a minimum of 2 cables per phase multiple bores will be required. It is expected the boring would be filled with thermal grout such as bentonite to aid in heat dissipation. Depth of the bore would be determined during detailed design once all existing infrastructure and other required inputs clarify the design.

**Figure 3-4 — Preliminary Bore Layout**



# 4. COST ESTIMATE

## 4.1. COST ESTIMATE ASSUMPTIONS

This cost estimate is based on standard pricing and/or pricing attained for a 5.5-mile-long underground line in urban, central Tucson. This cost estimate is not the total cost for the project. There are many factors that can affect the overall cost of the transmission line.

Below is a list of assumptions for this estimate:

1. Revision 7 costs are based on 2022 costs. For quotes that S&L was not able to obtain updated pricing, a 14.5% increase was assumed due to inflation. No escalation is included, therefore cost of materials can fluctuate and affect the overall estimate.
2. Cost estimate does not include costs associated with environmental and ROW acquisition. This report was prepared to examine the feasibility and cost of undergrounding. The estimate provided may increase based upon permitting and ROW acquisition.
3. Subsurface Conditions - Preliminary Sewer and water lines were considered in this estimate. Existing infrastructure can have major effects on construction and therefore would have significant impacts on cost. At this stage S&L has assumed a 6' deep trench typically and 15' deep trenchless installations would be acceptable. If additional crossings such as communications, gas, and electrical are discovered during design this will create additional design and construction costs during the construction of the project.
4. Soil types, such as rock, have impacts on cost. At this stage S&L assumed no rock or caliche would be encountered within the study area. If rock or caliche is experienced this would increase labor costs and overall schedule.
5. The City may have special requirements that may impact the current restoration estimate assumptions. S&L has assumed the project would only require repair of the removed asphalt, curbs, and sidewalks. If more is required by the City, this would increase the cost.
6. Estimate does not include any environmental costs. This could increase costs based on level of environmental requirements for the project. This would be defined in the detailed design stage of the project. It is important to understand this could have a significantly larger impact than overhead transmission lines. Due to the fact that trenching would be required throughout the route underground transmission lines have a much larger impact and therefore could have significant cost impact (permitting and mitigation) if environmental or archeological areas are encountered.
7. Assumes single point or cross bonding scheme.
8. Cost Estimate assumes two (2) 6000kcmil cables per phase.
9. Estimate does not include temporary construction easements.
10. Duct installation cost includes excavation, shoring, duct placement, placement of concrete (including red dye), and compaction of soil above. Cost of repaving is separate.
11. No spare material has been included, unless identified otherwise.
12. Only one railroad crossing requiring a jack and bore installation was assumed for the study.
13. An 8.7% sales tax has been included on all material costs.
14. A 20% contingency due to unknowns is included.
15. Materials used in the cost estimate meet all applicable industry standards.
16. Construction would be performed by qualified and experienced contractors.

17. S&L assumes 10 ducts for cable and 7 ducts for communications, ground continuity conductors, and spares.
18. Vaults are assumed to be installed approximately every 2,000 feet.
19. Asphalt repair assumes 8' wide repair.
20. Excavation assumes 30% swell of soils for hauling purposes.
21. Assumes civil contractor can install 100' of duct a day with a single crew.
22. Assumed Jack and bore across highway and rail oad. 2 – 42" hobas pipe
23. Assumes 2 vaults per splice (one per phase cable).
24. Permitting costs are not included, this includes city permits for installation, plan reviews, temporary traffic, or any other occurred cost.
25. It is assumed this work is performed during normal work hours. Night, weekends, or extended hours which would increase labor costs are not included in this estimate.

## 4.2. COST ESTIMATE

The transmission line was broken up into 7 sections in order to perform a cost estimate for the underground transmission line. In addition, a section titled "Engineering and Commissioning" accounts for costs that are lump sum or design, design support, and commissioning work. Sections 1 and 7 include costs related to the riser structures at the beginning and end of the underground portion of the line. These costs include the materials and labor for the installation of the terminations, arrestors, and splices. Section 3 accounts for a jack and bore under Aviation Parkway and Union Pacific Railroad. See Table 6 for the cost estimate summary broken down by section, as well as the total cost. See Appendix A for a detailed breakdown of costs by section.

**Table 7 – Cost Estimate Summary**

| Section | Cost ($) | Cost ($+20%) | Section Length (ft) | Cost ($/ mile) | Cost ($/mile +20%) |
|---|---|---|---|---|---|
| 1 | $9,292,249.27 | $11,150,699.13 | 3150 | $15,575,579.74 | $18,690,695.68 |
| 2 | $7,633,992.16 | $9,160,790.59 | 2886 | $13,966,555.30 | $16,759,866.36 |
| 3 | $27,283,277.50 | $32,739,933.00 | 9190 | $15,675,267.16 | $18,810,320.59 |
| 4 | $6,476,793.89 | $7,772,152.67 | 2330 | $14,677,026.50 | $17,612,431.80 |
| 5 | $8,851,290.80 | $10,621,548.97 | 2998 | $15,588,664.26 | $18,706,397.11 |
| 6 | $11,627,215.70 | $13,952,658.85 | 4247 | $14,455,309.38 | $17,346,371.25 |
| 7 | $12,797,155.50 | $15,356,586.60 | 4407 | $15,332,194.48 | $18,398,633.37 |
| Engineering and Commissioning | $5,501,832.47 | $6,602,198.96 | - | - | - |
| Total | $89,463,807.30 | $100,754,369.80 | 29208 | $16,172,586.37 | $18,213,608.35 |

# 5. CONSTRUCTION DURATION

The construction of underground transmission can be extremely impactful in urban environments. Construction requires open cut trenching which will close sections of roads and block entrances to building access, side roads, alleys, and home driveways temporarily. Dependent on locations of splice boxes for the cables there could be additional impacts such as temporary road or lane closures due to cable pulling and splicing. If accessibility is of concern night work can be performed, this has additional impacts both to the community with construction activities occurring during off hour, but also addition cost for labor to work nights would be an additional premium. But this would allow certain areas to be covered with steel plates during the day allowing access to homes and buildings.

Construction for a typical 1 mile section could take up to 130 working days, and dependent on allowable work times, could take up to 26 weeks to complete. This assumes installation of duct bank sections is with one crew for duct bank installation. It assumes vaults can be installed simultaneously in section with a separate crew, minimizing the civil construction duration, to help minimize major road or lane closures. This does not include pre-construction activities such as final locates and staking. This assumes the average of the overall 5.5 mile line route.

# 6. CONCLUSIONS

TEP's typical installation cost for a 138kV overhead transmission line is approximately $1 million a mile for a design in an urban environment which does not include right of way acquisition. Based on the underground estimate developed in this analysis, an underground transmission line would cost approximately $16.1 million a mile or about 16.1 times the cost of an overhead transmission line.

# 7. APPENDIX A - SECTION COST SUMMARIES

| Section 1 - 36th to Silverlake | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 31500 | $23.49 | $739,935.00 | $0.00 | $0.00 | $739,935.00 |
| 2 | 2 inch PVC Counduit, Per ft | 22100 | $2.95 | $65,195.00 | $0.00 | $0.00 | $65,195.00 |
| 3 | Conduit Duct Spacers, Each | 630 | $58.00 | $36,540.00 | $15.00 | $9,450.00 | $45,990.00 |
| 4 | Man Vault, Each | 4 | $45,000.00 | $180,000.00 | $25,000.00 | $100,000.00 | $280,000.00 |
| 5 | Duct Installation, Per ft | 3200 | $100.00 | $320,000.00 | $175.00 | $560,000.00 | $880,000.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 21120 | $2.00 | $42,240.00 | $2.00 | $42,240.00 | $84,480.00 |
| 7 | Thermal Backfill, cubic foot | 89500 | $3.50 | $313,250.00 | $2.00 | $179,000.00 | $492,250.00 |
| 8 | Haul Away, cubic ft | 172100 | $1.00 | $172,100.00 | $2.00 | $344,200.00 | $516,300.00 |
| 9 | Ashpalt Replacement, sq ft | 23700 | $5.50 | $130,350.00 | $5.00 | $118,500.00 | $248,850.00 |
| 10 | Sidewalk/Curb Replacement, ft | 11 | $100.00 | $1,100.00 | $40.00 | $440.00 | $1,540.00 |
| 11 | Landscape Restoration, sq ft | 1430 | $2.00 | $2,860.00 | $3.00 | $4,290.00 | $7,150.00 |
| 12 | Utility Relocation, ft | 160 | $100.00 | $16,000.00 | $100.00 | $16,000.00 | $32,000.00 |
| 13 | Steel plating, days | 52 | $480.00 | $24,960.00 | $0.00 | $0.00 | $24,960.00 |
| 14 | Traffic Control, days | 60 | $3,000.00 | $180,000.00 | $0.00 | $0.00 | $180,000.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 0 | $580.00 | $0.00 | $750.00 | $0.00 | $0.00 |
| 16 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $250,000.00 | $0.00 | $0.00 |
| 17 | Bore Spacer, each | 0 | $600.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 18 | Bore Grout, cubic ft | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 19 | Haul Away jack and bore, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 21 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 22 | Shoring, per sq ft | 0 | $15.00 | $0.00 | $50.00 | $0.00 | $0.00 |
| 23 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 24 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 18900 | $195.00 | $3,685,500.00 | $0.00 | $0.00 | $3,685,500.00 |
| 26 | Spare XLPE Cable on reel, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 27 | Terminator w/ NEMA pad, each | 6 | $10,168.20 | $61,009.20 | $28,578.70 | $171,472.20 | $232,481.40 |
| 28 | Spare Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $0.00 | $0.00 | $0.00 |
| 29 | Arresters, each | 6 | $4,500.00 | $27,000.00 | $7,850.00 | $47,100.00 | $74,100.00 |
| 30 | Spare Arrester, each | 0 | $4,500.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 31 | Splices, each | 12 | $11,162.90 | $133,954.80 | $21,963.70 | $263,564.40 | $397,519.20 |
| 32 | Racking for Vaults, each | 4 | $16,300.00 | $65,200.00 | $13,167.00 | $52,668.00 | $117,868.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 2 | $4,523.60 | $9,047.20 | $3,750.00 | $7,500.00 | $16,547.20 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 2 | $2,954.50 | $5,909.00 | $3,750.00 | $7,500.00 | $13,409.00 |
| 36 | Bonding Cable, per ft | 440 | $13.85 | $6,094.00 | $0.00 | $0.00 | $6,094.00 |
| 37 | Cable Clamps, each | 168 | $100.00 | $16,800.00 | $150.00 | $25,200.00 | $42,000.00 |
| 38 | Ground Continuity Conductors, per ft | 6300 | $12.53 | $78,939.00 | $0.00 | $0.00 | $78,939.00 |
| 39 | Cable Pulling, lot | 1 | $0.00 | $0.00 | $240,000.00 | $240,000.00 | $240,000.00 |
| 40 | Testing & Commisionning, lot | 0 | $0.00 | $0.00 | $480,000.00 | $0.00 | $0.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $350,000.00 | $0.00 | $0.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 4000 | $1.50 | $6,000.00 | $0.00 | $0.00 | $6,000.00 |
| 43 | Hand Vaults for Fiber, each | 2 | $700.00 | $1,400.00 | $2,500.00 | $5,000.00 | $6,400.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 128 | $1.00 | $128.00 | $3.00 | $384.00 | $512.00 |
| 45 | Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| 46 | Sidewalk/Curb Replacement, ft | 20 | $100.00 | $2,000.00 | $40.00 | $800.00 | $2,800.00 |
| 47 | Fiber Optic Cable splices, each | 4 | $1,000.00 | $4,000.00 | $4,000.00 | $16,000.00 | $20,000.00 |
| 48 | Temp. Sensing Fiber, ft | 4000 | $0.75 | $3,000.00 | $0.00 | $0.00 | $3,000.00 |
| 49 | Temp. Sensing Fiber System, lot | 0 | $30,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 1 | $90,000.00 | $90,000.00 | $50,000.00 | $50,000.00 | $140,000.00 |
| 51 | Foundation, each | 1 | $35,000.00 | $35,000.00 | $0.00 | $0.00 | $35,000.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 0 | $0.00 | $0.00 | $1,200,000.00 | $0.00 | $0.00 |
| 53 | Geotechnical Including Thermal, per bore | 3 | $0.00 | $0.00 | $4,600.00 | $13,800.00 | $13,800.00 |
| 54 | Underground Utility Survey, lot | 0 | $0.00 | $0.00 | $700,000.00 | $0.00 | $0.00 |
| 55 | Construction Management, lot | 0 | $0.00 | $0.00 | $1,100,000.00 | $0.00 | $0.00 |
| 56 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $450,000.00 | $0.00 | $0.00 |
| 57 | Permitting | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $561,629.47 | | | |
| | Summary of Cost | | | $7,017,140.67 | | $2,275,108.60 | $9,292,249.27 |
| | Summary of Cost with Contingancy (20%) | | | $8,420,568.81 | | $2,730,130.32 | $11,150,699.13 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

| Section 2 - Silverlake to 22nd | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 28900 | $23.49 | $678,861.00 | $0.00 | $0.00 | $678,861.00 |
| 2 | 2 inch PVC Counduit, Per ft | 20300 | $2.95 | $59,885.00 | $0.00 | $0.00 | $59,885.00 |
| 3 | Conduit Duct Spacers, Each | 580 | $58.00 | $33,640.00 | $15.00 | $8,700.00 | $42,340.00 |
| 4 | Man Vault, Each | 2 | $45,000.00 | $90,000.00 | $25,000.00 | $50,000.00 | $140,000.00 |
| 5 | Duct Installation, Per ft | 2900 | $100.00 | $290,000.00 | $175.00 | $507,500.00 | $797,500.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 35200 | $2.00 | $70,400.00 | $2.00 | $70,400.00 | $140,800.00 |
| 7 | Thermal Backfill, cubic foot | 66600 | $3.50 | $233,100.00 | $2.00 | $133,200.00 | $366,300.00 |
| 8 | Haul Away, cubic ft | 142300 | $1.00 | $142,300.00 | $2.00 | $284,600.00 | $426,900.00 |
| 9 | Ashpalt Replacement, sq ft | 14500 | $5.50 | $79,750.00 | $5.00 | $72,500.00 | $152,250.00 |
| 10 | Sidewalk/Curb Replacement, ft | 1275 | $100.00 | $127,500.00 | $40.00 | $51,000.00 | $178,500.00 |
| 11 | Landscape Restoration, sq ft | 12750 | $2.00 | $25,500.00 | $3.00 | $38,250.00 | $63,750.00 |
| 12 | Utility Relocation, ft | 245 | $100.00 | $24,500.00 | $100.00 | $24,500.00 | $49,000.00 |
| 13 | Steel plating, days | 39 | $480.00 | $18,720.00 | $0.00 | $0.00 | $18,720.00 |
| 14 | Traffic Control, days | 43 | $3,000.00 | $129,000.00 | $0.00 | $0.00 | $129,000.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 0 | $580.00 | $0.00 | $750.00 | $0.00 | $0.00 |
| 16 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $250,000.00 | $0.00 | $0.00 |
| 17 | Bore Spacer, each | 0 | $600.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 18 | Bore Grout, cubic ft | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 19 | Haul Away jack and bore, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 21 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 22 | Shoring, per sq ft | 0 | $15.00 | $0.00 | $50.00 | $0.00 | $0.00 |
| 23 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 24 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 17400 | $195.00 | $3,393,000.00 | $0.00 | $0.00 | $3,393,000.00 |
| 26 | Spare XLPE Cable on reel, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 27 | Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $28,578.70 | $0.00 | $0.00 |
| 28 | Spare Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $0.00 | $0.00 | $0.00 |
| 29 | Arresters, each | 0 | $4,500.00 | $0.00 | $7,850.00 | $0.00 | $0.00 |
| 30 | Spare Arrester, each | 0 | $4,500.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 31 | Splices, each | 6 | $11,162.90 | $66,977.40 | $21,963.70 | $131,782.20 | $198,759.60 |
| 32 | Racking for Vaults, each | 2 | $16,300.00 | $32,600.00 | $13,167.00 | $26,334.00 | $58,934.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 2 | $4,523.60 | $9,047.20 | $3,750.00 | $7,500.00 | $16,547.20 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 0 | $2,954.50 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 36 | Bonding Cable, per ft | 220 | $13.85 | $3,047.00 | $0.00 | $0.00 | $3,047.00 |
| 37 | Cable Clamps, each | 0 | $100.00 | $0.00 | $150.00 | $0.00 | $0.00 |
| 38 | Ground Continuity Conductors, per ft | 5800 | $12.53 | $72,674.00 | $0.00 | $0.00 | $72,674.00 |
| 39 | Cable Pulling, lot | 1 | $0.00 | $0.00 | $130,000.00 | $130,000.00 | $130,000.00 |
| 40 | Testing & Commisionning, lot | 0 | $0.00 | $0.00 | $480,000.00 | $0.00 | $0.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $350,000.00 | $0.00 | $0.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 3000 | $1.50 | $4,500.00 | $0.00 | $0.00 | $4,500.00 |
| 43 | Hand Vaults for Fiber, each | 1 | $700.00 | $700.00 | $2,500.00 | $2,500.00 | $3,200.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 64 | $1.00 | $64.00 | $3.00 | $192.00 | $256.00 |
| 45 | Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| 46 | Sidewalk/Curb Replacement, ft | 10 | $100.00 | $1,000.00 | $40.00 | $400.00 | $1,400.00 |
| 47 | Fiber Optic Cable splices, each | 2 | $1,000.00 | $2,000.00 | $4,000.00 | $8,000.00 | $10,000.00 |
| 48 | Temp. Sensing Fiber, ft | 3000 | $0.75 | $2,250.00 | $0.00 | $0.00 | $2,250.00 |
| 49 | Temp. Sensing Fiber System, lot | 0 | $30,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 0 | $90,000.00 | $0.00 | $50,000.00 | $0.00 | $0.00 |
| 51 | Foundation, each | 0 | $35,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 0 | $0.00 | $0.00 | $1,200,000.00 | $0.00 | $0.00 |
| 53 | Geotechnical Including Thermal, per bore | 2 | $0.00 | $0.00 | $4,600.00 | $9,200.00 | $9,200.00 |
| 54 | Underground Utility Survey, lot | 0 | $0.00 | $0.00 | $700,000.00 | $0.00 | $0.00 |
| 55 | Construction Management, lot | 0 | $0.00 | $0.00 | $1,100,000.00 | $0.00 | $0.00 |
| 56 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $450,000.00 | $0.00 | $0.00 |
| 57 | Permitting | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $486,418.36 | | | |
| | Summary of Cost | | | $6,077,433.96 | | $1,556,558.20 | $7,633,992.16 |
| | Summary of Cost with Contingancy (20%) | | | $7,292,920.75 | | $1,867,869.84 | $9,160,790.59 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

| Section 3 - 22nd Broadway | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 91900 | $23.49 | $2,158,731.00 | $0.00 | $0.00 | $2,158,731.00 |
| 2 | 2 inch PVC Counduit, Per ft | 64400 | $2.95 | $189,980.00 | $0.00 | $0.00 | $189,980.00 |
| 3 | Conduit Duct Spacers, Each | 1840 | $58.00 | $106,720.00 | $15.00 | $27,600.00 | $134,320.00 |
| 4 | Man Vault, Each | 10 | $45,000.00 | $450,000.00 | $25,000.00 | $250,000.00 | $700,000.00 |
| 5 | Duct Installation, Per ft | 9200 | $100.00 | $920,000.00 | $175.00 | $1,610,000.00 | $2,530,000.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 133760 | $2.00 | $267,520.00 | $2.00 | $267,520.00 | $535,040.00 |
| 7 | Thermal Backfill, cubic foot | 245500 | $3.50 | $859,250.00 | $2.00 | $491,000.00 | $1,350,250.00 |
| 8 | Haul Away, cubic ft | 486700 | $1.00 | $486,700.00 | $2.00 | $973,400.00 | $1,460,100.00 |
| 9 | Ashpalt Replacement, sq ft | 57500 | $5.50 | $316,250.00 | $5.00 | $287,500.00 | $603,750.00 |
| 10 | Sidewalk/Curb Replacement, ft | 2160 | $100.00 | $216,000.00 | $40.00 | $86,400.00 | $302,400.00 |
| 11 | Landscape Restoration, sq ft | 7000 | $2.00 | $14,000.00 | $3.00 | $21,000.00 | $35,000.00 |
| 12 | Utility Relocation, ft | 695 | $100.00 | $69,500.00 | $100.00 | $69,500.00 | $139,000.00 |
| 13 | Steel plating, days | 142 | $480.00 | $68,160.00 | $0.00 | $0.00 | $68,160.00 |
| 14 | Traffic Control, days | 162 | $3,000.00 | $486,000.00 | $0.00 | $0.00 | $486,000.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 800 | $580.00 | $464,000.00 | $750.00 | $600,000.00 | $1,064,000.00 |
| 16 | Mobilization / Demobilization, lot | 1 | $0.00 | $0.00 | $250,000.00 | $250,000.00 | $250,000.00 |
| 17 | Bore Spacer, each | 160 | $600.00 | $96,000.00 | $100.00 | $16,000.00 | $112,000.00 |
| 18 | Bore Grout, cubic ft | 15800 | $3.50 | $55,300.00 | $2.00 | $31,600.00 | $86,900.00 |
| 19 | Haul Away jack and bore, cubic ft | 10100 | $1.00 | $10,100.00 | $2.00 | $20,200.00 | $30,300.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 25688 | $1.00 | $25,688.00 | $2.00 | $51,376.00 | $77,064.00 |
| 21 | Ashpalt Replacement, sq ft | 1036 | $5.50 | $5,698.00 | $5.00 | $5,180.00 | $10,878.00 |
| 22 | Shoring, per sq ft | 2470 | $15.00 | $37,050.00 | $50.00 | $123,500.00 | $160,550.00 |
| 23 | Traffic Control, days | 20 | $3,000.00 | $60,000.00 | $0.00 | $0.00 | $60,000.00 |
| 24 | Steel plating, days | 20 | $480.00 | $9,600.00 | $0.00 | $0.00 | $9,600.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 55200 | $195.00 | $10,764,000.00 | $0.00 | $0.00 | $10,764,000.00 |
| 26 | Spare XLPE Cable on reel, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 27 | Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $28,578.70 | $0.00 | $0.00 |
| 28 | Spare Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $0.00 | $0.00 | $0.00 |
| 29 | Arresters, each | 0 | $4,500.00 | $0.00 | $7,850.00 | $0.00 | $0.00 |
| 30 | Spare Arrester, each | 0 | $4,500.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 31 | Splices, each | 30 | $11,162.90 | $334,887.00 | $21,963.70 | $658,911.00 | $993,798.00 |
| 32 | Racking for Vaults, each | 10 | $16,300.00 | $163,000.00 | $13,167.00 | $131,670.00 | $294,670.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 10 | $4,523.60 | $45,236.00 | $3,750.00 | $37,500.00 | $82,736.00 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 0 | $2,954.50 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 36 | Bonding Cable, per ft | 1100 | $13.85 | $15,235.00 | $0.00 | $0.00 | $15,235.00 |
| 37 | Cable Clamps, each | 0 | $100.00 | $0.00 | $150.00 | $0.00 | $0.00 |
| 38 | Ground Continuity Conductors, per ft | 18400 | $12.53 | $230,552.00 | $0.00 | $0.00 | $230,552.00 |
| 39 | Cable Pulling, lot | 1 | $0.00 | $0.00 | $560,000.00 | $560,000.00 | $560,000.00 |
| 40 | Testing & Commisionning, lot | 0 | $0.00 | $0.00 | $480,000.00 | $0.00 | $0.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $350,000.00 | $0.00 | $0.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 10000 | $1.50 | $15,000.00 | $0.00 | $0.00 | $15,000.00 |
| 43 | Hand Vaults for Fiber, each | 5 | $700.00 | $3,500.00 | $2,500.00 | $12,500.00 | $16,000.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 320 | $1.00 | $320.00 | $3.00 | $960.00 | $1,280.00 |
| 45 | Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| 46 | Sidewalk/Curb Replacement, ft | 50 | $100.00 | $5,000.00 | $40.00 | $2,000.00 | $7,000.00 |
| 47 | Fiber Optic Cable splices, each | 10 | $1,000.00 | $10,000.00 | $4,000.00 | $40,000.00 | $50,000.00 |
| 48 | Temp. Sensing Fiber, ft | 10000 | $0.75 | $7,500.00 | $0.00 | $0.00 | $7,500.00 |
| 49 | Temp. Sensing Fiber System, lot | 0 | $30,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 0 | $90,000.00 | $0.00 | $50,000.00 | $0.00 | $0.00 |
| 51 | Foundation, each | 0 | $35,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 0 | $0.00 | $0.00 | $1,200,000.00 | $0.00 | $0.00 |
| 53 | Geotechnical Including Thermal, per bore | 9 | $0.00 | $0.00 | $4,600.00 | $41,400.00 | $41,400.00 |
| 54 | Underground Utility Survey, lot | 0 | $0.00 | $0.00 | $700,000.00 | $0.00 | $0.00 |
| 55 | Construction Management, lot | 0 | $0.00 | $0.00 | $1,100,000.00 | $0.00 | $0.00 |
| 56 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $450,000.00 | $0.00 | $0.00 |
| 57 | Permitting | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $1,650,083.50 | | | |
| | Summary of Cost | | | $20,616,560.50 | | $6,666,717.00 | $27,283,277.50 |
| | Summary of Cost with Contingancy (20%) | | | $24,739,872.60 | | $8,000,060.40 | $32,739,933.00 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

| Section 4 - Broadway to 6th | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 23300 | $23.49 | $547,317.00 | $0.00 | $0.00 | $547,317.00 |
| 2 | 2 inch PVC Counduit, Per ft | 16400 | $2.95 | $48,380.00 | $0.00 | $0.00 | $48,380.00 |
| 3 | Conduit Duct Spacers, Each | 470 | $58.00 | $27,260.00 | $15.00 | $7,050.00 | $34,310.00 |
| 4 | Man Vault, Each | 2 | $45,000.00 | $90,000.00 | $25,000.00 | $50,000.00 | $140,000.00 |
| 5 | Duct Installation, Per ft | 2400 | $100.00 | $240,000.00 | $175.00 | $420,000.00 | $660,000.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 42240 | $2.00 | $84,480.00 | $2.00 | $84,480.00 | $168,960.00 |
| 7 | Thermal Backfill, cubic foot | 57300 | $3.50 | $200,550.00 | $2.00 | $114,600.00 | $315,150.00 |
| 8 | Haul Away, cubic ft | 118500 | $1.00 | $118,500.00 | $2.00 | $237,000.00 | $355,500.00 |
| 9 | Ashpalt Replacement, sq ft | 10900 | $5.50 | $59,950.00 | $5.00 | $54,500.00 | $114,450.00 |
| 10 | Sidewalk/Curb Replacement, ft | 1940 | $100.00 | $194,000.00 | $40.00 | $77,600.00 | $271,600.00 |
| 11 | Landscape Restoration, sq ft | 3650 | $2.00 | $7,300.00 | $3.00 | $10,950.00 | $18,250.00 |
| 12 | Utility Relocation, ft | 120 | $100.00 | $12,000.00 | $100.00 | $12,000.00 | $24,000.00 |
| 13 | Steel plating, days | 34 | $480.00 | $16,320.00 | $0.00 | $0.00 | $16,320.00 |
| 14 | Traffic Control, days | 38 | $3,000.00 | $114,000.00 | $0.00 | $0.00 | $114,000.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 0 | $580.00 | $0.00 | $750.00 | $0.00 | $0.00 |
| 16 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $250,000.00 | $0.00 | $0.00 |
| 17 | Bore Spacer, each | 0 | $600.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 18 | Bore Grout, cubic ft | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 19 | Haul Away jack and bore, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 21 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 22 | Shoring, per sq ft | 0 | $15.00 | $0.00 | $50.00 | $0.00 | $0.00 |
| 23 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 24 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 14000 | $195.00 | $2,730,000.00 | $0.00 | $0.00 | $2,730,000.00 |
| 26 | Spare XLPE Cable on reel, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 27 | Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $28,578.70 | $0.00 | $0.00 |
| 28 | Spare Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $0.00 | $0.00 | $0.00 |
| 29 | Arresters, each | 0 | $4,500.00 | $0.00 | $7,850.00 | $0.00 | $0.00 |
| 30 | Spare Arrester, each | 0 | $4,500.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 31 | Splices, each | 6 | $11,162.90 | $66,977.40 | $21,963.70 | $131,782.20 | $198,759.60 |
| 32 | Racking for Vaults, each | 2 | $16,300.00 | $32,600.00 | $13,167.00 | $26,334.00 | $58,934.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 2 | $4,523.60 | $9,047.20 | $3,750.00 | $7,500.00 | $16,547.20 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 0 | $2,954.50 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 36 | Bonding Cable, per ft | 220 | $13.85 | $3,047.00 | $0.00 | $0.00 | $3,047.00 |
| 37 | Cable Clamps, each | 0 | $100.00 | $0.00 | $150.00 | $0.00 | $0.00 |
| 38 | Ground Continuity Conductors, per ft | 4700 | $12.53 | $58,891.00 | $0.00 | $0.00 | $58,891.00 |
| 39 | Cable Pulling, lot | 1 | $0.00 | $0.00 | $130,000.00 | $130,000.00 | $130,000.00 |
| 40 | Testing & Commisionning, lot | 0 | $0.00 | $0.00 | $480,000.00 | $0.00 | $0.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $350,000.00 | $0.00 | $0.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 3000 | $1.50 | $4,500.00 | $0.00 | $0.00 | $4,500.00 |
| 43 | Hand Vaults for Fiber, each | 2 | $700.00 | $1,400.00 | $2,500.00 | $5,000.00 | $6,400.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 128 | $1.00 | $128.00 | $3.00 | $384.00 | $512.00 |
| 45 | Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| 46 | Sidewalk/Curb Replacement, ft | 20 | $100.00 | $2,000.00 | $40.00 | $800.00 | $2,800.00 |
| 47 | Fiber Optic Cable splices, each | 4 | $1,000.00 | $4,000.00 | $4,000.00 | $16,000.00 | $20,000.00 |
| 48 | Temp. Sensing Fiber, ft | 3000 | $0.75 | $2,250.00 | $0.00 | $0.00 | $2,250.00 |
| 49 | Temp. Sensing Fiber System, lot | 0 | $30,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 0 | $90,000.00 | $0.00 | $50,000.00 | $0.00 | $0.00 |
| 51 | Foundation, each | 0 | $35,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 0 | $0.00 | $0.00 | $1,200,000.00 | $0.00 | $0.00 |
| 53 | Geotechnical Including Thermal, per bore | 2 | $0.00 | $0.00 | $4,600.00 | $9,200.00 | $9,200.00 |
| 54 | Underground Utility Survey, lot | 0 | $0.00 | $0.00 | $700,000.00 | $0.00 | $0.00 |
| 55 | Construction Management, lot | 0 | $0.00 | $0.00 | $1,100,000.00 | $0.00 | $0.00 |
| 56 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $450,000.00 | $0.00 | $0.00 |
| 57 | Permitting | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $406,716.09 | | | |
| | Summary of Cost | | | $5,081,613.69 | | $1,395,180.20 | $6,476,793.89 |
| | Summary of Cost with Contingancy (20%) | | | $6,097,936.43 | | $1,674,216.24 | $7,772,152.67 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

| Section 5 - 6th to Speedway | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 30000 | $23.49 | $704,700.00 | $0.00 | $0.00 | $704,700.00 |
| 2 | 2 inch PVC Counduit, Per ft | 21000 | $2.95 | $61,950.00 | $0.00 | $0.00 | $61,950.00 |
| 3 | Conduit Duct Spacers, Each | 600 | $58.00 | $34,800.00 | $15.00 | $9,000.00 | $43,800.00 |
| 4 | Man Vault, Each | 4 | $45,000.00 | $180,000.00 | $25,000.00 | $100,000.00 | $280,000.00 |
| 5 | Duct Installation, Per ft | 3000 | $100.00 | $300,000.00 | $175.00 | $525,000.00 | $825,000.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 52800 | $2.00 | $105,600.00 | $2.00 | $105,600.00 | $211,200.00 |
| 7 | Thermal Backfill, cubic foot | 86900 | $3.50 | $304,150.00 | $2.00 | $173,800.00 | $477,950.00 |
| 8 | Haul Away, cubic ft | 165600 | $1.00 | $165,600.00 | $2.00 | $331,200.00 | $496,800.00 |
| 9 | Ashpalt Replacement, sq ft | 16100 | $5.50 | $88,550.00 | $5.00 | $80,500.00 | $169,050.00 |
| 10 | Sidewalk/Curb Replacement, ft | 2387 | $100.00 | $238,700.00 | $40.00 | $95,480.00 | $334,180.00 |
| 11 | Landscape Restoration, sq ft | 9600 | $2.00 | $19,200.00 | $3.00 | $28,800.00 | $48,000.00 |
| 12 | Utility Relocation, ft | 150 | $100.00 | $15,000.00 | $100.00 | $15,000.00 | $30,000.00 |
| 13 | Steel plating, days | 50 | $480.00 | $24,000.00 | $0.00 | $0.00 | $24,000.00 |
| 14 | Traffic Control, days | 58 | $3,000.00 | $174,000.00 | $0.00 | $0.00 | $174,000.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 0 | $580.00 | $0.00 | $750.00 | $0.00 | $0.00 |
| 16 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $250,000.00 | $0.00 | $0.00 |
| 17 | Bore Spacer, each | 0 | $600.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 18 | Bore Grout, cubic ft | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 19 | Haul Away jack and bore, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 21 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 22 | Shoring, per sq ft | 0 | $15.00 | $0.00 | $50.00 | $0.00 | $0.00 |
| 23 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 24 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 18000 | $195.00 | $3,510,000.00 | $0.00 | $0.00 | $3,510,000.00 |
| 26 | Spare XLPE Cable on reel, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 27 | Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $28,578.70 | $0.00 | $0.00 |
| 28 | Spare Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $0.00 | $0.00 | $0.00 |
| 29 | Arresters, each | 0 | $4,500.00 | $0.00 | $7,850.00 | $0.00 | $0.00 |
| 30 | Spare Arrester, each | 0 | $4,500.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 31 | Splices, each | 12 | $11,162.90 | $133,954.80 | $21,963.70 | $263,564.40 | $397,519.20 |
| 32 | Racking for Vaults, each | 4 | $16,300.00 | $65,200.00 | $13,167.00 | $52,668.00 | $117,868.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 4 | $4,523.60 | $18,094.40 | $3,750.00 | $15,000.00 | $33,094.40 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 0 | $2,954.50 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 36 | Bonding Cable, per ft | 440 | $13.85 | $6,094.00 | $0.00 | $0.00 | $6,094.00 |
| 37 | Cable Clamps, each | 0 | $100.00 | $0.00 | $150.00 | $0.00 | $0.00 |
| 38 | Ground Continuity Conductors, per ft | 6000 | $12.53 | $75,180.00 | $0.00 | $0.00 | $75,180.00 |
| 39 | Cable Pulling, lot | 1 | $0.00 | $0.00 | $240,000.00 | $240,000.00 | $240,000.00 |
| 40 | Testing & Commisionning, lot | 0 | $0.00 | $0.00 | $480,000.00 | $0.00 | $0.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $350,000.00 | $0.00 | $0.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 4000 | $1.50 | $6,000.00 | $0.00 | $0.00 | $6,000.00 |
| 43 | Hand Vaults for Fiber, each | 2 | $700.00 | $1,400.00 | $2,500.00 | $5,000.00 | $6,400.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 128 | $1.00 | $128.00 | $3.00 | $384.00 | $512.00 |
| 45 | Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| 46 | Sidewalk/Curb Replacement, ft | 20 | $100.00 | $2,000.00 | $40.00 | $800.00 | $2,800.00 |
| 47 | Fiber Optic Cable splices, each | 4 | $1,000.00 | $4,000.00 | $4,000.00 | $16,000.00 | $20,000.00 |
| 48 | Temp. Sensing Fiber, ft | 4000 | $0.75 | $3,000.00 | $0.00 | $0.00 | $3,000.00 |
| 49 | Temp. Sensing Fiber System, lot | 0 | $30,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 0 | $90,000.00 | $0.00 | $50,000.00 | $0.00 | $0.00 |
| 51 | Foundation, each | 0 | $35,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 0 | $0.00 | $0.00 | $1,200,000.00 | $0.00 | $0.00 |
| 53 | Geotechnical Including Thermal, per bore | 2 | $0.00 | $0.00 | $4,600.00 | $9,200.00 | $9,200.00 |
| 54 | Underground Utility Survey, lot | 0 | $0.00 | $0.00 | $700,000.00 | $0.00 | $0.00 |
| 55 | Construction Management, lot | 0 | $0.00 | $0.00 | $1,100,000.00 | $0.00 | $0.00 |
| 56 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $450,000.00 | $0.00 | $0.00 |
| 57 | Permitting | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $542,993.20 | | | |
| | Summary of Cost | | | $6,784,294.40 | | $2,066,996.40 | $8,851,290.80 |
| | Summary of Cost with Contingancy (20%) | | | $8,141,153.29 | | $2,480,395.68 | $10,621,548.97 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

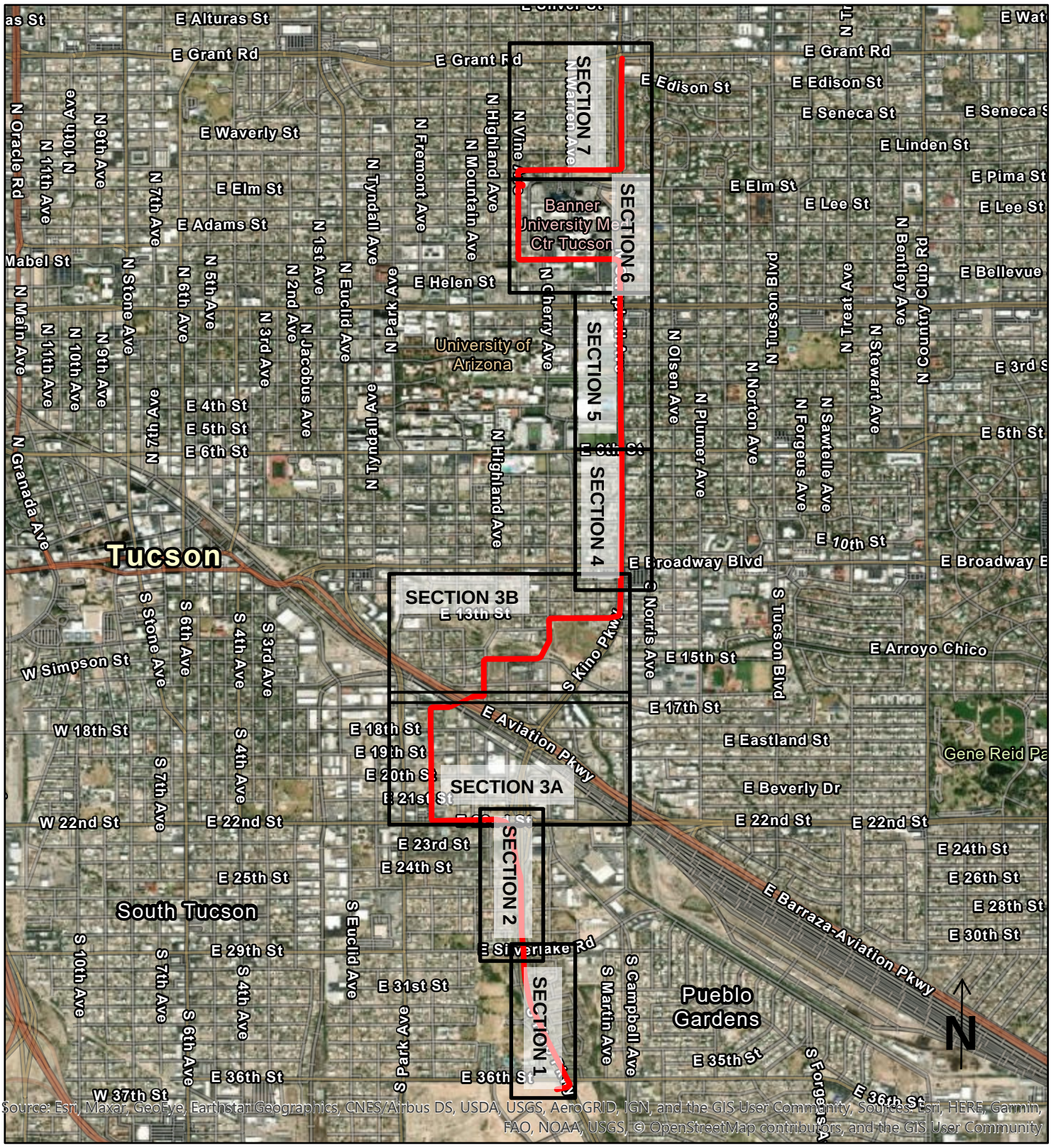
| Section 6 - Speedway to UA North Sub | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 42500 | $23.49 | $998,325.00 | $0.00 | $0.00 | $998,325.00 |
| 2 | 2 inch PVC Counduit, Per ft | 29800 | $2.95 | $87,910.00 | $0.00 | $0.00 | $87,910.00 |
| 3 | Conduit Duct Spacers, Each | 850 | $58.00 | $49,300.00 | $15.00 | $12,750.00 | $62,050.00 |
| 4 | Man Vault, Each | 4 | $45,000.00 | $180,000.00 | $25,000.00 | $100,000.00 | $280,000.00 |
| 5 | Duct Installation, Per ft | 4300 | $100.00 | $430,000.00 | $175.00 | $752,500.00 | $1,182,500.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 52800 | $2.00 | $105,600.00 | $2.00 | $105,600.00 | $211,200.00 |
| 7 | Thermal Backfill, cubic foot | 107700 | $3.50 | $376,950.00 | $2.00 | $215,400.00 | $592,350.00 |
| 8 | Haul Away, cubic ft | 219200 | $1.00 | $219,200.00 | $2.00 | $438,400.00 | $657,600.00 |
| 9 | Ashpalt Replacement, sq ft | 30700 | $5.50 | $168,850.00 | $5.00 | $153,500.00 | $322,350.00 |
| 10 | Sidewalk/Curb Replacement, ft | 1980 | $100.00 | $198,000.00 | $40.00 | $79,200.00 | $277,200.00 |
| 11 | Landscape Restoration, sq ft | 2000 | $2.00 | $4,000.00 | $3.00 | $6,000.00 | $10,000.00 |
| 12 | Utility Relocation, ft | 215 | $100.00 | $21,500.00 | $100.00 | $21,500.00 | $43,000.00 |
| 13 | Steel plating, days | 63 | $480.00 | $30,240.00 | $0.00 | $0.00 | $30,240.00 |
| 14 | Traffic Control, days | 71 | $3,000.00 | $213,000.00 | $0.00 | $0.00 | $213,000.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 0 | $580.00 | $0.00 | $750.00 | $0.00 | $0.00 |
| 16 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $250,000.00 | $0.00 | $0.00 |
| 17 | Bore Spacer, each | 0 | $600.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 18 | Bore Grout, cubic ft | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 19 | Haul Away jack and bore, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 21 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 22 | Shoring, per sq ft | 0 | $15.00 | $0.00 | $50.00 | $0.00 | $0.00 |
| 23 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 24 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 25500 | $195.00 | $4,972,500.00 | $0.00 | $0.00 | $4,972,500.00 |
| 26 | Spare XLPE Cable on reel, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 27 | Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $28,578.70 | $0.00 | $0.00 |
| 28 | Spare Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $0.00 | $0.00 | $0.00 |
| 29 | Arresters, each | 0 | $4,500.00 | $0.00 | $7,850.00 | $0.00 | $0.00 |
| 30 | Spare Arrester, each | 0 | $4,500.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 31 | Splices, each | 12 | $11,162.90 | $133,954.80 | $21,963.70 | $263,564.40 | $397,519.20 |
| 32 | Racking for Vaults, each | 4 | $16,300.00 | $65,200.00 | $13,167.00 | $52,668.00 | $117,868.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 4 | $4,523.60 | $18,094.40 | $3,750.00 | $15,000.00 | $33,094.40 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 0 | $2,954.50 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 36 | Bonding Cable, per ft | 440 | $13.85 | $6,094.00 | $0.00 | $0.00 | $6,094.00 |
| 37 | Cable Clamps, each | 0 | $100.00 | $0.00 | $150.00 | $0.00 | $0.00 |
| 38 | Ground Continuity Conductors, per ft | 8500 | $12.53 | $106,505.00 | $0.00 | $0.00 | $106,505.00 |
| 39 | Cable Pulling, lot | 1 | $0.00 | $0.00 | $240,000.00 | $240,000.00 | $240,000.00 |
| 40 | Testing & Commisionning, lot | 0 | $0.00 | $0.00 | $480,000.00 | $0.00 | $0.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $350,000.00 | $0.00 | $0.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 5000 | $1.50 | $7,500.00 | $0.00 | $0.00 | $7,500.00 |
| 43 | Hand Vaults for Fiber, each | 2 | $700.00 | $1,400.00 | $2,500.00 | $5,000.00 | $6,400.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 128 | $1.00 | $128.00 | $3.00 | $384.00 | $512.00 |
| 45 | Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| 46 | Sidewalk/Curb Replacement, ft | 20 | $100.00 | $2,000.00 | $40.00 | $800.00 | $2,800.00 |
| 47 | Fiber Optic Cable splices, each | 4 | $1,000.00 | $4,000.00 | $4,000.00 | $16,000.00 | $20,000.00 |
| 48 | Temp. Sensing Fiber, ft | 5000 | $0.75 | $3,750.00 | $0.00 | $0.00 | $3,750.00 |
| 49 | Temp. Sensing Fiber System, lot | 0 | $30,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 0 | $90,000.00 | $0.00 | $50,000.00 | $0.00 | $0.00 |
| 51 | Foundation, each | 0 | $35,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 0 | $0.00 | $0.00 | $1,200,000.00 | $0.00 | $0.00 |
| 53 | Geotechnical Including Thermal, per bore | 3 | $0.00 | $0.00 | $4,600.00 | $13,800.00 | $13,800.00 |
| 54 | Underground Utility Survey, lot | 0 | $0.00 | $0.00 | $700,000.00 | $0.00 | $0.00 |
| 55 | Construction Management, lot | 0 | $0.00 | $0.00 | $1,100,000.00 | $0.00 | $0.00 |
| 56 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $450,000.00 | $0.00 | $0.00 |
| 57 | Permitting | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $731,148.10 | | | |
| | Summary of Cost | | | $9,135,149.30 | | $2,492,066.40 | $11,627,215.70 |
| | Summary of Cost with Contingancy (20%) | | | $10,962,179.17 | | $2,990,479.68 | $13,952,658.85 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

| Section 7 - UA North Sub to Grant | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 44100 | $23.49 | $1,035,909.00 | $0.00 | $0.00 | $1,035,909.00 |
| 2 | 2 inch PVC Counduit, Per ft | 30900 | $2.95 | $91,155.00 | $0.00 | $0.00 | $91,155.00 |
| 3 | Conduit Duct Spacers, Each | 890 | $58.00 | $51,620.00 | $15.00 | $13,350.00 | $64,970.00 |
| 4 | Man Vault, Each | 4 | $45,000.00 | $180,000.00 | $25,000.00 | $100,000.00 | $280,000.00 |
| 5 | Duct Installation, Per ft | 4500 | $100.00 | $450,000.00 | $175.00 | $787,500.00 | $1,237,500.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 52800 | $2.00 | $105,600.00 | $2.00 | $105,600.00 | $211,200.00 |
| 7 | Thermal Backfill, cubic foot | 110400 | $3.50 | $386,400.00 | $2.00 | $220,800.00 | $607,200.00 |
| 8 | Haul Away, cubic ft | 226100 | $1.00 | $226,100.00 | $2.00 | $452,200.00 | $678,300.00 |
| 9 | Ashpalt Replacement, sq ft | 32200 | $5.50 | $177,100.00 | $5.00 | $161,000.00 | $338,100.00 |
| 10 | Sidewalk/Curb Replacement, ft | 2260 | $100.00 | $226,000.00 | $40.00 | $90,400.00 | $316,400.00 |
| 11 | Landscape Restoration, sq ft | 500 | $2.00 | $1,000.00 | $3.00 | $1,500.00 | $2,500.00 |
| 12 | Utility Relocation, ft | 700 | $100.00 | $70,000.00 | $100.00 | $70,000.00 | $140,000.00 |
| 13 | Steel plating, days | 65 | $480.00 | $31,200.00 | $0.00 | $0.00 | $31,200.00 |
| 14 | Traffic Control, days | 73 | $3,000.00 | $219,000.00 | $0.00 | $0.00 | $219,000.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 0 | $580.00 | $0.00 | $750.00 | $0.00 | $0.00 |
| 16 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $250,000.00 | $0.00 | $0.00 |
| 17 | Bore Spacer, each | 0 | $600.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 18 | Bore Grout, cubic ft | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 19 | Haul Away jack and bore, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 21 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 22 | Shoring, per sq ft | 0 | $15.00 | $0.00 | $50.00 | $0.00 | $0.00 |
| 23 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 24 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 26500 | $195.00 | $5,167,500.00 | $0.00 | $0.00 | $5,167,500.00 |
| 26 | Spare XLPE Cable on reel, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 27 | Terminator w/ NEMA pad, each | 6 | $10,168.20 | $61,009.20 | $28,578.70 | $171,472.20 | $232,481.40 |
| 28 | Spare Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $0.00 | $0.00 | $0.00 |
| 29 | Arresters, each | 6 | $4,500.00 | $27,000.00 | $7,850.00 | $47,100.00 | $74,100.00 |
| 30 | Spare Arrester, each | 0 | $4,500.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 31 | Splices, each | 12 | $11,162.90 | $133,954.80 | $21,963.70 | $263,564.40 | $397,519.20 |
| 32 | Racking for Vaults, each | 4 | $16,300.00 | $65,200.00 | $13,167.00 | $52,668.00 | $117,868.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 4 | $4,523.60 | $18,094.40 | $3,750.00 | $15,000.00 | $33,094.40 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 2 | $2,954.50 | $5,909.00 | $3,750.00 | $7,500.00 | $13,409.00 |
| 36 | Bonding Cable, per ft | 660 | $13.85 | $9,141.00 | $0.00 | $0.00 | $9,141.00 |
| 37 | Cable Clamps, each | 96 | $100.00 | $9,600.00 | $150.00 | $14,400.00 | $24,000.00 |
| 38 | Ground Continuity Conductors, per ft | 8900 | $12.53 | $111,517.00 | $0.00 | $0.00 | $111,517.00 |
| 39 | Cable Pulling, lot | 1 | $0.00 | $0.00 | $350,000.00 | $350,000.00 | $350,000.00 |
| 40 | Testing & Commisionning, lot | 0 | $0.00 | $0.00 | $480,000.00 | $0.00 | $0.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $350,000.00 | $0.00 | $0.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 5000 | $1.50 | $7,500.00 | $0.00 | $0.00 | $7,500.00 |
| 43 | Hand Vaults for Fiber, each | 2 | $700.00 | $1,400.00 | $2,500.00 | $5,000.00 | $6,400.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 128 | $1.00 | $128.00 | $3.00 | $384.00 | $512.00 |
| 45 | Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| 46 | Sidewalk/Curb Replacement, ft | 20 | $100.00 | $2,000.00 | $40.00 | $800.00 | $2,800.00 |
| 47 | Fiber Optic Cable splices, each | 4 | $1,000.00 | $4,000.00 | $4,000.00 | $16,000.00 | $20,000.00 |
| 48 | Temp. Sensing Fiber, ft | 5000 | $0.75 | $3,750.00 | $0.00 | $0.00 | $3,750.00 |
| 49 | Temp. Sensing Fiber System, lot | 0 | $30,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 0 | $0.00 | $0.00 | $10,000.00 | $0.00 | $0.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 1 | $90,000.00 | $90,000.00 | $50,000.00 | $50,000.00 | $140,000.00 |
| 51 | Foundation, each | 1 | $35,000.00 | $35,000.00 | $0.00 | $0.00 | $35,000.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 0 | $0.00 | $0.00 | $1,200,000.00 | $0.00 | $0.00 |
| 53 | Geotechnical Including Thermal, per bore | 3 | $0.00 | $0.00 | $4,600.00 | $13,800.00 | $13,800.00 |
| 54 | Underground Utility Survey, lot | 0 | $0.00 | $0.00 | $700,000.00 | $0.00 | $0.00 |
| 55 | Construction Management, lot | 0 | $0.00 | $0.00 | $1,100,000.00 | $0.00 | $0.00 |
| 56 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $450,000.00 | $0.00 | $0.00 |
| 57 | Permitting | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 0 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $783,329.50 | | | |
| | Summary of Cost | | | $9,787,116.90 | | $3,010,038.60 | $12,797,155.50 |
| | Summary of Cost with Contingancy (20%) | | | $11,744,540.28 | | $3,612,046.32 | $15,356,586.60 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
|---|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | QUANTITY | MATERIAL UNIT PRICE ($/UNIT) | TOTAL MATERIAL COST ($) | LABOR UNIT PRICE ($ UNIT) | TOTAL LABOR COST ($) | TOTAL OVERALL COST ($) |
| EARTHWORK AND DUCT BANK INSTALLATION | | | | | | | |
| 1 | 8 inch PVC Counduit, Per ft | 0 | $23.49 | $0.00 | $0.00 | $0.00 | $0.00 |
| 2 | 2 inch PVC Counduit, Per ft | 0 | $2.95 | $0.00 | $0.00 | $0.00 | $0.00 |
| 3 | Conduit Duct Spacers, Each | 0 | $58.00 | $0.00 | $15.00 | $0.00 | $0.00 |
| 4 | Man Vault, Each | 0 | $45,000.00 | $0.00 | $25,000.00 | $0.00 | $0.00 |
| 5 | Duct Installation, Per ft | 0 | $100.00 | $0.00 | $175.00 | $0.00 | $0.00 |
| 6 | Additional Excavation due to UG Crossing, cubic foot | 0 | $2.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 7 | Thermal Backfill, cubic foot | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 8 | Haul Away, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 9 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 10 | Sidewalk/Curb Replacement, ft | 0 | $100.00 | $0.00 | $40.00 | $0.00 | $0.00 |
| 11 | Landscape Restoration, sq ft | 0 | $2.00 | $0.00 | $3.00 | $0.00 | $0.00 |
| 12 | Utility Relocation, ft | 0 | $100.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 13 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 14 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| TRENCHLESS INSTALLATION (JACK AND BORE) | | | | | | | |
| 15 | Jack and Bore, Per ft | 0 | $580.00 | $0.00 | $750.00 | $0.00 | $0.00 |
| 16 | Mobilization / Demobilization, lot | 0 | $0.00 | $0.00 | $250,000.00 | $0.00 | $0.00 |
| 17 | Bore Spacer, each | 0 | $600.00 | $0.00 | $100.00 | $0.00 | $0.00 |
| 18 | Bore Grout, cubic ft | 0 | $3.50 | $0.00 | $2.00 | $0.00 | $0.00 |
| 19 | Haul Away jack and bore, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 20 | Excavation Pit Soil Removal, Replacement and Compaction, cubic ft | 0 | $1.00 | $0.00 | $2.00 | $0.00 | $0.00 |
| 21 | Ashpalt Replacement, sq ft | 0 | $5.50 | $0.00 | $5.00 | $0.00 | $0.00 |
| 22 | Shoring, per sq ft | 0 | $15.00 | $0.00 | $50.00 | $0.00 | $0.00 |
| 23 | Traffic Control, days | 0 | $3,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 24 | Steel plating, days | 0 | $480.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| CABLE AND ACCESSORIES | | | | | | | |
| 25 | XLPE Cable, per ft | 0 | $195.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 26 | Spare XLPE Cable on reel, per ft | 4200 | $195.00 | $819,000.00 | $0.00 | $0.00 | $819,000.00 |
| 27 | Terminator w/ NEMA pad, each | 0 | $10,168.20 | $0.00 | $28,578.70 | $0.00 | $0.00 |
| 28 | Spare Terminator w/ NEMA pad, each | 2 | $10,168.20 | $20,336.40 | $0.00 | $0.00 | $20,336.40 |
| 29 | Arresters, each | 0 | $4,500.00 | $0.00 | $7,850.00 | $0.00 | $0.00 |
| 30 | Spare Arrester, each | 2 | $4,500.00 | $9,000.00 | $0.00 | $0.00 | $9,000.00 |
| 31 | Splices, each | 0 | $11,162.90 | $0.00 | $21,963.70 | $0.00 | $0.00 |
| 32 | Spare Splices, each | 8 | $16,300.00 | $130,400.00 | $13,167.00 | $105,336.00 | $235,736.00 |
| 33 | 3 Ph Link Box for Vault (w/ SVL), each | 0 | $4,523.60 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 34 | 3 Ph Link Box for Structure (earthing), each | 0 | $2,740.00 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 35 | 3 Ph Link Box for Structure (w/ SVL), each | 0 | $2,954.50 | $0.00 | $3,750.00 | $0.00 | $0.00 |
| 36 | Bonding Cable, per ft | 0 | $13.85 | $0.00 | $0.00 | $0.00 | $0.00 |
| 37 | Cable Clamps, each | 0 | $100.00 | $0.00 | $150.00 | $0.00 | $0.00 |
| 38 | Ground Continuity Conductors, per ft | 0 | $12.53 | $0.00 | $0.00 | $0.00 | $0.00 |
| 39 | Cable Pulling, lot | 0 | $0.00 | $0.00 | $240,000.00 | $0.00 | $0.00 |
| 40 | Testing & Commisionning, lot | 1 | $0.00 | $0.00 | $480,000.00 | $480,000.00 | $480,000.00 |
| 41 | Cable Installer Mobilization / Demobilization, lot | 1 | $0.00 | $0.00 | $350,000.00 | $350,000.00 | $350,000.00 |
| FIBER OPTIC | | | | | | | |
| 42 | Fiber Optic Cable, per ft | 0 | $1.50 | $0.00 | $0.00 | $0.00 | $0.00 |
| 43 | Hand Vaults for Fiber, each | 0 | $700.00 | $0.00 | $2,500.00 | $0.00 | $0.00 |
| 44 | Excavation for Hand Vaults & Haul away, cubic ft | 0 | $1.00 | $0.00 | $3.00 | $0.00 | $0.00 |
| 45 | Fiber System Commisioning | 1 | $0.00 | $0.00 | $10,000.00 | $10,000.00 | $10,000.00 |
| 46 | Sidewalk/Curb Replacement, ft | 0 | $100.00 | $0.00 | $40.00 | $0.00 | $0.00 |
| 47 | Fiber Optic Cable splices, each | 0 | $1,000.00 | $0.00 | $4,000.00 | $0.00 | $0.00 |
| 48 | Temp. Sensing Fiber, ft | 0 | $0.75 | $0.00 | $0.00 | $0.00 | $0.00 |
| 49 | Temp. Sensing Fiber System, lot | 1 | $30,000.00 | $30,000.00 | $0.00 | $0.00 | $30,000.00 |
| 50 | Temp. Sensing Fiber System Commisioning | 1 | $0.00 | $0.00 | $10,000.00 | $10,000.00 | $10,000.00 |
| TERMINATION (RISER STRUCTURES) | | | | | | | |
| 50 | Structure, each | 0 | $90,000.00 | $0.00 | $50,000.00 | $0.00 | $0.00 |
| 51 | Foundation, each | 0 | $35,000.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| ENGINEEERING/ MANAGEMENT/ MISC. | | | | | | | |
| 52 | Engineering, lot | 1 | $0.00 | $0.00 | $1,200,000.00 | $1,200,000.00 | $1,200,000.00 |
| 53 | Geotechnical Including Thermal, per bore | 0 | $0.00 | $0.00 | $4,600.00 | $0.00 | $0.00 |
| 54 | Underground Utility Survey, lot | 1 | $0.00 | $0.00 | $700,000.00 | $700,000.00 | $700,000.00 |
| 55 | Construction Management, lot | 1 | $0.00 | $0.00 | $1,100,000.00 | $1,100,000.00 | $1,100,000.00 |
| 56 | Mobilization / Demobilization, lot | 1 | $0.00 | $0.00 | $450,000.00 | $450,000.00 | $450,000.00 |
| 57 | Permitting | 1 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| 58 | Environmental Compliance & Monitoring | 1 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| SUMMARY | | | | | | | |
| | Sales Tax (8.7%) | | | $87,760.07 | | | |
| | Summary of Cost | | | $1,096,496.47 | | $4,405,336.00 | $5,501,832.47 |
| | Summary of Cost with Contingancy (20%) | | | $1,315,795.76 | | $5,286,403.20 | $6,602,198.96 |
| NOTES | | | | | | | |
| 1 | Section Length is assumed to be 0.60 miles (3,150 ft) | | | | | | |
| 2 | 4 water pipe crossing | | | | | | |
| 3 | 2 sewer pipe crossing | | | | | | |

# 8.APPENDIX B - ROUTE MAP

# ROUTE MAP - 138KV UNDERGROUND STUDY

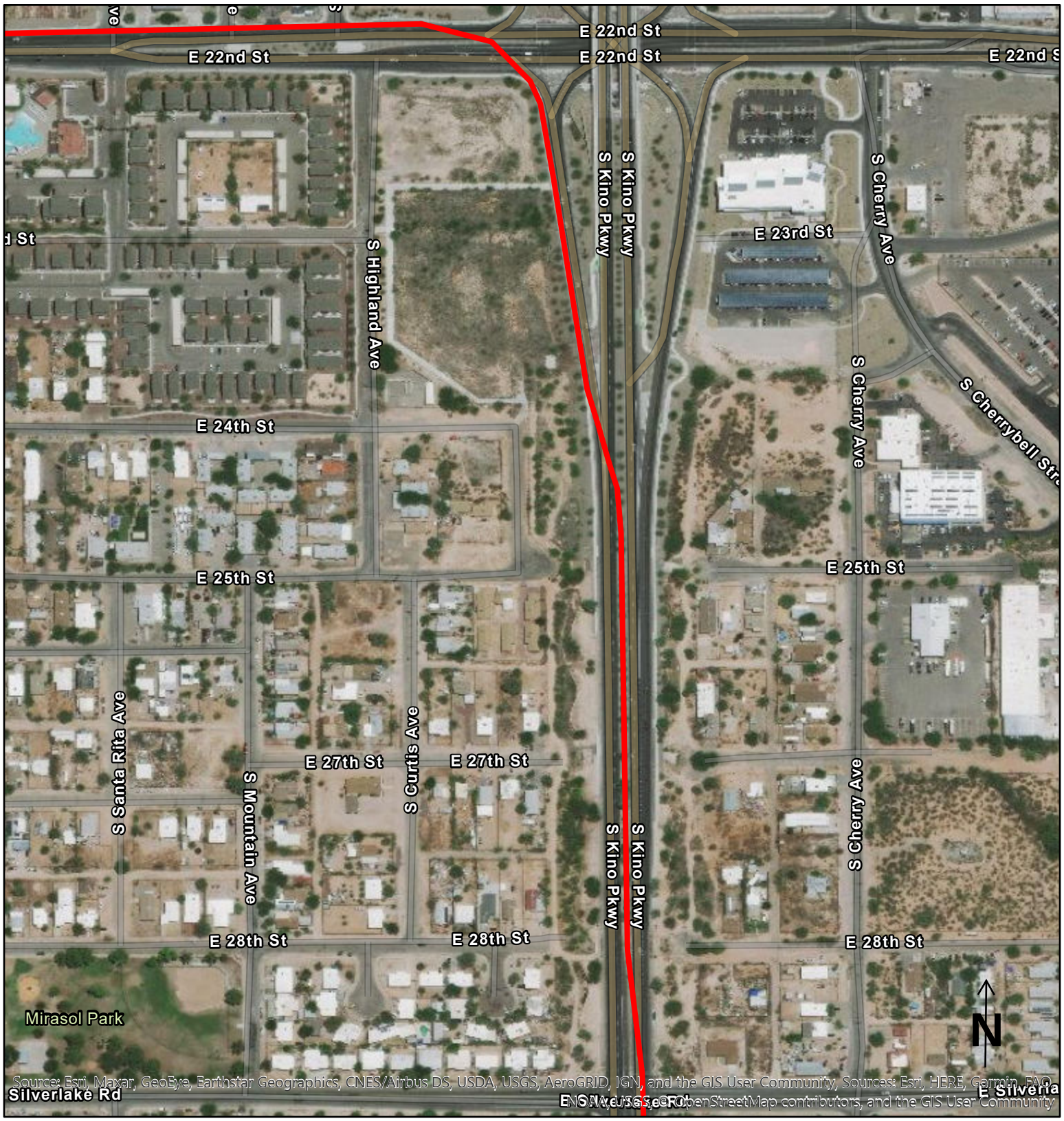



# MAP INDEX

# ROUTE MAP - 138KV UNDERGROUND STUDY


# SECTION 1 - 36TH TO SILVERLAKE

# ROUTE MAP - 138KV UNDERGROUND STUDY




# SECTION 2 - SILVERLAKE TO 22ND

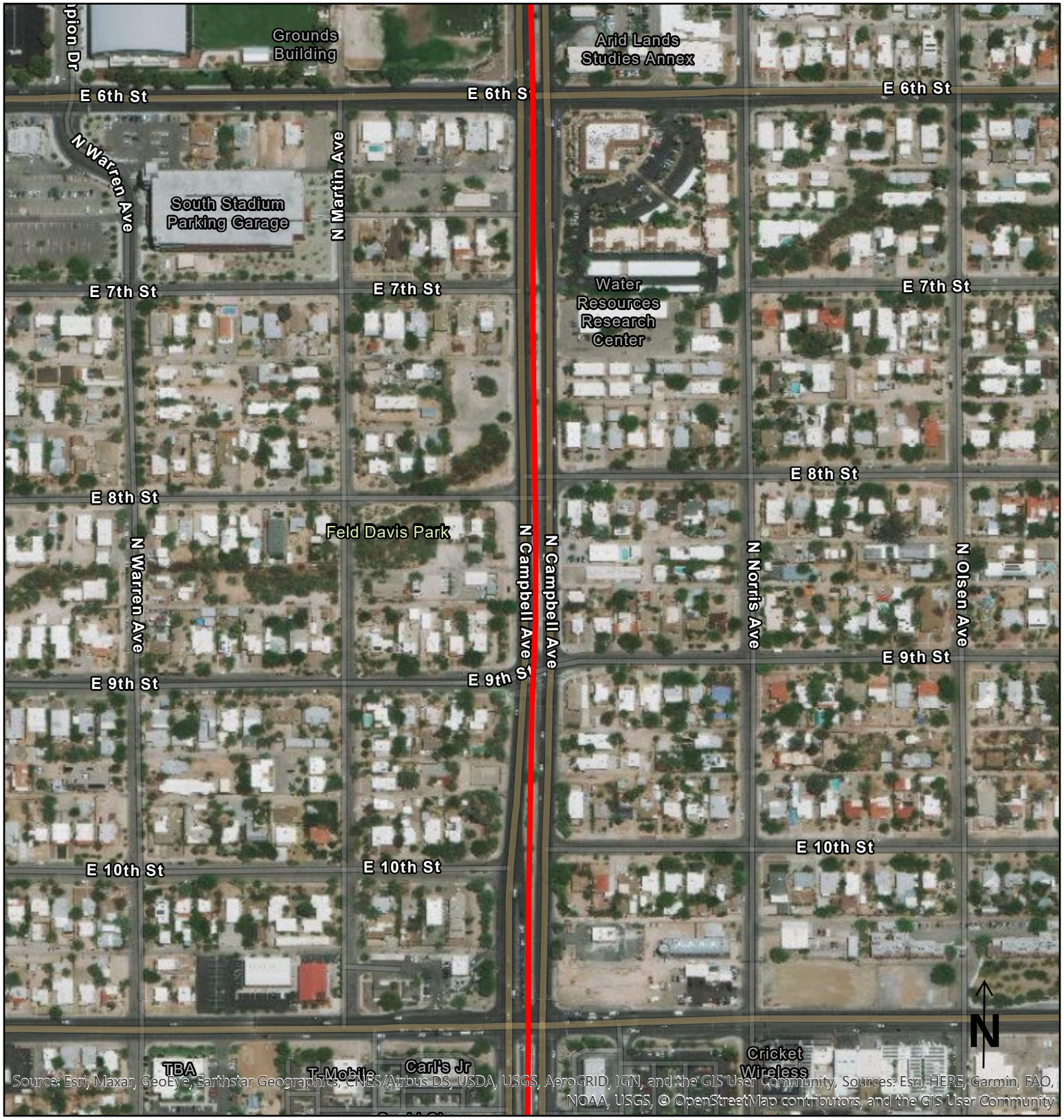
# ROUTE MAP - 138KV UNDERGROUND STUDY


# SECTION 3 - 22ND TO BROADWAY (1 OF 2)

# ROUTE MAP - 138KV UNDERGROUND STUDY

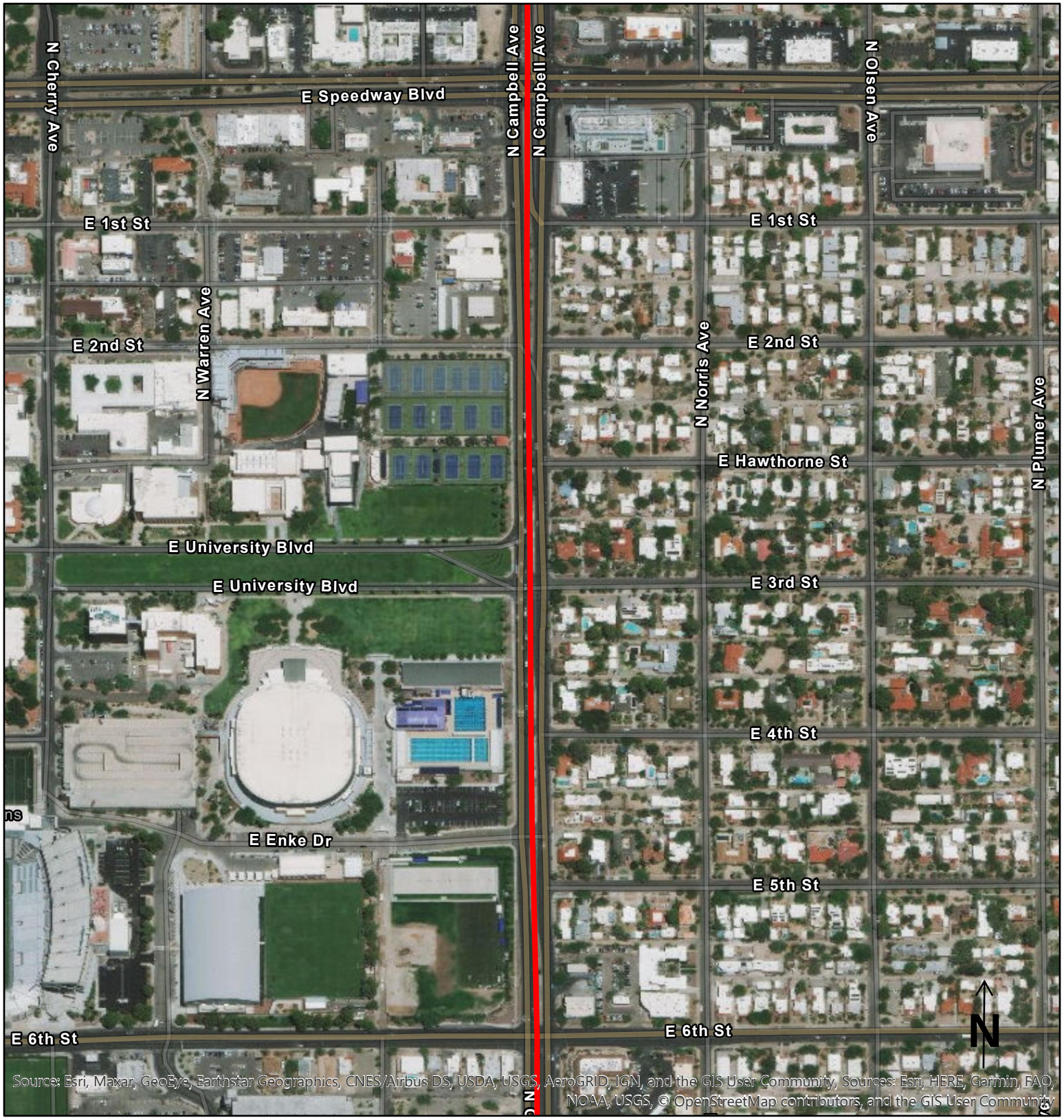

# SECTION 3 - 22ND TO BROADWAY (2 OF 2)

# ROUTE MAP - 138KV UNDERGROUND STUDY



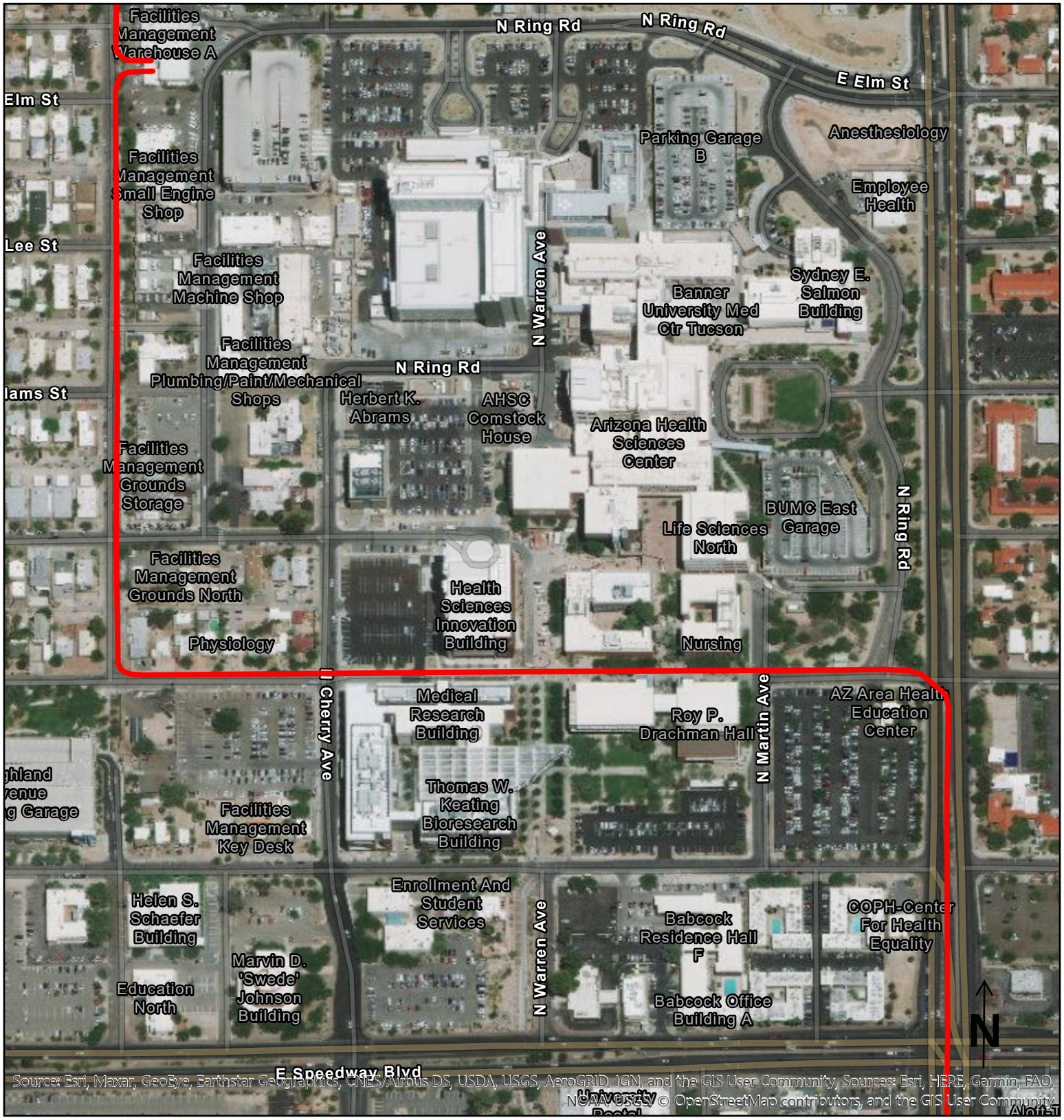

# SECTION 4 - BROADWAY TO 6TH

# ROUTE MAP - 138KV UNDERGROUND STUDY



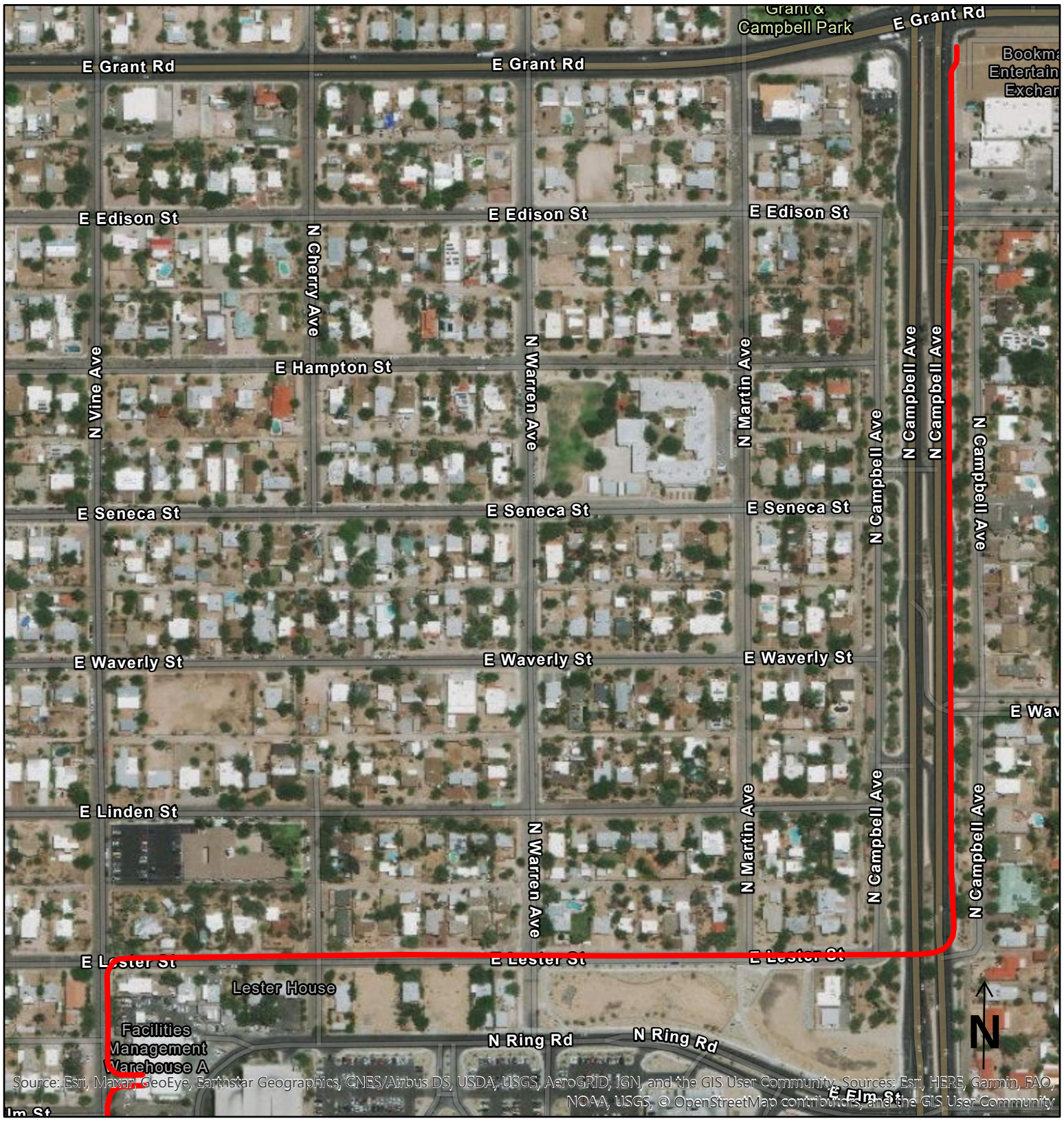

# SECTION 5 - 6TH TO SPEEDWAY

# ROUTE MAP - 138KV UNDERGROUND STUDY




# SECTION 6- SPEEDWAY TO NORTH UA SUBSTATION

# ROUTE MAP - 138KV UNDERGROUND STUDY




# SECTION 7 - NORTH UA SUBSTATION TO GRANT