Transportation Design Manual and Complete Streets Guide

Volume 1

Appendix C

Fiber Optic Design Requirements

May 21, 2021


CITY OF BELLEVUE
WASHINGTON

FIBER OPTIC COMMUNICATION SYSTEM

The City of Bellevue operates and maintains an expansive citywide fiber optic system that provides network connectivity for critical city functions. Critical functions include, but are not limited to, network connectivity for traffic signal operations, traffic cameras, emergency services, and operations at off-site city facilities. Bellevue requires available conduit and fiber optic infrastructure to establish network connections and provision for future system expansion. The City of Bellevue's approach to communication system design aims to separate fiber optic cables in a dedicated infrastructure system, which is important for overall network management and system maintenance. This Design Requirements Manual describes the requirements necessary to accomplish this approach and applies to projects where the fiber optic system is impacted or where new communication systems are required. These standards ensure that City of Bellevue's communication network is available, functional and reliable.

I. GENERAL

Plan, specifications and estimate (PS&E) submittals in the City of Bellevue shall convey the necessary detail to provide clear instructions on how to establish communications to new traffic signals and Intelligent Transportation Systems (ITS) via a fiber optic communication system. Additionally, projects that disrupt the existing fiber communication systems within city right-of-way shall include the necessary design detail to maintain connectivity during construction.

A good design results in a complete, fully-functional and maintainable communication network. Fiber optic communication design may be included in the illumination and traffic signal plans, except in cases where separate ITS communication plans are necessary to provide design clarity and intent. The fiber optic components shown shall include all the information necessary for a complete review of the work being performed. They must also include all the information required for construction or installation, and for documentation of the completed work for future reference.

II. SUBMITTAL REQUIREMENTS

Plans:

- Title block, north arrow and scale bar
- Legend of symbols
- Existing communication conduit, junction box and splice vault layout
- Temporary fiber optic communications design, if necessary
- Permanent fiber optic communications design
- Fiber optic splice details
- Patch panel layout details
- One-line fiber distribution diagram (if design complexity necessitates)
- Details for all non-standard installations and elements
- All other information needed or required elsewhere to properly document the work being done

III. COMMUNICATION SYSTEM INFRASTRUCTURE DESIGN PARAMETERS

The City of Bellevue's communication system infrastructure standard implements purpose-built infrastructure that separates fiber optic cabling from all other conductor types. This approach is applied to conduit systems, junction boxes and splice vaults and is intended to provide a highly available, functional and reliable system as described in the overview.

A. Communication Junction Boxes

1. Fiber optic cables shall be routed through City of Bellevue Type 2 modified junction boxes (Standard Plan SL-180-1) or a large communication junction box (Standard Plan SL-181-1). Junction boxes are permitted for fiber routing where fiber splices do not exist. Fiber optic splices shall be located in fiber optic splice vaults only (see Section 1.1.2), unless otherwise directed by the City of Bellevue ITS Engineer.

2. New communication junction boxes shall not be located on paved roadway surfaces. If an existing communication junction box is located on a paved roadway surface, within the project limits, the junction box shall be relocated or the lid shall be upgraded to traffic bearing, if relocation is not possible.

3. All communication system junction boxes shall be marked as "COB COMM" on the lid.

4. All Junction boxes shall include a non-skid lid.

5. All junction boxes shall be located outside of existing or proposed curb ramps.

6. The minimum spacing between communication junction boxes and/or vaults is 200 ft, except on road crossings, infrastructure associated with Small Wireless Facility (SWF) communications, and other instances directed by the City of Bellevue ITS Engineer.

7. The maximum spacing between communication junction boxes and/or vaults is 600 ft.

8. Communication junction boxes are required at both ends of roadway crossings, borings, or bridges.

9. Conduits shall only enter the sides of a communication junction box, and not the bottom.

B. Fiber Optic Splice Vaults

1. Fiber optic splice enclosures shall only be permitted in a Fiber Optic Splice Vault in accordance with Bellevue Standard Plan SL-190-1, unless otherwise directed by the City of Bellevue ITS Engineer.

2. Each signalized intersection shall include a minimum of two fiber optic splice vaults, which may be located on the same corner or on adjacent corners. The location of the splice vaults shall be reviewed and approved by the City of Bellevue ITS Engineer. The conduit

configuration shall be in accordance with the layout shown on Figure 2, located at the end of this document.

3. All fiber optic splice vaults shall be marked as "COB COMM" on the lid.

4. Splice vaults are not permitted on paved surfaces, except sidewalk, unless otherwise approved by the City of Bellevue ITS Engineer.

5. All splice vaults shall include a non-skid lid.

6. The maximum space between two fiber optic splice vaults is 1,500 ft.

7. Conduits shall only enter the manufacturer's designed entry points of a fiber optic splice vault.

C. Communication System Conduits

1. All new projects shall install a standard configuration of conduits for the purposes of communications, as shown on Figure 2. The standard configuration includes three 3" conduits and one 2" conduit along a project frontage, unless otherwise directed by the City of Bellevue ITS Engineer.

2. The standard configuration of communication system conduits shall be placed on both sides of the road for any roadway classified as a Major, Minor, and Collector Arterial.

3. Neighborhood streets shall include one 3" conduit on both sides of the road for communication purposes where the improvements exceed 200' along the roadway, unless otherwise directed by the City of Bellevue ITS Engineer.

4. Communication conduits shall connect with junction boxes and vaults in accordance with the layout shown on Figure 2.

5. Communication conduits shall only connect with communication junction boxes and fiber optic splice vaults, unless otherwise directed by the City of Bellevue ITS Engineer. The only exception to this requirement is the final fiber optic cable conduit entry into the signal cabinet foundation as shown on Figure 2. The City of Bellevue ITS Engineer may also specify other communication conduit tie-in points.

6. Existing conduits used for the installations of a new communication system shall conform to the conduit and junction box layouts as shown on Figure 2. Coordination with the City of Bellevue signal shop staff will be necessary to identify conduit and junction box upgrades needed for conformity.

7. Projects will be required to tie into existing communication system conduits across the road or driveway at its project limits where a continued communication conduit pathway exists.

8. Projects that do interface with a traffic signal shall terminate communication conduits at a Type 2 modified junction boxes (Standard Plan SL-180-1) at the project limits or alternative location determined by the City of Bellevue ITS Engineer. Separate junction boxes will be required for the SWF system infrastructure described in Section 1.2.

9. All communication system conduits shall include detectable mule tape. Detectable mule tape shall be replaced for any instance where it is used for pulling new communication cabling.

10. Parallel communication conduits shall be combined in the same trench or bore location to the maximum extents feasible. Conduits shall be installed in accordance with the trench detail shown on Bellevue Standard Plan SL-122-1.

11. Communication conduits, as specified in Section 1.1.3.2 and 1.1.3.3, shall be included in a shared roadway crossing trench or underground bore where other utility infrastructure is proposed. A communication junction box shall be installed on both sides of the road to receive the communication conduits.

12. Communication conduits, as specified in Section 1.1.3.2 and 1.1.3.3, shall be extended by means of a roadway conduit crossing to connect with an existing communication conduit system, where one exists. **This requirement may result in infrastructure improvements extending beyond the property limits of a project.**

IV. SMALL WIRELESS FACILITY (SWF) COMMUNICATION INFRASTRUCTURE DESIGN PARAMETERS

The City of Bellevue's communication system design standards is forward-compatible with Small Wireless Facility (SWF) deployments. SWF equipment will occupy city-owned streetlight poles and require a conduit system capable of providing SWF power and communications. Figure 2, located at the end of this document, identifies the City of Bellevue's standard for SWF deployments and is intended for application on new construction projects in the city. Adherence to this standard is required for the installation of any new street light pole owned by the City of Bellevue. In cases where the street lighting system is impacted, the project shall coordinate with the City of Bellevue Transportation Department to determine application of the standard depicted in Figure 2.

A. A: SWF Communication Junction Boxes

1. One large communication junction box is required for SWF at each corner of a signalized intersection in accordance with the layout shown on Figure 2, unless a fiber optic splice vault exists or is proposed for SWF. A large junction box shall be deployed in accordance with the Bellevue Standard Plan SL-181-1.

2. One Type 2 modified junction box as shown on Bellevue Standard Plan SL-180-1 shall be placed adjacent to each streetlight pole, in addition to the standard street lighting junction box.

3. All SWF junction boxes shall be marked as "SWF COMM" on the lid.

4. All SWF junction boxes shall include a non-skid lid.

5. All SWF junction boxes shall be separate from the City of Bellevue street lighting, communications and traffic signal conduit systems, unless otherwise specified by the City of Bellevue ITS Engineer.

V. FIBER OPTIC CABLING DESIGN PARAMETERS

The City of Bellevue deploys Single Mode Fiber Optic (SMFO) as an Outside Plant (OSP) standard in the city. Fiber optic cables are deployed as they support long distance network communications and high-speed data. This section outlines the deployment standards for Bellevue's trunk, distribution, and lateral fiber optic cables.

A. Installation

1. Fiber optic cables shall be only be placed in conduit systems separated from all other conductive cabling, except low-voltage Ethernet cables.

2. Fiber optic cables shall not use cabinets as a raceway or junction box. If a cable is not intended for use in a cabinet, it shall not be installed into or through that cabinet.

B. Slack Fiber Optic Cable

1. All fiber optic cables pulled continuously through a vault must contain a minimum of 100 feet of slack. Slack fiber optic cable shall be racked in a "Figure 8" configuration inside each vault.

2. 100 feet of slack cable shall be provided for each direction of every cable entering a splice enclosure, unless otherwise specified by the ITS Engineer.

C. Removal of Unused Cabling

Any fiber optic or copper interconnect cables that are not part of a permanent ITS network shall be removed on a given project, unless otherwise directed by the City of Bellevue ITS Engineer.

D. Fiber Optic Trunk Cables

Fiber optic trunk cables are purposed for backhaul communications between two major splice points or fiber termination points. Trunk cables may carry multiple owner/operators and are intended to have as few splices as possible to preserve data transmission quality.

1. The minimum strand count for new fiber optic trunk cables shall be 144 count single-mode fiber, unless specified otherwise by the City of Bellevue ITS Engineer.

2. Where an existing trunk fiber optic cable is impacted by a project, the cable shall be replaced between existing splices (i.e. no new splices shall be added, unless approved the City of Bellevue ITS Engineer). **Infrastructure improvements may extend beyond the project limits to re-install the replacement fiber optic trunk cable.**

3. New fiber optic trunk cables shall be required for all major and minor arterials where the project area exceeds ½ mile (2,640 ft) of continuous roadway improvements. Splices points for the new fiber optic trunk cable shall be determined by the City of Bellevue ITS Engineer.

E. Fiber Optic Distribution Cables

Fiber optic distribution cables are used for providing connections to field devices including, but not limited to, traffic signal systems, traffic cameras, data collection devices, and Wi-Fi antennas. Distribution fiber optic cables typically only carry City of Bellevue applications.

1. The minimum fiber optic distribution cable shall be 96 count single-mode fiber, unless specified otherwise by the City of Bellevue ITS Engineer.

2. Where an existing fiber optic distribution cable is impacted by a project, the project shall coordinate with the City of Bellevue ITS Engineer and signal shop staff to determine the appropriate design for the replacement cable. **Infrastructure improvements may extend beyond the project limits to re-install the replacement fiber optic distribution cable.**

3. A new fiber optic distribution cable shall be required for all major, minor and collector arterials, unless otherwise directed by the City of Bellevue ITS Engineer. A new fiber optic distribution cable is not required when an existing distribution cable that meets current design standards already exists.

F. Fiber Optic Lateral and Drop Cables

In the City of Bellevue. fiber optic lateral and drop cables are used to provide a network connection between the fiber distribution cable and an end-device. These single end-point connections are also referred to as drop cables as they provide a network drop to the end-device. Lateral cables typically connect to the distribution fiber optic cable but may also connect to trunk cables in limited scenarios.

1. The minimum strand count for a fiber optic lateral cable is 24ct when the end-device is a traffic signal cabinet. All other applications shall be reviewed by the City of Bellevue ITS Engineer.

2. The length of lateral fiber optic cables shall not exceed the distance between two fiber optic splice enclosures that are along the conduit pathway to the end-device.

3. Lateral fiber optic cables are permitted in traffic signal and illumination junction boxes when the end-device is owned and operated by the City of Bellevue. All other applications will require a dedicated communication system for the lateral fiber optic cable as described in the overview.

G. Fiber Optic Splices

Fiber optic splices vary in configuration due to many factors, including but not limited to, the availability of dark strands on existing fiber optic cables, necessary connections to end-devices, number of cables meeting at a splice point, etc. As a result of this variability, a standardized splice in the City of Bellevue does not exist. This section provides general design guidance for a typical splice at a traffic signal cabinet location.

1. A typical fiber optic splice in the City of Bellevue includes a single 24ct SMFO drop cable from a distribution fiber optic cable to a traffic signal cabinet. The typical layout is shown in Figure 1 below:

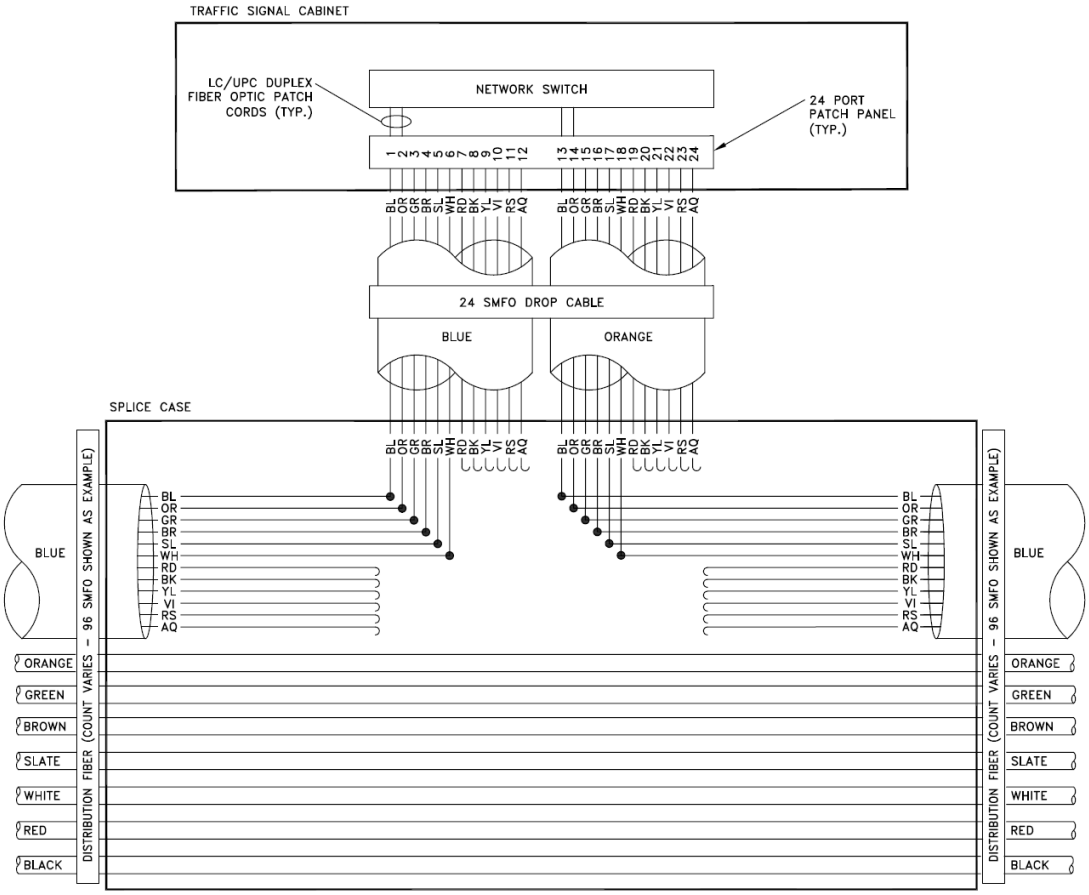

Figure 1: Typical Splice Detail at Traffic Signal Cabinet Location

2. All fiber optic splice designs shall be coordinated with and approved by the City of Bellevue ITS Engineer.

V. TEMPORARY FIBER OPTIC COMMUNICATION SYSTEMS

During construction, it is necessary to maintain operations of the communication system at the project owner's expense. Impacts to the communication system are typically encountered when a communication conduit system is disturbed. In many cases, it will be necessary to temporarily relocate or modify the City of Bellevue's fiber optic system to maintain operations. For all instances where the communication system is impacted, the project shall coordinate with the City of Bellevue Transportation Department on available options to maintain network connectivity. Temporary network connections may include, but are not limited to, the installation of temporary fiber optic cables, fiber optic splices, conduit, and other network equipment.

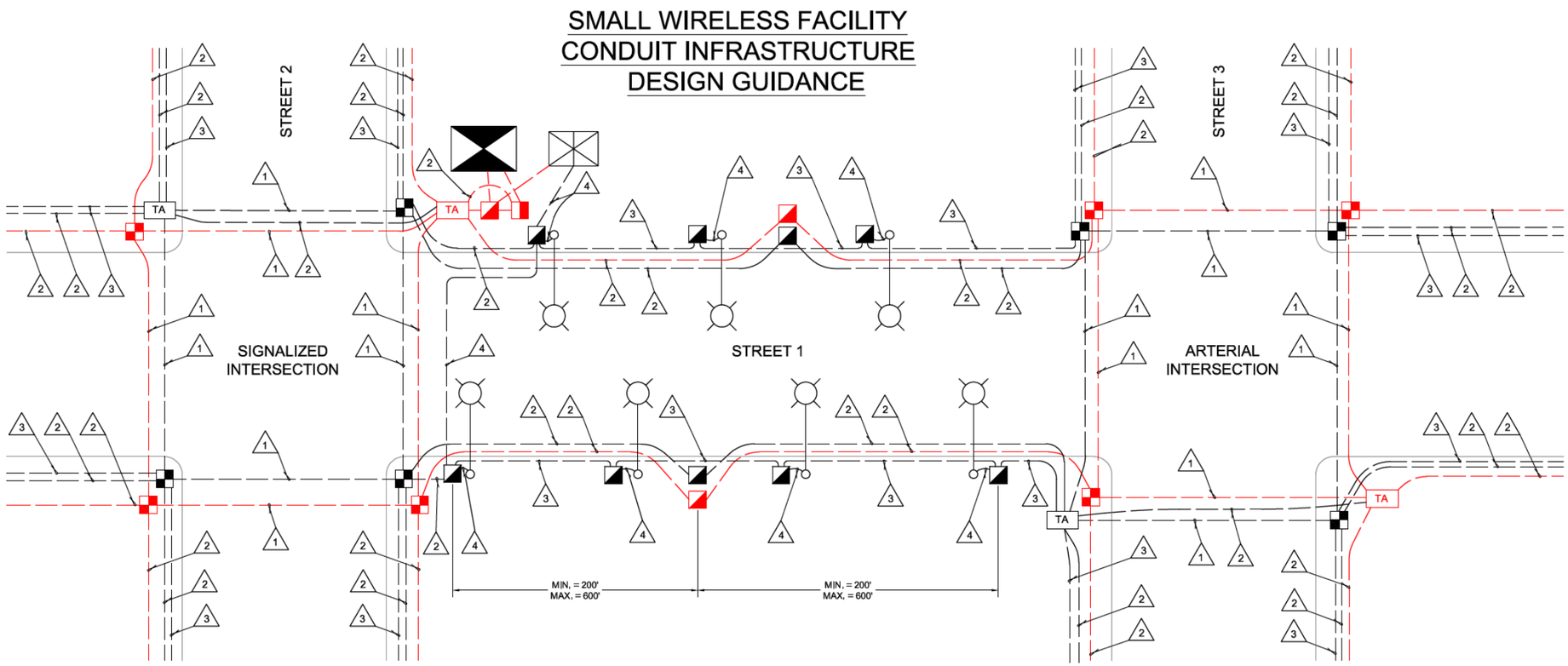

Figure 2: Small Wireless Facility Conduit Infrastructure Design Guidance