

## SECTION 33 81 26 – OUTSIDE PLANT PATHWAYS FOR UNDERGROUND COMMUNICATIONS

### 1.01 SUMMARY:

- A. **Scope:** This Section covers the performance, design, supply, installation, and commissioning <sup>A17</sup>requirements of complete underground outside plant pathways, as required, for telecommunications as part of the Works. <sup>A17</sup> This Section of the Employer's Requirements shall be read in conjunction with the Sections listed in Table 33 81 26-1.
- B. **Related Sections:**

Table 33 81 26-1: Related Sections	
1.	Section 01 14 00 - Work Restrictions (refer to protection of sub-aquatic fiber optic cables)
2.	Section 01 81 26 - Communications, Control, Safety, and Security Systems.
3.	Section 26 05 43 - Underground Ducts and Raceways for Electrical Systems.
4.	Section 31 23 00 - Excavation and Fill.
5.	Section 33 82 00 - Cabling for Underground Communications Outside Plant.

### 1.02 REFERENCE:

- A. **Applicable Publications:** Refer to Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.02.
- B. **Employer Background Information:**
- Existing underground trans-isthmian duct line near Atlantic locks complex and Davis has twelve 38 mm (1.5 in) high density polyethylene (HDPE) ducts and a fiber optics (FO) cable with sixty single mode fibers. This shall require a bypass via a Crossunder in the Atlantic locks complex.
  - Existing FO cable between Agua Clara and Gatun is part aerial (crossing French Canal) and part underground. It has twenty eight single mode fibers and shall require a bypass via a Crossunder in the Atlantic locks complex.
  - Existing underground FO cable in Davis area to be excavated goes underground near the road crossing the 1939 excavation. It has eight non-zero dispersion <sup>A17</sup>single mode <sup>A17</sup>(NZDS) fibers optimized for 1,550 nm for compatibility with submarine cables, and is rented to Global Crossing.
  - Existing aerial FO cable between Miraflores and Howard has eighteen single mode fibers. This shall require a bypass via a Crossunder in the Pacific locks complex.

C. <sup>A17</sup>**Reference Drawings:**

1. For existing telecommunications infrastructure, see Volume VI, Part 1 (*Reference Drawings*), Drawings 5802-2 through 5802-15 for the Atlantic side and 5803-2 through 5803-39, for the Pacific side.
2. For existing telecommunications infrastructure in the Miraflores-Cocoli-Rodman area, see Volume VI, Part 1 (*Reference Drawings*), Drawings VF-1710-69-001 and VF-1710-69-002.<sup>A17</sup>

**1.03 REQUIREMENTS:**

A. **General Requirements:**

1. **General:**

- a. The Contractor shall meet all applicable requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.03.
- b. Conduits and ducts shall be dimensioned so that initial cable fill does not exceed 40% in every individual conduit or duct.
- c. Spare ducts shall be available for future use as deemed necessary.
- d. <sup>A3</sup>Cable material, installation, quality assurance, and testing shall be in accordance with Section 33 82 00 (*Cabling for Underground Communications Outside Plant*).<sup>A3</sup>

2. **Coordination:**

- a. Construction work for the Atlantic locks complex shall be done in a way that prevents isolating the existing Gatun Locks for telecommunications purposes. This shall include a temporary aerial fiber optics cable between Gatun Locks and Atlantic locks complexes on the north side, and the permanent underground trans-isthmian duct line with fiber optics cables along the old railroad pathway on the south side. One cable shall be rerouted and operational before the other is affected.
- b. <sup>A3</sup>The Contractor shall coordinate with Cable & Wireless Panamá (CWP), Global Crossing, and others as necessary.<sup>A3</sup>
- c. <sup>A17</sup>The Contractor shall coordinate with the Employer with no less than 30 days advance time and as required by Panama’s “Autoridad Nacional de los Servicios Públicos” (ASEP) for notification of service interruptions, to allow the appropriate Employer response on time and without hurries.<sup>A17</sup>

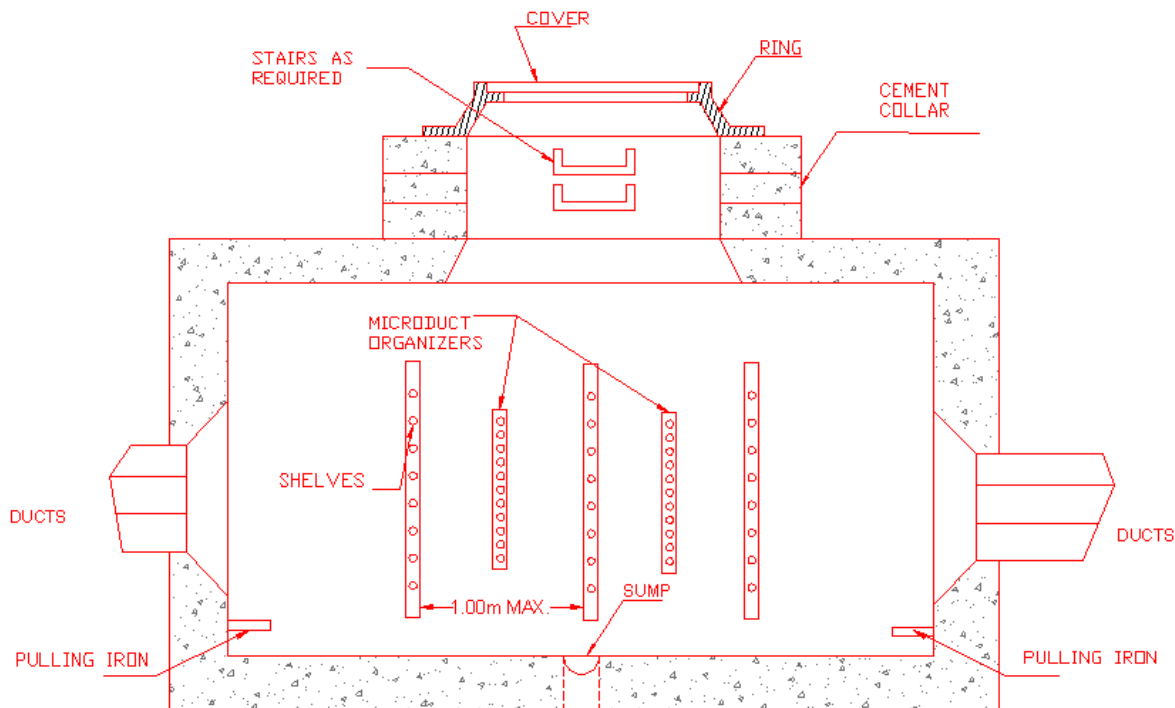
3. **Identifiers:** Shall be unique and easy to interpret,<sup>A17</sup> and shall include ducts, duct line markers, manholes, pullholes, and all other outside plant items.<sup>A17</sup>

- <sup>A5</sup>4. **Route Diversity:** Physical separation between any two alternate paths shall be as required to avoid single point of failures in accordance with Subparagraph 1.03 H. of Section 40 00 00 (*Process Integration*).<sup>A5</sup>

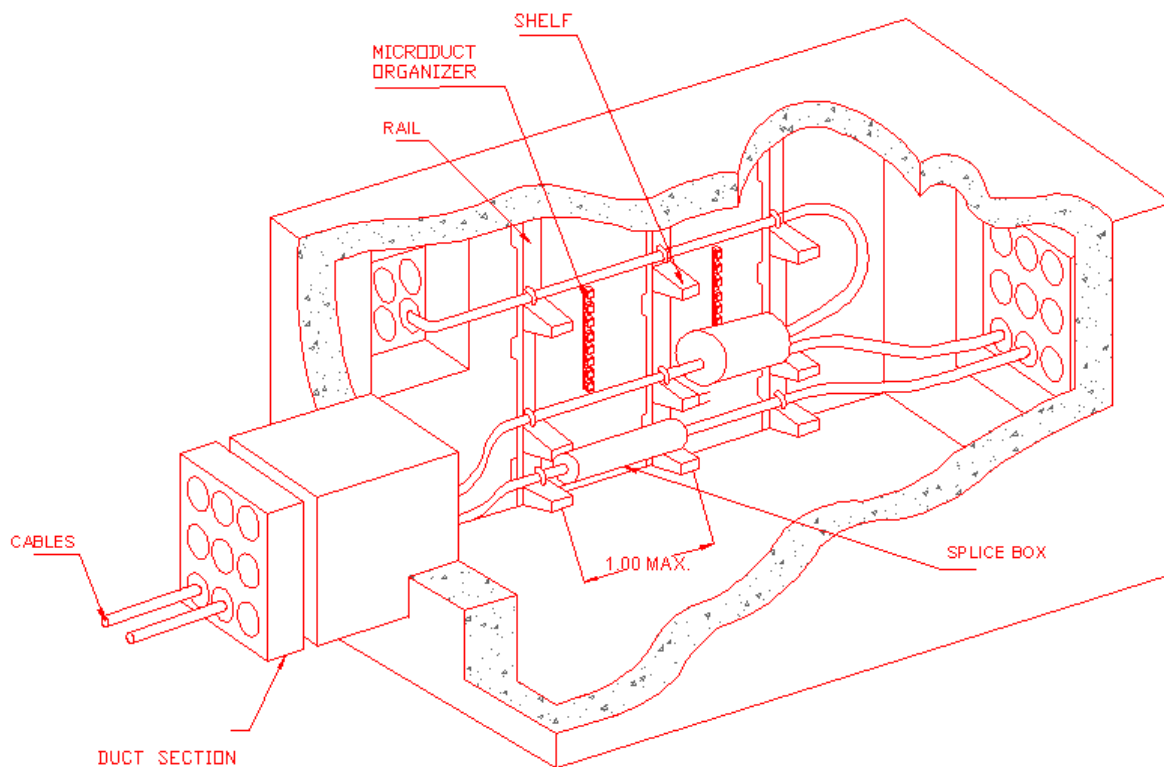
B. **Spaces:**

1. **Maintenance Holes or Manholes (MHs):**

- a. <sup>A20</sup>Manholes for telecommunications shall be in accordance with standard Drawing M1008-25 (type B) as a guideline, but modified and improved as specified herein and as illustrated in figures 33 81 26-1 and 2.<sup>A20</sup>



<sup>A20</sup>Figure 33 81 26-1: Conceptual manhole elevation<sup>A20</sup>



<sup>A20</sup>Figure 33 81 26-2: Conceptual manhole detail<sup>A20</sup>

- b. Manholes shall be <sup>A17</sup>completely rectangular and <sup>A17</sup>sized as follows, whichever is the largest:
  - 1) Shall be big enough to permit technical personnel entering and working properly inside.
  - 2) As required for installation of cables using the air blowing method.
  - 3) <sup>A20</sup>MH inside dimensions shall be 2.45 m long by 1.85 m wide by 2.15 m deep, or larger.<sup>A20</sup>
- c. The distance between each cable entry and the opposite wall shall be at least 36 times the external diameter of the largest possible cable. Also, the distance between each cable entry and the corresponding exit shall be at least 36 times the external diameter of the largest cable.
- d. The holes shall meet or exceed the requirements of NFPA 70 Article 370D, 7 CFR 1753F-151, and 7 CFR 1753F-401.
- e. <sup>A17</sup>Duct entry shall be splay type (off-centered or near a corner) for easy cable and duct positioning.<sup>A17</sup>

- f. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction.
  - g. Holes shall have bonding inserts, cable trays, covers, grounding rod, pulling hooks, reinforcing bars, stair, and sump hole (drainage) with a minimum diameter of 305 mm (1 ft), as required.
  - h. The concrete slab shall have a 25 mm (1 in) diameter PVC sleeve to pass a ground rod through the floor.
  - i. <sup>A3</sup>Manholes and top covers shall be suitable for roads with heavy traffic and heavy vehicles. <sup>A3</sup>
2. **Pull Holes:** Shall be long lasting <sup>A3</sup>, adequate for expected vehicular traffic above (if any), <sup>A3</sup> and sized as required.
- <sup>A13</sup>3. **Duct Bridges:**
- a. Duct bridges shall be structures made of galvanized steel or other reviewed metal, and shall furnish adequate mechanical protection and support to ducts in the applicable railroad and vehicular bridge crossings. Hardware shall also be galvanized.
  - b. Duct bridges shall be sized as required and include all necessary angles, brackets, dividers, guards, hangers, junction boxes, pads, and spacers. <sup>A13</sup>
  - c. <sup>A17</sup>Duct bridges shall have removable covers and shall normally cover ducts entirely so that sunlight never hits the ducts. <sup>A17</sup>

C. **Equipment and Materials:**

- 1. **Anchors, Bolts, and Washers for Fiberglass Cable Racks and Trays:** Shall be made of corrosion resistant steel conforming to AISI 316 in accordance with AISI Stainless Steel Uses in Architecture.
- 2. **Cable Racks and Trays in Manholes:**
  - a. Cable racks and trays shall be made of non-conducting, non-metallic, corrosion proof, rigid, break resistant and light-weight material.
  - b. <sup>A19</sup>Racks and trays shall be sized as required to cover no less than 60% of MH inner wall areas. Tray arms shall be provided for no less than three levels of trays and shall have a minimum width of 279 mm (11"). <sup>A19</sup> Rack vertical rail separation shall not exceed 1 m.
- 3. **Conduits and Ducts:**
  - a. **General:**
    - 1) <sup>A13</sup>Unless otherwise specified, conduit and ducts shall be of circular cross section. Where inner-ducts or micro-ducts are

used, ducts containing smaller ducts shall have circular or hexagonal cross-section. <sup>A13</sup>

- 2) Accessories, conduits, and ducts for direct burial shall be rodent and termite resistant, and shall meet the applicable requirements of TT GR2884.
- 3) Conduits and ducts that will be exposed to the sun after installation, e.g., in duct bridges, shall meet the requirements of ultra-violet resistance of ASTM D 1248.

4. **High Density Polyethylene (HDPE) Ducts:**

- a. HDPE ducts shall be made of virgin raw material with additive or additives for molecular memory and rodent proofing. Ducts using any percentage of recycled materials are unacceptable. Raw material shall be PE100 type as classified by ISO 9080, PE34 as defined by ASTM D 1248, or better.
- b. Ducts shall meet the requirements of ASTM D 256, ASTM D 638, ASTM D 746, ASTM D 790, ASTM D 1238, ASTM D 1505, ASTM D 1693, ASTM D 2122, ASTM D 2240, ASTM D 2837, ASTM D 3350, and ASTM D 4883; as well as ASTM D 2247 or ASTM D 3035, or both as indicated in the table below.
- c. Ducts shall be all dielectric and have high tensile strength and excellent crush resistance or pressure withstand capability. Ducts for use in duct bridges shall be ultraviolet (UV) resistant.
- d. Ducts shall also be flexible for manageability during installation and rigid enough to resist undulation in a trench.
- e. There shall be no need for special bends and <sup>A17</sup>sweeps. <sup>A17</sup>
- f. Ducts shall be suitable for direct burial and for the intended application as indicated below. Ducts shall be supplied in reels, and be resistant to chemicals that may be normally found in soil.
- g. Ducts shall have the following or better characteristics:

Table 33 81 26-2: Duct Characteristics			
Characteristic	Unit	Duct Nominal Size	
		32 mm (1.25 in)	100 mm (4 in)
<sup>A17</sup> (deleted row) <sup>A17</sup>			
Application	N/A	<sup>A13</sup> For micro-ducts or fiber optic cables <sup>A13</sup> to be installed by others by blowing method, at speeds up to 30 m/min (98 ft/min)	For inner ducts or <sup>A17</sup> telecommunications <sup>A17</sup> cables
Coefficient of Friction	-	0.12	0.30
Inner Diameter	mm (in)	32 (1.25)	100 (4)

<b>Table 33 81 26-2: Duct Characteristics</b>				
<b>Characteristic</b>		<b>Unit</b>	<b>Duct Nominal Size</b>	
			<b>32 mm (1.25 in)</b>	<b>100 mm (4 in)</b>
Lubrication		N/A	Pre-lubricated with silicon or better, <sup>A17</sup> unless equipped with microducts <sup>A17</sup>	Preferable
Pressure Withstand Capability		kPa (psi)	862 (125)	
<sup>A16</sup> Reel Length		m (ft)	610 (2,000)	122 (400) <sup>A16</sup>
Surfaces	Inside	N/A	<sup>A19</sup> Smooth wall <sup>A19</sup>	<sup>A19</sup> Smooth wall <sup>A19</sup>
	Outside	N/A	<sup>A16</sup> Each one with plain black or red background, stripe(s) with unique high contrast color, sequential markings in meters, and the following private label in white letters: <sup>A16</sup> “Telecomunicaciones – Autoridad del Canal de Panamá”	
Tensile Strength		kg (lb)	1,180 (2,600)	5,455 (12,000)
Useful Life	Exposed to Sunlight	year	15	
	Underground	year	40	
<sup>A16</sup> Walls	Thickness		SDR 13.5	SDR 13.5 <sup>A16</sup>

- h. <sup>A13</sup>Micro-ducts shall have outer diameter somewhere between 5 and 16 mm (sized as required), be plenum and riser rated, **low fire hazard, all dielectric**, <sup>A17</sup>have a useful life of 20 years or longer, <sup>A17</sup> and meet the applicable requirements of NFPA 262, UL 94, UL1666, and UL 2024. <sup>A13</sup>

5. **Polyvinyl Chloride (PVC) Conduits (for Manhole Drainages):**

- a. Unless otherwise specified, conduits shall have a diameter of 100 mm (4 in), and be schedule 40 meeting the applicable requirements of <sup>A10</sup>7 CFR 345-151, and UL 651. <sup>A10</sup>
- b. PVC conduits to be exposed to sunlight, such as vertical conduits tied to poles, shall be type D. All other PVC conduits shall be type B, C, or D.
- c. Conduits to be embedded in concrete shall meet the requirements of NEMA TC8, type EB-35; or NEMA TC9, type EB-40.
- d. Conduit shall be supplied in sections of no less than 6,096 mm (20 ft).
- e. Accessories shall meet the requirements of NEMA TC3 or TC9, or both.
- f. HDPE Schedule 40 or better is allowed instead of PVC.

6. **Cone Grates:** Shall be made of cast iron (or better material if reviewed by the Employer's Representative) and be sized as required for drainage purposes.

7. **Duct Bases (PVC Conduit):** Bases shall maintain suitable separation between bottom conduits and the bottom of the trench, as recommended by the conduit manufacturer and reviewed by the Employer's Representative.
8. **Duct Couplers for HDPE Ducts:**
  - a. **General:**
    - 1) Couplers shall withstand the air pressure to be applied during cable blowing, and shall be as recommended by the HDPE duct manufacturer.
    - 2) <sup>A19</sup>Unless otherwise specified, tensile pull-off capability shall be 160 kg (350 lbs) with 80 kg (175 lbs) tail load, and seal shall be adequate for pressures up to 862 kPa (125 psi).<sup>A19</sup>
  - b. <sup>A16</sup>**Electro-Fusion Couplers:** These couplers are an acceptable alternative to thermo-fusion couplers for 25 mm (1 in) and smaller ducts.<sup>A16</sup>
  - c. <sup>A16</sup>**Thermo-Fusion Couplers:** Shall be used for ducts larger than 25 mm (1 in).<sup>A16</sup>
  - d. <sup>A19</sup>**Micro-Duct Couplers:** Each coupler shall be a clear in-line tube unit with plastic push/pull quick release pneumatic cap capable of withstanding pressures up to 1,379 kPa (200 psi).<sup>A19</sup>
9. **Duct Line Markers:** Shall have long duration.
10. **Duct Spacers:** Shall be sized as required, and be made of polycarbonate resin or an approved material with better resistance. Metallic units are unacceptable.
11. **End Bells:** Bells for non-metallic conduit shall match the corresponding size, meet the applicable requirements of NEMA TC6, and be as recommended by the conduit manufacturer and reviewed by the Employer's Representative.
12. **Identifiers:** Outside plant (OSP) identifiers in drawings and data bases shall be in accordance with <sup>A10</sup>TIA 606.<sup>A10</sup>
13. **Inner-ducts:** <sup>A19</sup>Shall be three 32 mm (1.25 in) HDPE type, pre-lubricated inside 100 mm (4 in) ducts, unless otherwise specified. Inner-ducts shall meet the requirements for ducts of the same size.<sup>A19</sup>
14. **Lubricant:**
  - a. <sup>A17</sup>Lubricant shall have a coefficient of friction lower than 0.14, be suitable for cable pulling, recommended by the duct manufacturer, and reviewed by the Employer's Representative.
  - b. Lubricant shall be stable and permanent, shall maintain its physical properties during the entire duct service life, and shall be easy to



distribute evenly along the entire length of the duct. Lubricant shall not react to water, displace, nor become sticky like an adhesive.<sup>A17</sup>

15. **Manhole Hardware Materials:** Metallic hardware inside manholes shall be hot dip galvanized by the manufacturer, except where specified to be stainless steel.
16. **Manhole Covers and Frames:**
  - a. Covers shall be made of cast steel and be of the type that may never fall inside. The units shall be circular with overall diameter larger than the corresponding MH head clearance.
  - b. Covers shall have a lifting handle in the center, and sufficient ventilation holes to allow the escape of gas. The top surface shall have anti-sliding checker and be permanently marked with the following legend: *"Telecomunicaciones. ACP"*.
  - c. <sup>A11</sup>All manhole covers for use outside locks fenced areas shall be tamper-proof, security type with a single master key or means of access.<sup>A11</sup>  
<sup>A19</sup>Should screws be used to secure manhole covers, each cover shall have at least four security type screws.<sup>A19</sup>
17. **Manhole Heads:**
  - a. <sup>A17</sup>Heads shall be made of heavy-duty cast steel (preferably) or cast iron, and be coordinated with cover dimensions. The clear opening and the underside shall have a minimum diameter of 810 mm (32 in) and 1,620 mm (64 in), respectively.
  - b. Wherever security is required for manhole covers, screws shall not be smaller than 50 mm (2 in) long by 13 mm (0.5 in) in diameter. Security screws shall be made of stainless steel unless otherwise recommended by the Contractor and reviewed by the Employer Representative.<sup>A17</sup>
18. **Plugs:**
  - a. Plugs shall be suitable for closing spare ducts and inner-ducts to avoid dust and mud to contaminate them.
  - b. Plugs for conduit shall match the corresponding size, meet the applicable requirements of NEMA TC6, and shall be recommended by the conduit manufacturer.
  - c. Plugs shall be removable and reusable, and shall provide a water proof union.
  - d. Plugs for conduit shall be as recommended by the duct manufacturer.
19. **P Traps:** Shall be made of HDPE or PVC and shall be suitable for manhole drainages.

20. **Sealant:** Shall be suitable for sealing the walls penetrations in hand holes and manholes for duct passing through.
21. <sup>A17</sup>**Security Tool:** Shall be adequate to remove and relocate security hardware in the applicable manhole covers.
22. **Warning Tapes:**
  - a. Tapes shall be suitable for direct burial and be made of durable polyethylene or plastic material resistant to chemicals found in soil, including sulphates and alkalies.
  - b. Tape material shall have a minimum width of 114 mm (4.5 in), overall thickness of 5 mils, and sufficient metal particles for easy location after burial by using a standard metal detector.
  - c. Tape shall be American Public Works Association (APWA) UCC color coded. Thus, tapes shall have an approved private label in black letters on an orange background. Legend shall say: “*Telecomunicaciones de la ACP - Llamar al 272-1111 en caso de accidente*” in 63 mm (2.5 in) high or larger letters. The Contractor shall check for possible telephone number change before warning tape labels are printed.
  - d. Upon excavation, the tape shall stretch enough distance to be noticeable above ground before breaking. <sup>A17</sup>
23. <sup>A19</sup>**Micro-duct Organizers:** Shall have multiple tube clips suitable for the number and type of micro-ducts provided.
24. **Micro-duct Tube Splice Cases:** Shall be sealed, water tight, and adequate for installation in flooded manholes.
25. **Water Blocking Tape:** Shall be as recommended for tube splicing by the micro-duct manufacturer. <sup>A19</sup>
26. **End Caps:** Shall be as required to prevent contamination and water ingress in micro-duct tubes.

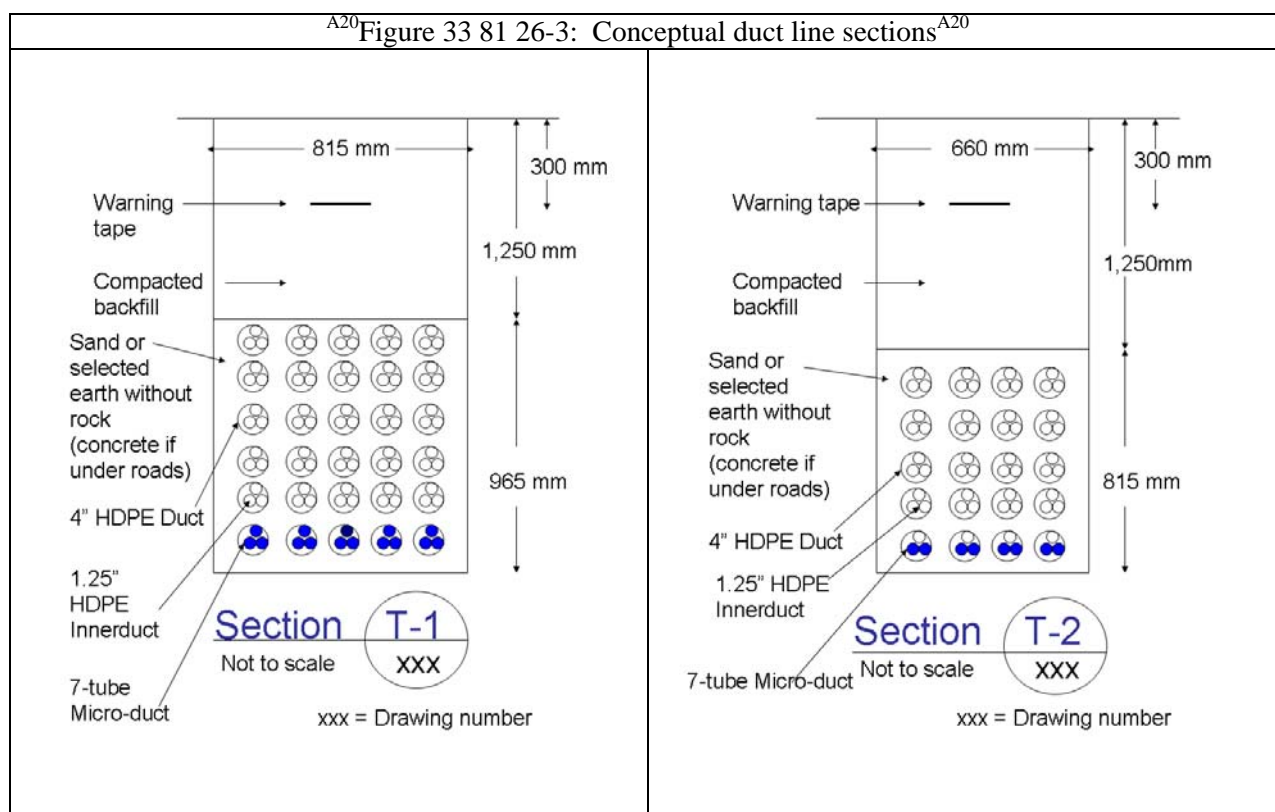
D. **Installation:**

1. **General:**

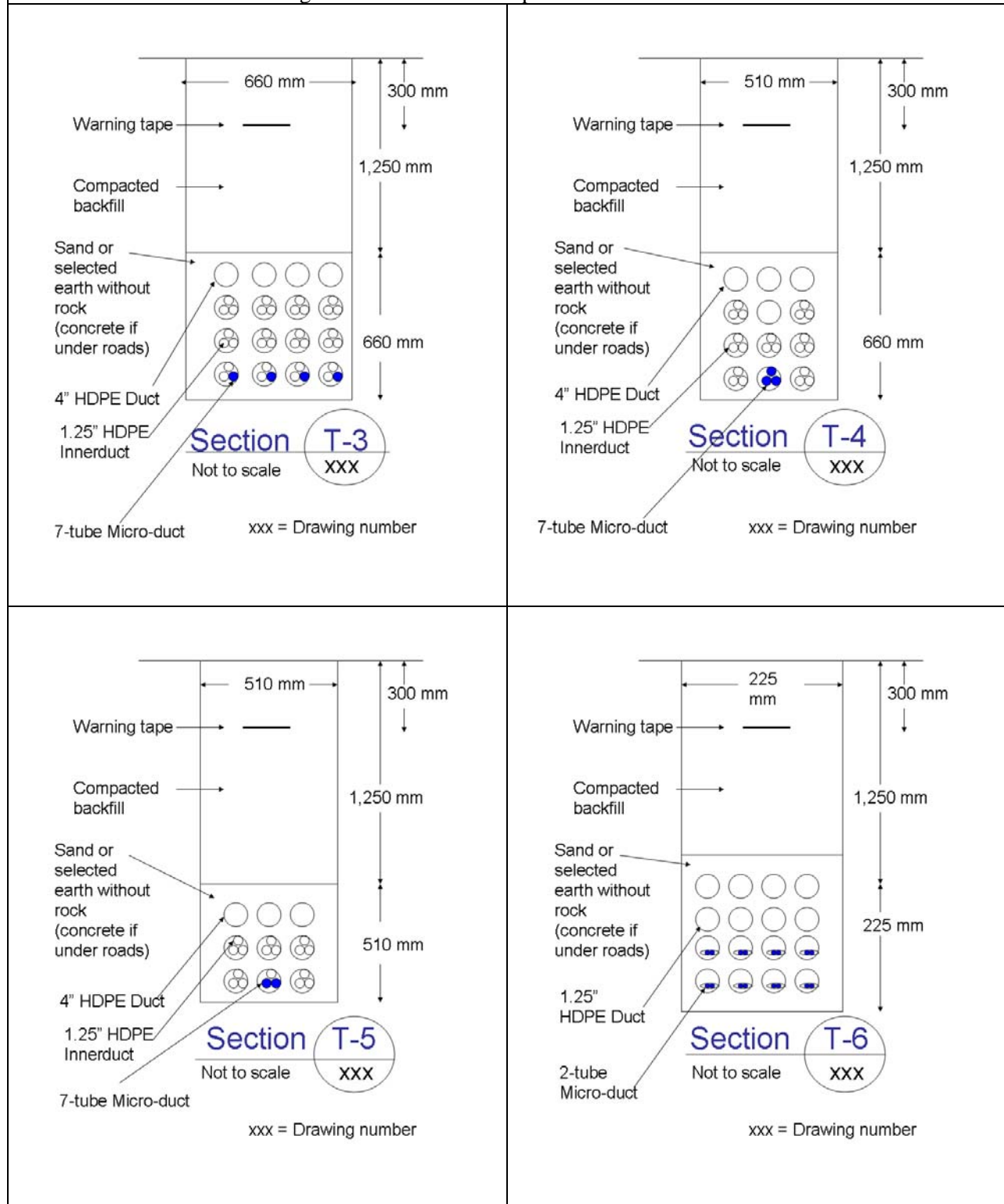
- a. The entire installation shall be done in accordance with the <sup>A17</sup>final-design Contract drawings <sup>A17</sup>, [the applicable manufacturer instructions](#), and the applicable requirements of 3M TOPN, AT&T OPEH, BICSI OSPDRM, GTE OSPE, IEEE NESC, IRHE MC1, and NFPA 70.

- b. Equipment and materials shall be installed to secure the required results with the greatest assurance of satisfactory operation and protection of life and property.
  - c. Equipment shall be located to avoid interference with mechanical or structural features without deviating from the <sup>A17</sup>final design Contract drawings. <sup>A17</sup>
  - d. The Contractor shall maintain all ducts and materials free of garbage, loose cement, and dirt during the installation.
  - e. Liquid detergents shall not be used since most of these will promote stress cracks when used on polyethylene.
  - f. Before permanent pathways are built, the Contractor shall also provide any and all necessary temporary aerial or underground pathways or facilities to minimize service interruptions to existing CWP, Employer, and GC pathways to be relocated under this contract. When temporary cable is required elsewhere in this section, cable characteristics shall be the same or better than existing cables.
  - g. On the Atlantic and Pacific sides, there shall not be more than one communications pathway affected simultaneously per side. <sup>A3</sup>
2. **Cable Racks:**
- a. Racks in manholes shall be installed all around inner walls, <sup>A17</sup>and shall cover no less than 60% of the wall areas. <sup>A17</sup>
  - b. Racks on equipment room walls shall be all around the room at a height that does not cause accidents with humans walking inside.
3. **Concrete:** Formwork, reinforcement, and concrete shall be in accordance with <sup>A7</sup>Section 03 30 00 (*Concrete*)<sup>A7</sup>.
4. **Conduits:** Shall be embedded in concrete, not directly buried.
5. **Ducts:**
- a. <sup>A19</sup>Minimum depth or earth cover shall be 1.25 m. Duct lines shall gradually change depth as required to cross streets and reach duct-bridges.
  - b. All outside plant ducts in excavated earth shall be embedded in concrete when crossing under railroad tracks and roads. <sup>A19</sup>
  - c. Work shall include ducts to connect the new locks adjacent to the old ones.
  - d. <sup>A19</sup>Underground duct along roads shall be 1 m or farther away from the outer edge of road shoulders. <sup>A19</sup>

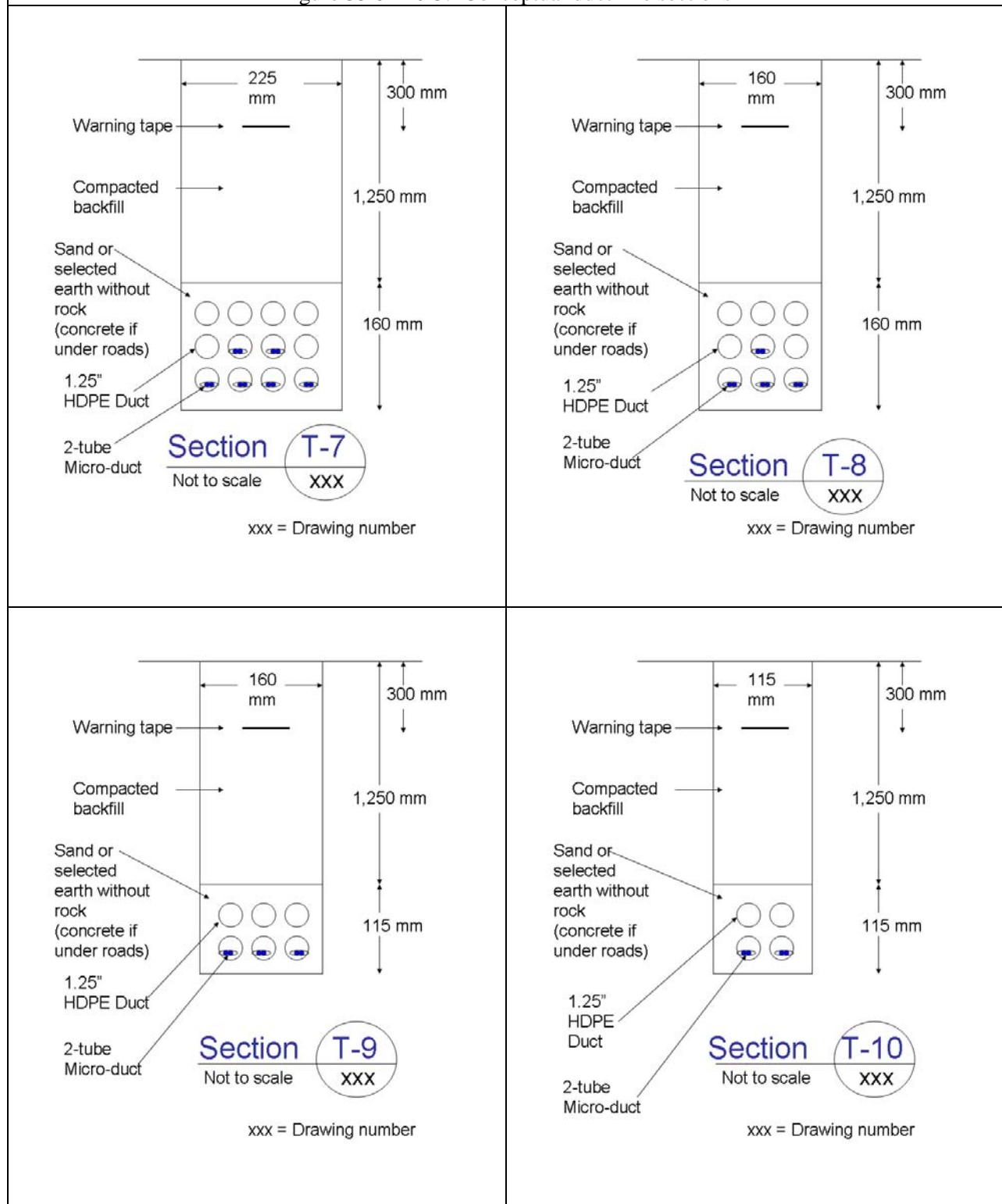
- e. Conduit cuts shall be straight, perpendicular to their axis, and free of cutting edges. Cuts shall be made with saws or other adequate tools.
- f. Duct routes shall follow sufficiently stable and firm ground to support the necessary equipment for laying ducts and cables.
- g. Mud, silt, and other obstructions in ducts shall be completely blown, cleaned, and removed. Damaged, deformed, or obstructed ducts are unacceptable.
- h. The Contractor and his personnel shall follow the safety recommendations and requirements of ANSI C2-97 (NESC) at all times.
- i. <sup>A20</sup>Figure 33 81 26-3 shows conceptual duct line sections that may be used:<sup>A20</sup>

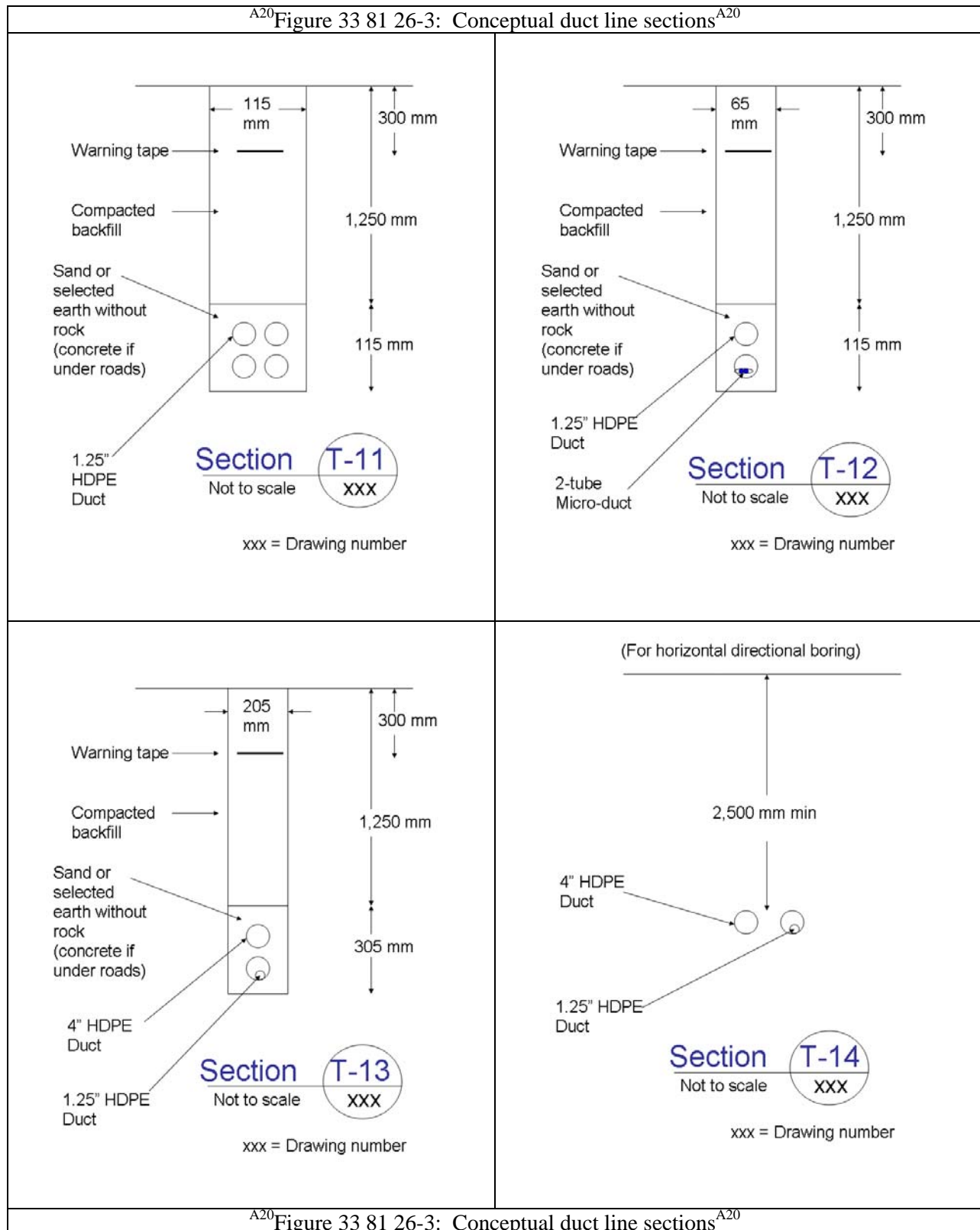


A20 Figure 33 81 26-3: Conceptual duct line sections A20



A20 Figure 33 81 26-3: Conceptual duct line sections A20





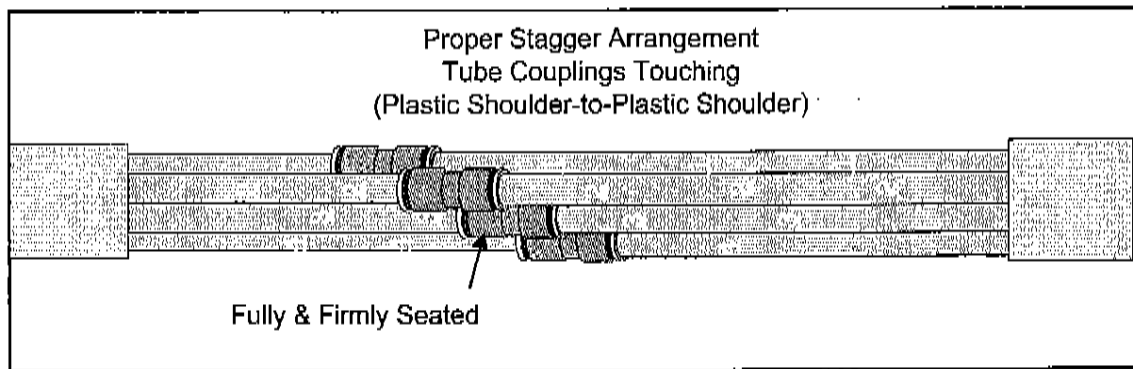
- j. Installation shall be done with care to avoid kinking (i.e., when uncoiling) and sharp bends. Duct bending radius shall not be smaller than that published by the corresponding manufacturer.
  - k. The Contractor shall minimize the time ducts are exposed to sunlight.
6. **Earthwork:** Shall be in accordance with Section 31 23 00 (*Excavation and Fill*). Trenches shall be as straight as possible, as required to provide ducts with uniform support, and without undulations and excessive radius of curvatures. Stones or other sharp or heavy items shall not be placed on ducts while backfilling trenches.
7. **Manholes:**
- a. <sup>A17</sup>**Spacing:** <sup>A17</sup> <sup>A13</sup> MHs shall be spaced as required and unless otherwise specified, not to exceed 900 m. <sup>A13</sup>
  - b. <sup>A17</sup>**Exclusive Use:** <sup>A17</sup> MHs for telecommunications shall not be used for AC power wiring. MHs for electrical work, refer to Section 26 05 43 (*Underground Ducts and Raceways for Electrical Systems*), shall not be used for telecommunications wiring.
  - c. <sup>A17</sup>**Crossunder MHs:** <sup>A17</sup> Both ends of all ducts along locks Crossunders shall terminate in manholes.
  - d. <sup>A17</sup>**Location:** The exact location for each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. Whenever possible, holes shall be located beneath lawn or sidewalks, and away from streets and street shoulders. Whenever manholes are located beneath vehicular roads, they shall be made of poured concrete and adequate to support vehicular traffic.
  - e. **Drainage:** The floor slab shall slope slightly towards the center for drainage purposes. Manholes shall have one or more drains, each one with a cone grate, "P" trap, and sewer HDPE or PVC pipe(s). Drainage pipes shall be extended as long as necessary to reach an adequate point at a lower level than the manhole floor.
  - f. **Manhole Covers:**
    - 1) **In Paved Areas:** MH covers for manhole entrances in vehicular traffic areas shall be flush with the pavement finished surface.
    - 2) **In Unpaved Areas:** The top of manhole covers shall be slightly above the finished grade, at a minimum of 13 mm (0.5 in) high.
  - g. **Connections to Duct Lines:** Wherever duct lines enter a MH, the sections of duct may be either cast in concrete or may enter the manhole through a square or rectangular opening of suitable dimensions furnished in the MH walls.



- h. **Cable Pulling Irons:** Unless otherwise recommended by the Contractor and reviewed by the Employer's Representative, a cable pulling iron shall be installed on the MH wall opposite to each duct line entrance.
- i. **Cable Routing:** MHs shall allow cable routing minimizing cable crossover, furnish access space for maintenance and installation of additional cables, and shall allow for a loop of slack fiber optics cable in the horizontal and vertical planes, and splice cases as required.
- j. **Duct Entrances:**
  - 1) Whenever possible, ducts for telecommunications shall enter manholes as close as possible to opposite corners.
  - 2) The position of each colored duct shall be consistently the same at all entry and exit points of manholes, and in all manholes.<sup>A17</sup>
- k. <sup>A19</sup>**Micro-Ducts:**
  - 1) Micro-ducts between two adjacent manholes or a manhole and an adjacent pull hole shall be continuous from end to end and without couplings. Whenever feasible, micro-ducts shall be a single piece between the telecommunications node and the building being serviced.
  - 2) Sealing couplings shall be installed at a visible location in manholes and pull holes to connect micro-duct tubes when installing a single run is not possible, or when changing the micro-duct type, i.e., from 2 to 7 tubes. Micro-duct couplers shall be installed to provide end-to-end micro-duct continuity and to minimize air pressure losses during cable installation.
  - 3) Micro-duct tubes in maintenance holes and pull holes shall be grouped in order, using micro-duct organizers and/or cable trays permanently fixed to the walls.
  - 4) <sup>A20</sup>Micro-duct tube splices shall be firm and staggered, as shown on Figure Nos. 33 81 26-3 and 4, and as recommended by the micro-duct manufacturer, whichever is the strictest:<sup>A20</sup>

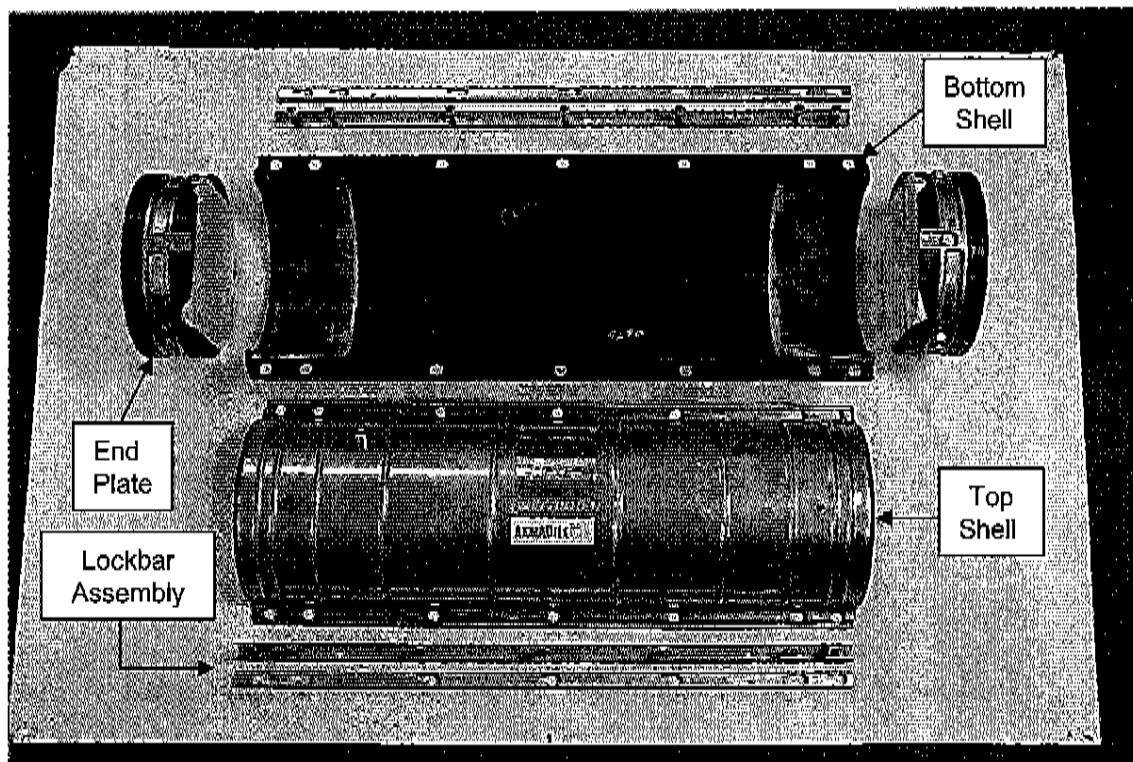


<sup>A20</sup>**Figure 33 81 26-3: Micro-duct tube splices**<sup>A20</sup>

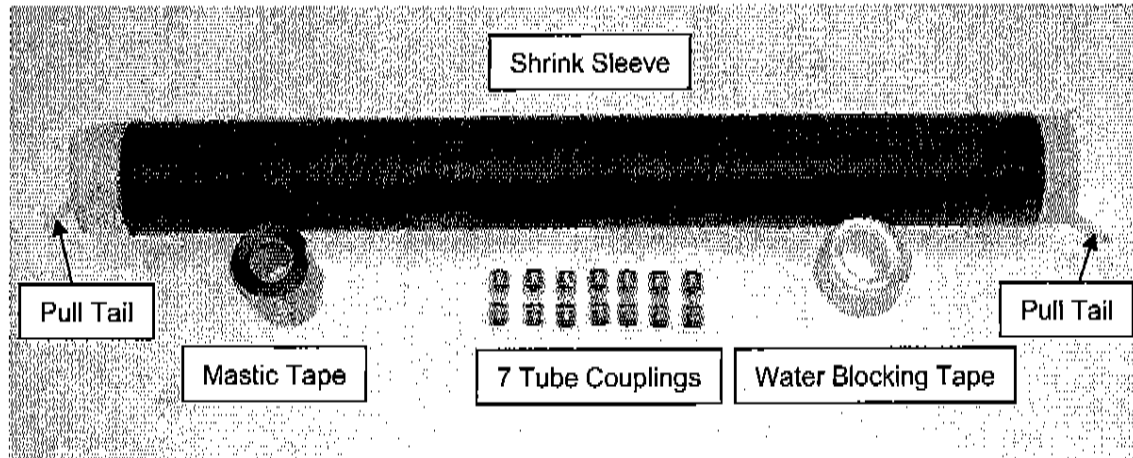


<sup>A20</sup>Figure 33 81 26-4: Micro-duct tube splices<sup>A20</sup>

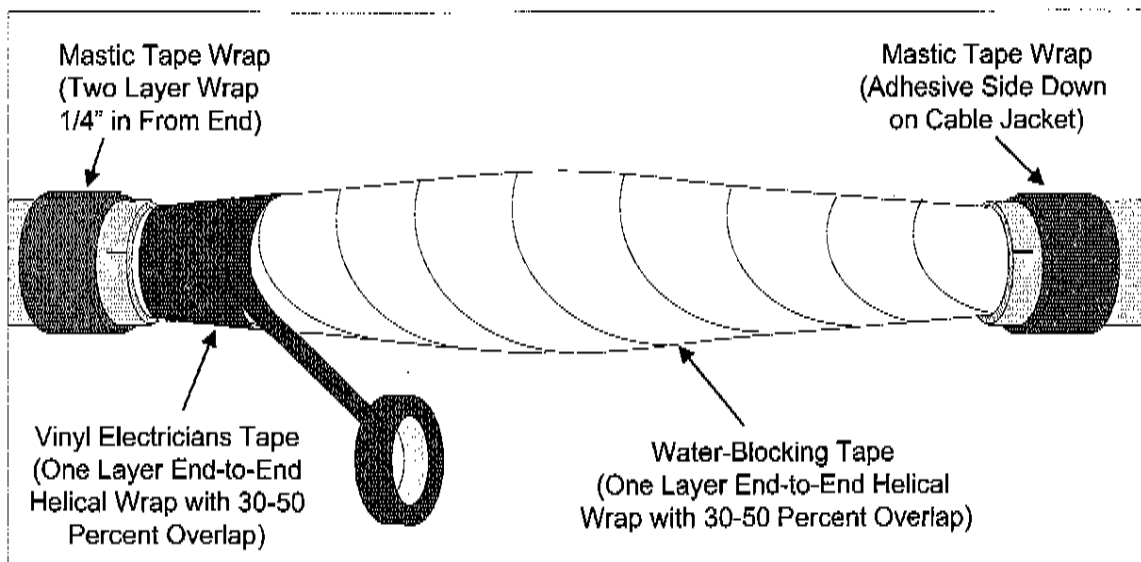
- 5) <sup>A20</sup>Groups of spliced tubes shall be installed in a water-tight, sealed splice case suitable for underground plant, as shown on Figure 33 81 26-5, or use a shrink sleeve, water blocking tape, and electric tape, as shown on Figure Nos. 33 81 26-6 and 7.<sup>A20</sup>



<sup>A20</sup>Figure 33 81 26-5: Splice case for micro-duct tubes<sup>A20</sup>



<sup>A20</sup>Figure 33 81 26-6: Shrink sleeve, couplings, and tapes for splicing groups of micro-duct tubes<sup>A20</sup>



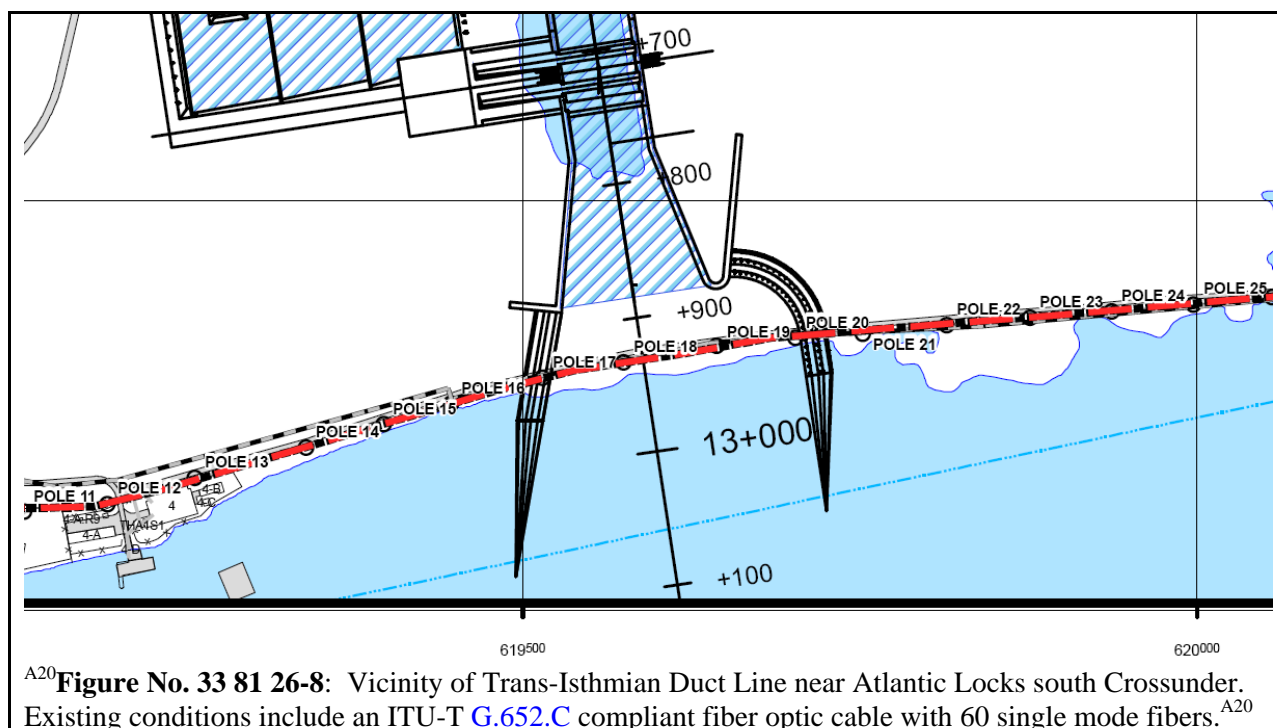
<sup>A20</sup>Figure 33 81 26-7: Sealing of a group of micro-duct tubes<sup>A20</sup>

- 6) Micro-duct couplers shall not be installed directly buried or inside ducts.<sup>A19</sup>
- 7) End caps shall be installed in micro-duct tube ends left in place for future use.

## 8. Pathways:

### a. Existing Pathways to be Removed and Permanently Relocated:

- 1) <sup>A13</sup> Pathways in Agua Clara shall include underground ducts and cables to relocate two aerial fiber optic cables between Agua Clara and Gatun, using Atlantic locks complex's northernmost and/or middle Crossunders. Although existing cables have 28 and 36 fibers, each new cable shall have 36 or more single mode, ITU [G.652.C](#) compliant, low water peak type fibers. <sup>A13</sup>
- 2) Pathways in Davis shall also include trans-isthmian duct line bypass through the Atlantic Locks southernmost Crossunder, consisting of no less than twelve 38 mm (1.5 in) HDPE pipes. <sup>A20</sup> The vicinity area is illustrated in Figure No. 33 81 26-8 and the duct line is shown in red. <sup>A20</sup> For details see <sup>A17</sup> Volume VI, Part 1 (*Reference Drawings*), <sup>A17</sup> Drawing 5802-15 (Atlantic Locks Complex - Existing Utilities – Water, Sanitary, Storm, Electrical and Communication).

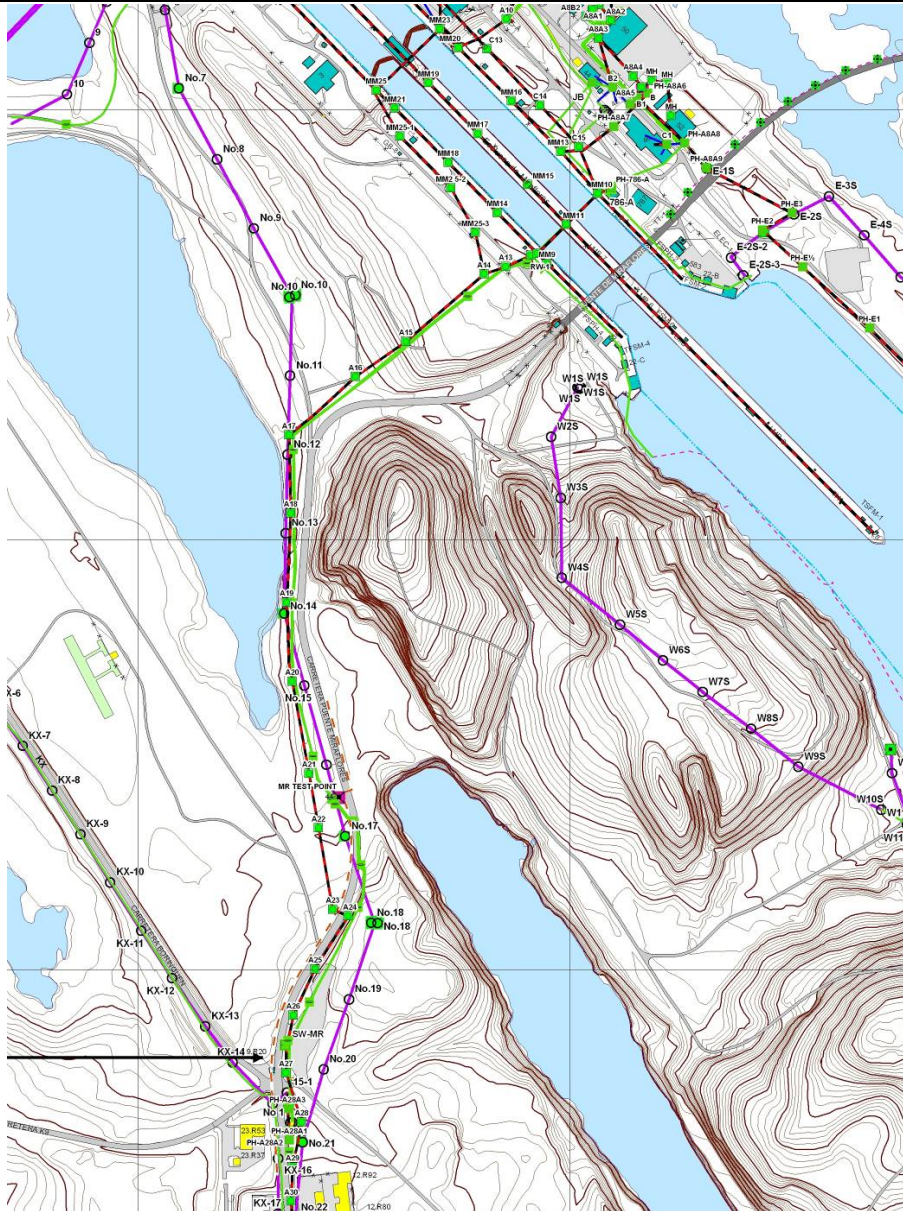


- 3) Pathways in the Pacific locks complex shall include the following:
  - a) Miraflores Locks - Pacific locks link via two different routes and Crossunders of Miraflores Locks.
  - b) <sup>A20</sup> A bypass for Miraflores - Howard aerial fiber optic cable through Pacific locks complex northernmost



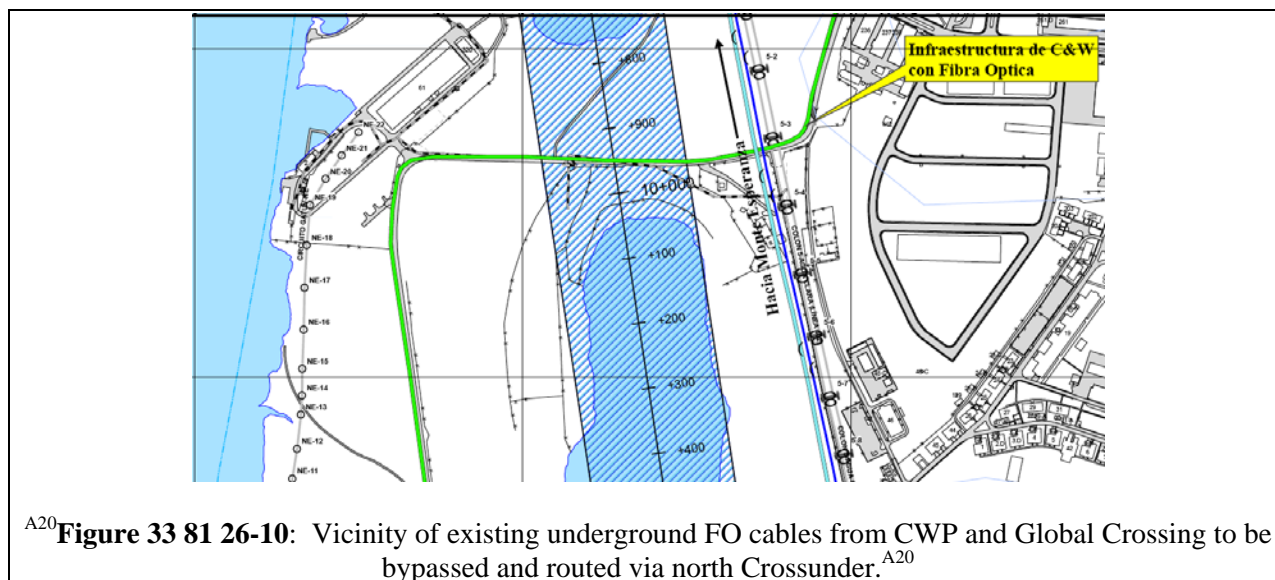
Crossunder (pole line is shown on Figure No. 33 81 26-9).<sup>A20</sup> For details see <sup>A17</sup>Volume VI, Part 1 (*Reference Drawings*), <sup>A17</sup> Drawing 5802-15 (Pacific Locks Complex - Existing Utilities – Water, Sanitary, Electrical and Communication).

- <sup>A10</sup>c) A bypass for Miraflores-Cocoli 12R85 duct line with no less than two 100 mm (4 in) ducts and a 100 pair #24 AWG copper cable for telephony.<sup>A10</sup>



<sup>A20</sup>Figure No. 33 81 26-9: Vicinity of Pacific and Miraflores Locks Complexes<sup>A20</sup>

- <sup>A11</sup>4) <sup>A20</sup>Pathways in the Atlantic locks complex shall include a bypass of Cable & Wireless Panama's duct line in the vicinity of the area shown in Figure 33 81 26-10. The permanent bypass shall go across the new locks via the north Crossunder<sup>A20</sup> and shall consist of one ITU-T G.653 (Dispersion Shifted) compliant fiber optic cable with four or more fibers, four 100 mm (4 in) HDPE ducts, three 32 mm (1.25 in) HDPE inner-ducts in each one of two ducts, and a manhole at each end of the bypass.<sup>A11</sup> The Contractor shall perform the required permanent manhole and duct work as required for this bypass. Others will furnish, install, splice, test, and pay this new cable section.

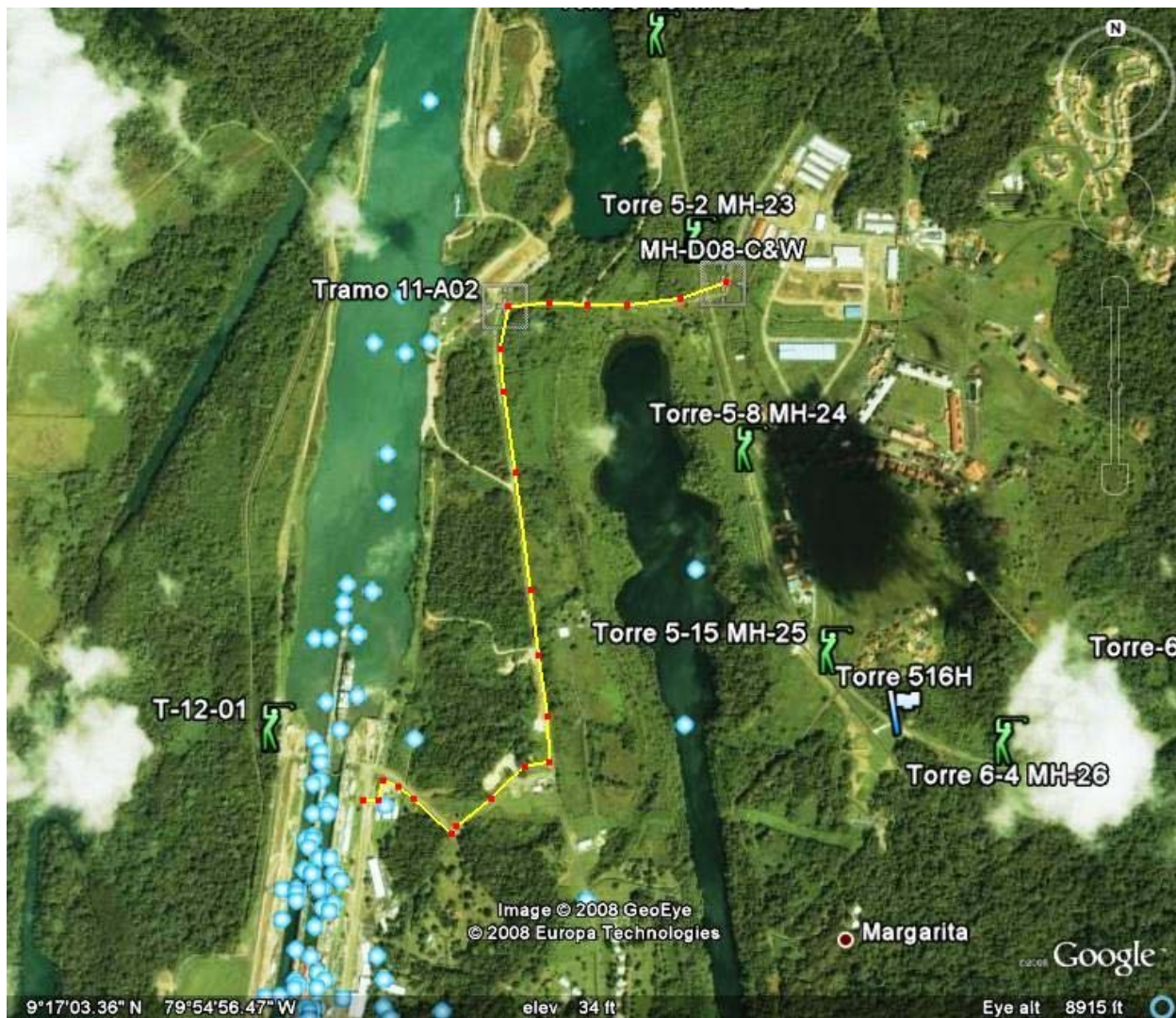


- 5) <sup>A20</sup>Pathways in the Atlantic locks complex shall include a bypass of a Global Crossing underground cable in the vicinity of the area shown in Figure 33 81 26-11.
- a) This cable is presently installed in CWP duct line illustrated in Figure 33 81 26-10.<sup>A20</sup>
  - b) This bypass shall consist of one ITU-T G.655 compliant, subsea type fiber optic cable with six or more positive non-zero dispersion shifted fibers.
  - c) Cable shall be Lucent Optical Cable NCA-8145-006, or approved equal.
  - d) Fibers shall be Lucent Technologies ([www.alcatel-lucent.com](http://www.alcatel-lucent.com)) TrueWave RS, and cable construction shall be OFS ([www.ofsoptics.com](http://www.ofsoptics.com)) LightPack® LXE Cable or approved equal, respectively.



- e) Additional cable length and splices may be critical to Global Crossing.<sup>A11</sup>

A11



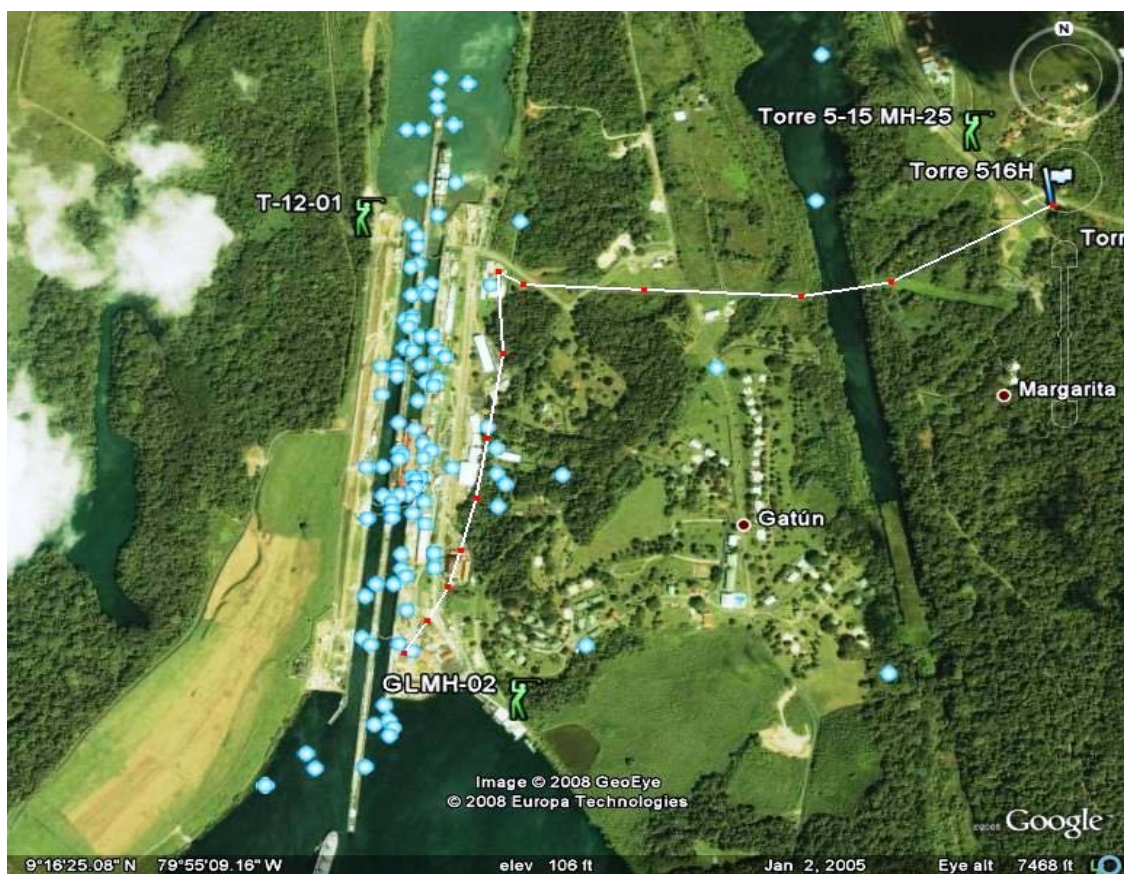
<sup>A20</sup>**Figure 33 81 26-11:** Vicinity of existing underground FO cable from Global Crossing to be bypassed and routed via north Crossunder.<sup>A20</sup>

- 6) <sup>A20</sup>Pathways in the Atlantic locks complex shall include a bypass of an Employer aerial fiber optic cable in the vicinity of the area shown in Figure 33 81 26-12.<sup>A20</sup> This cable is currently rented to Global Crossing.
- a) This bypass shall consist of one ITU-T G.655 compliant, subsea type, all dielectric, self-supported fiber optic cable with eight or more negative non-zero dispersion

shifted fibers. Hanging accessories shall be furnished as required.

- b) Cable shall be Lucent Optical Cable AT-XXX27L8-008, or approved equal.
- c) Fibers shall be OFS TrueWave XL Ocean Fiber, and cable construction shall be OFS ([www.ofsoptics.com](http://www.ofsoptics.com)) Power Guide Loose Tube Cable or approved equal, respectively.
- d) Additional cable length and splices may be critical to Global Crossing.<sup>A11</sup>
- e) <sup>A17</sup>For details see Volume VI, Part 1 (*Reference Drawings*), Drawing 5802-3 (Atlantic Locks Complex - Existing Utilities – Water, Sanitary, Storm, Electrical and Communication).<sup>A17</sup>

A11



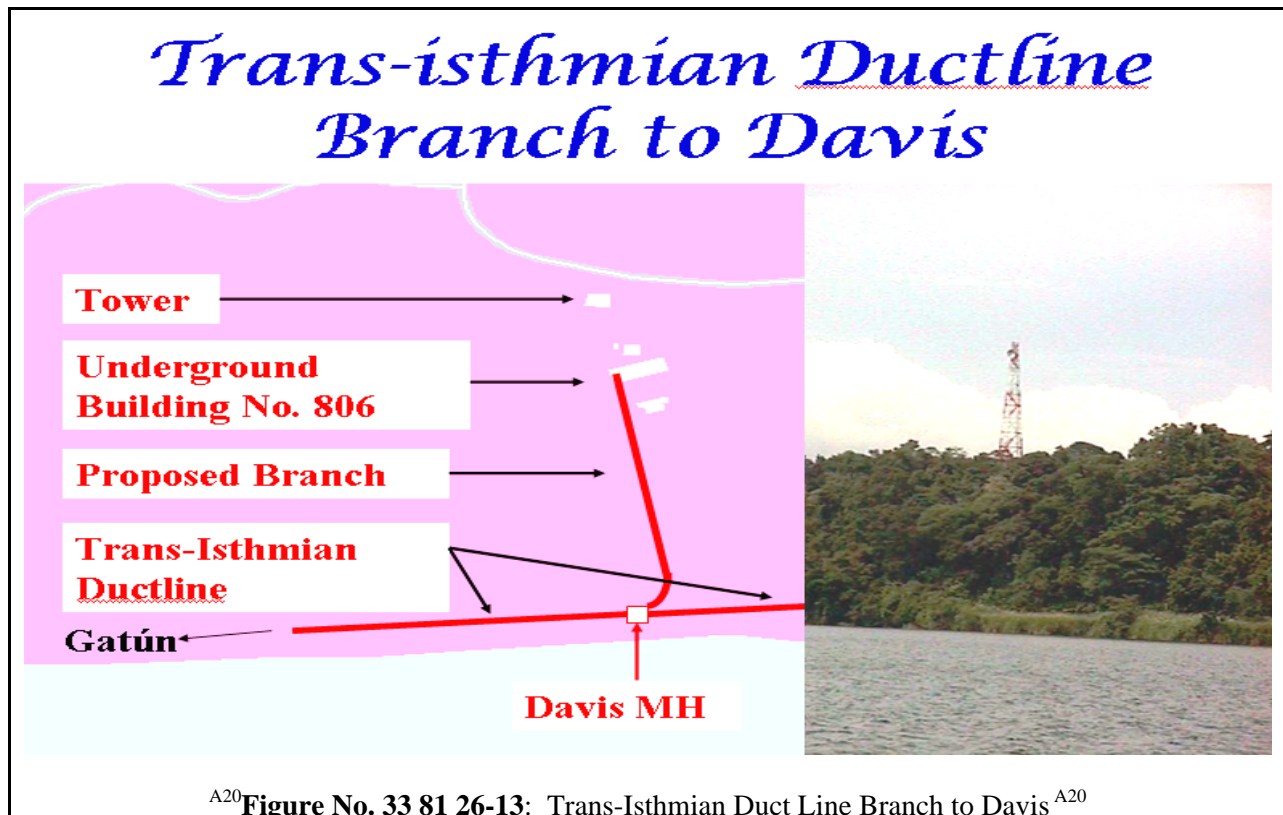
<sup>A20</sup>**Figure 33 81 26-12:** Vicinity of existing Employer aerial FO cable rented to Global Crossing, to be bypassed and routed via nearest Crossunder (except northernmost Crossunder to maintain route diversity).<sup>A20</sup>

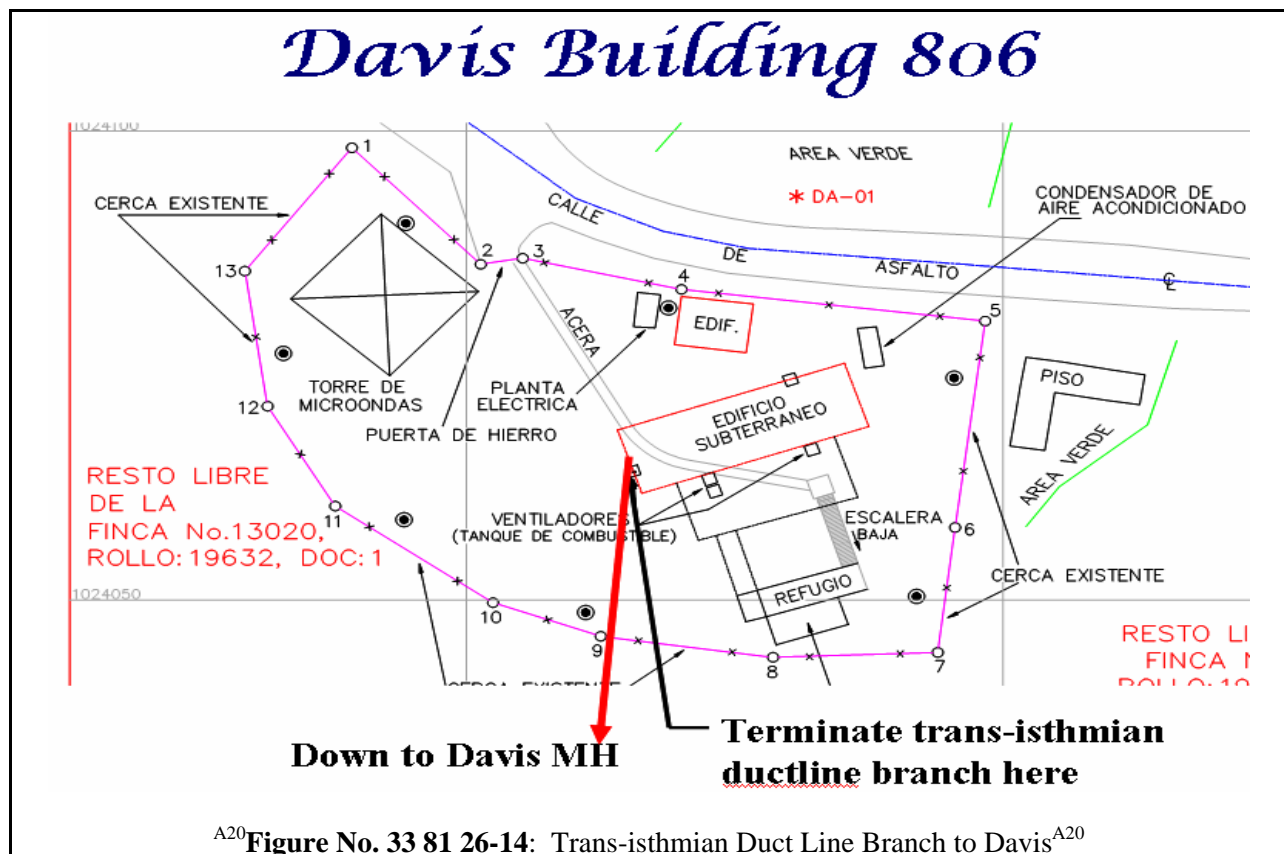


- <sup>A11</sup>7) All other existing telecommunications pathways and cables found in place and not specified above shall be relocated, and shall use equivalent or better materials.<sup>A11</sup>

b. **New Pathways by the Contractor:**

- 1) Pathways in the Atlantic locks complex shall include routing through the trans-isthmian duct line.
- 2) Pathways in the Pacific locks complex shall include routing through the Miraflores Building No. 7D. This building is a termination point of a trans-isthmian duct line branch.
- 3) <sup>A11</sup>(Reserved)<sup>A11</sup>
- 4) <sup>A20</sup>Pathways in Davis south shall include a new branch of the trans-isthmian duct line in accordance with Figures Nos. 33 81 26-13 and -14, except there will be an existing building (built by others) instead of an old bunker.<sup>A20</sup> This shall facilitate a temporary aerial fiber optic cable installation to Gatun Locks via Agua Clara electrical substation, and shall be completed long before the trans-isthmian duct line is affected by the excavations south of Atlantic Locks Complex.<sup>A13</sup> This pathway shall include nine or more 32 mm (1.25 in) HDPE ducts.<sup>A13</sup>





- 5) Pathways in the Pacific side shall include a new duct line with no less than four 32 mm (1.25 inch) HDPE ducts and an ITU-T [G.652.C](#) compliant fiber optic cable with no less than 36 single mode fibers between Miraflores Bldg. 7D and Rodman Bldg. 22.  
<sup>A10</sup>Unless otherwise recommended by the Contractor and reviewed by the Employer Representative, the duct route shall be along the east side of Bruja Road.<sup>A10</sup> <sup>A17</sup>See Volume VI, Part 1 (*Reference Drawings*), Drawing VF-1710-69-001 and VF-1710-69-002 for details of existing infrastructure.<sup>A17</sup>
- 6) Pathways in the Atlantic side shall include a new duct line with no less than nine 32 mm (1.25 inch) HDPE ducts and an ITU-T [G.652.C](#) compliant fiber optic cable with no less than 72 single mode, low water peak fibers between Agua Clara substation and Gatun Bldg. 26.
- 7) <sup>A13</sup>Every Crossunder of the new locks shall have no less than nine 100 mm (4 in) ducts, each one with three 32 mm (1.25 in) inner-ducts, and micro-ducts as required.<sup>A13</sup>

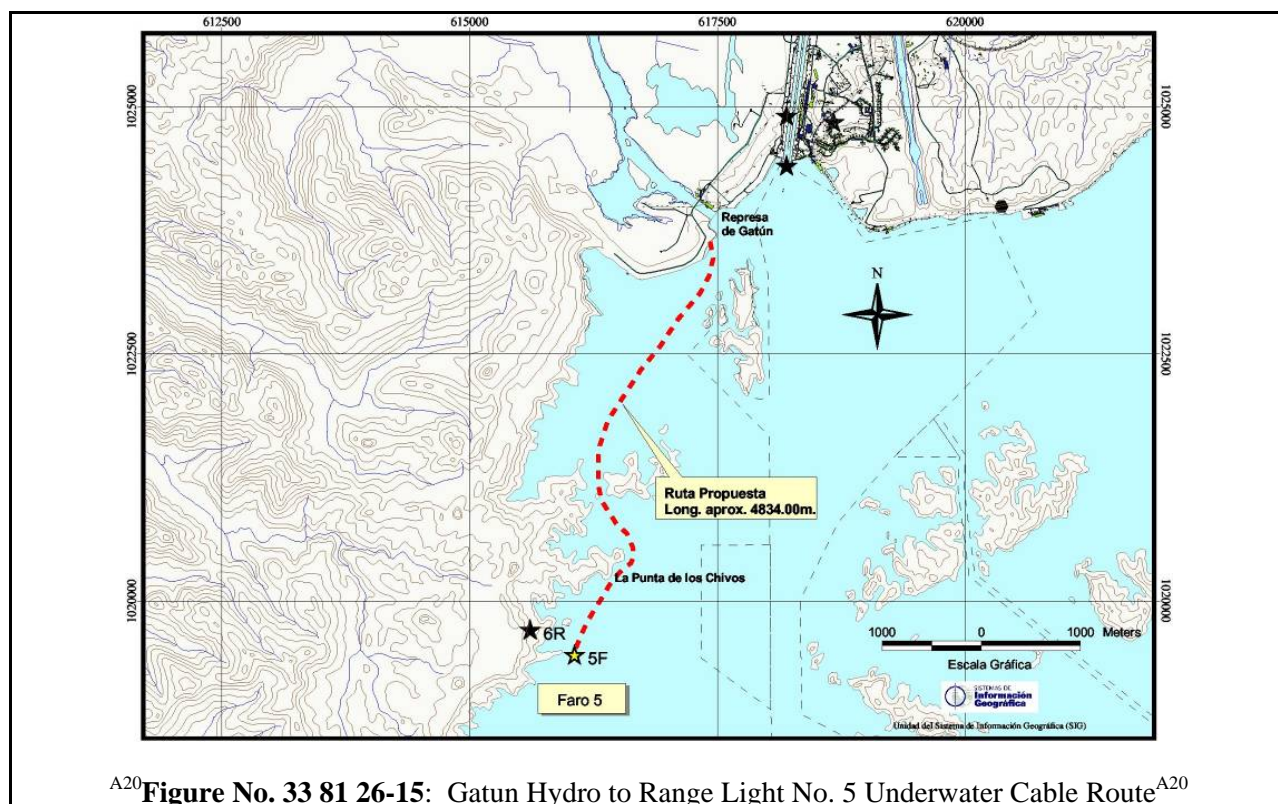
c. <sup>A19</sup>**Pathways to be Removed or Abandoned:**

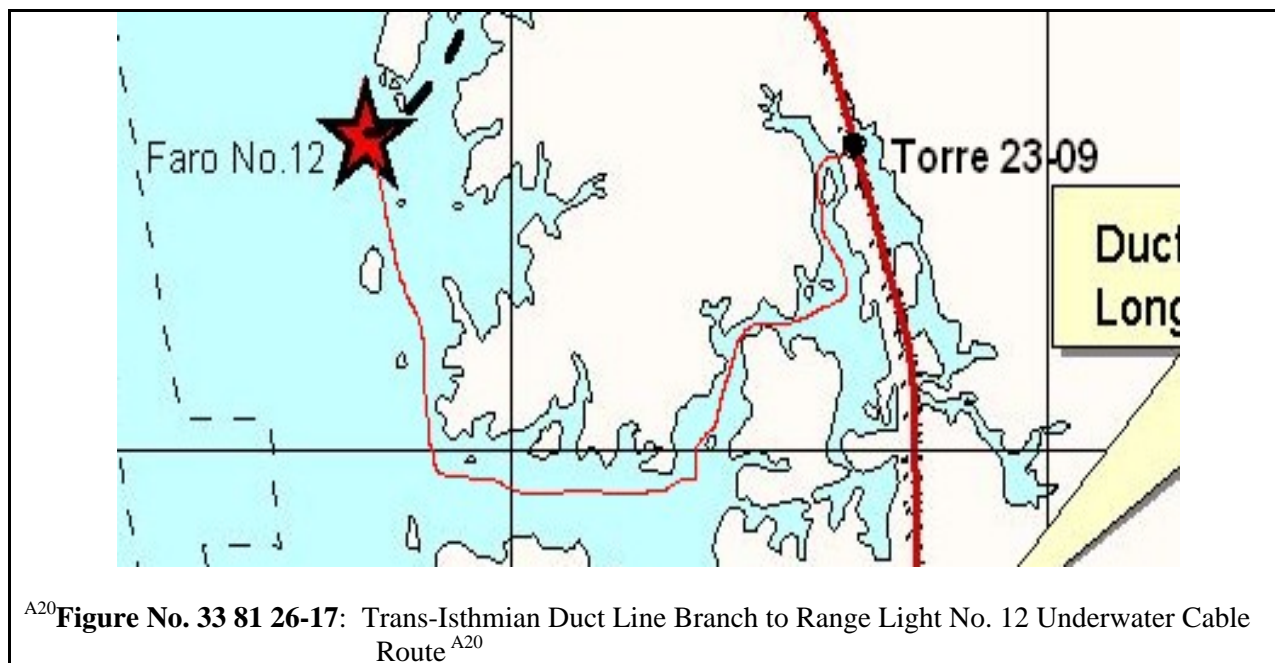
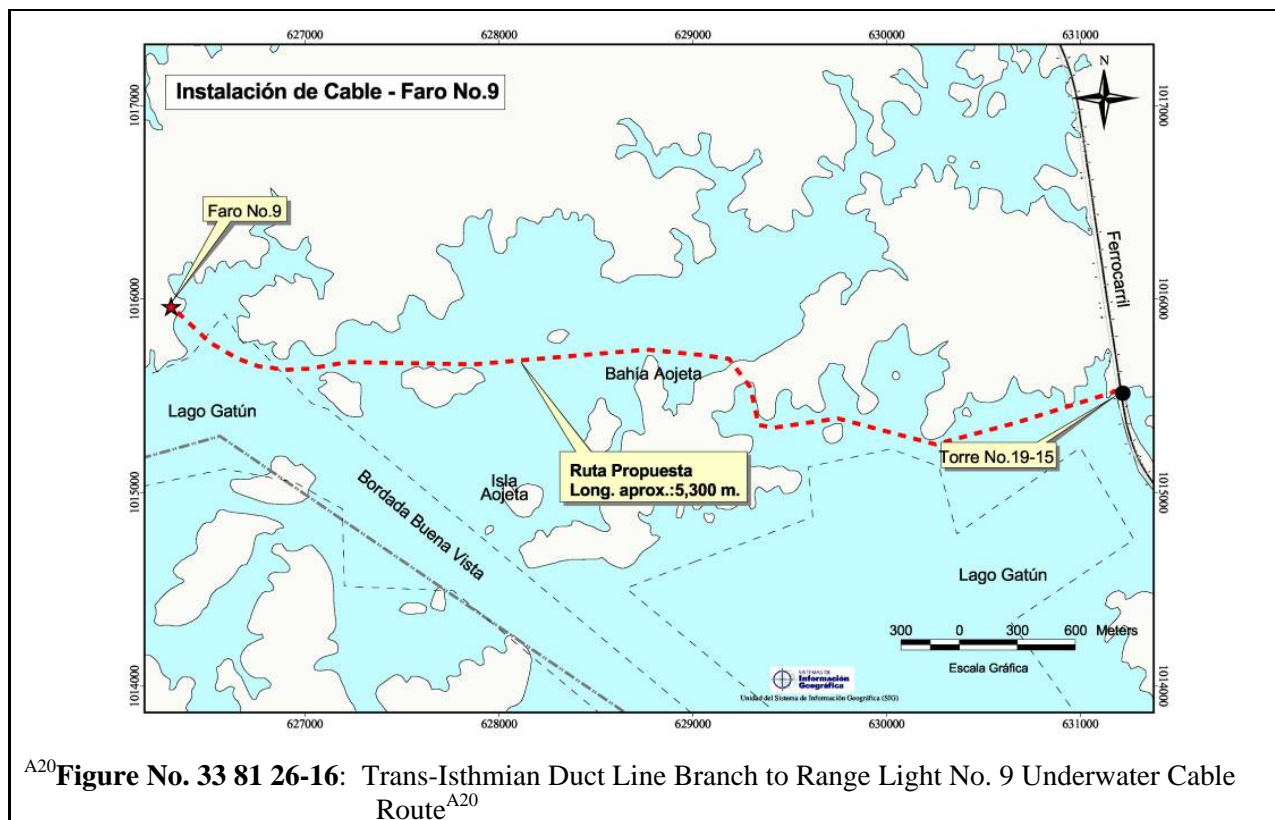
- 1) CWP cables, ducts, and manholes in Cocoli area will be removed or abandoned in place, as determined by CWP. <sup>A19</sup>

9. **Plugs:** Shall be used to close spare ducts and inner-ducts.

10. **Protection of Existing Work:**

- a. Existing pathways shall be protected against damages so these can remain in use.
- b. Existing sub-aquatic sections of the trans-isthmian duct line in north Gatun Lake shall be protected against damage from dumping dredged and excavated materials in accordance with Section 01 14 00 (*Work Restrictions*). <sup>A17</sup>See Volume II, Part 4 (*Requirement Drawings*), Drawing 5802-28 (Location Plan of Proposed Disposal Site in Atlantic Area) for details. <sup>A17</sup>
- c. Existing sub-aquatic cables in Gatun Lake shall be protected against damage from dumping dredged and excavated materials in accordance with Section 01 14 00 (*Work Restrictions*). <sup>A20</sup>The above cables are illustrated in Figures 33 81 26-15 through -17. <sup>A20</sup>

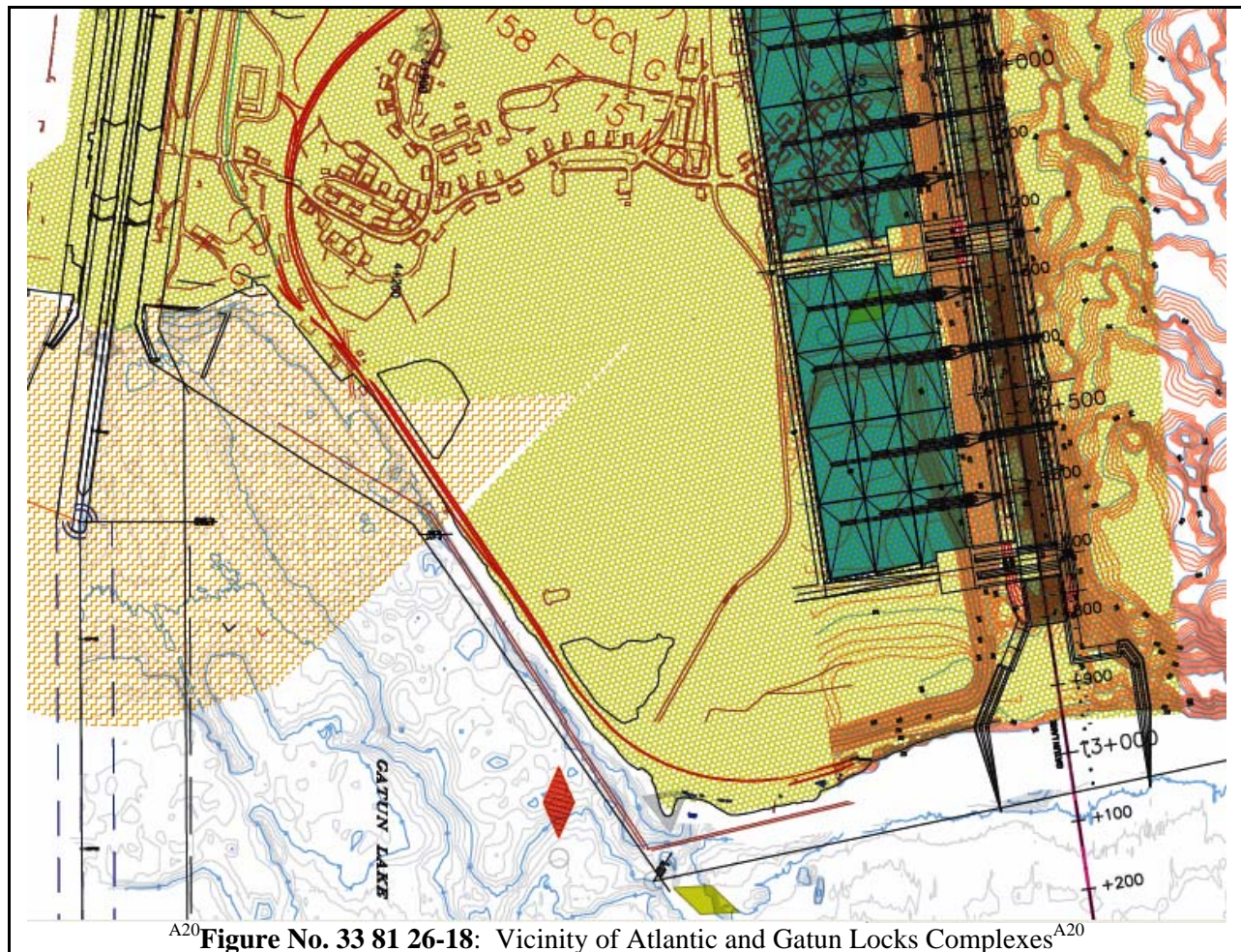




- d. Unless otherwise specified, all construction above existing duct lines shall be disallowed. <sup>A20</sup>Should a road be built from Gatun to the divers school near Davis along the old railroad pathway (same route as pole line



near lake shore on Figure 33 81 26-18), the road and its shoulders shall not be built above the existing trans-isthmian duct line.<sup>A20</sup>



<sup>A20</sup>Figure No. 33 81 26-18: Vicinity of Atlantic and Gatun Locks Complexes<sup>A20</sup>

- e. <sup>A17</sup>On the Atlantic side, an existing directly buried fiber optic cable between Agua Clara Substation and the former Ft. Davis bunker shall be protected from damages. It has single mode fibers, runs parallel to the road, and is not shown on reference drawings.<sup>A17</sup>

# 11. **Pull Holes (PH):**

- <sup>A8</sup>a. PHs shall be installed between MHs as required.<sup>A8</sup>

- <sup>A8</sup>b. <sup>A8</sup> PHs for telecommunications shall not be used for AC power wiring. PHs for electrical work, refer to Section 26 05 43 (*Underground Ducts and Raceways for Electrical Systems*), shall not be used for telecommunications wiring.

- 12. **Warning Tape:** Shall be used above ducts excavated in the ground. <sup>A11</sup>Tape shall be installed at <sup>A13</sup>300 mm <sup>A13</sup> below earth surface.<sup>A11</sup>

13. <sup>A13</sup>**Duct Bridges:** Shall be installed wherever the telecommunications pathway crosses a creek, railroad bridge, river, or vehicular bridge.
14. **Duct Spacers:** Shall be installed in duct lines at intervals not to exceed 10 m. <sup>A13</sup>

#### 1.04 DESIGN CRITERIA/SYSTEM PERFORMANCE:

##### A. General:

1. **Problem to be Solved:** Pathways shall solve the following business needs:
  - a. Provide safe space for outside plant communications cabling.
  - b. Provide adequate separation between telecommunications and power cabling.
  - c. <sup>A19</sup>Protect cables from flooding effects, specially during the rainy season. <sup>A19</sup>
2. **Restrictions to be Considered:** (reserved)

##### B. Design Criteria:

1. OSP shall be designed as required for all communications and electronic signaling necessary for Locks operations.
2. <sup>A16</sup>Design shall meet the applicable requirements of 3M TOPN, 7 CFR <sup>A16</sup> 1751F-641, 7 CFR 1751F-642, 7 CFR 1751F-643, 7 CFR 1753F-401, AT&T OPEH, BICSI OSPDRM, EIA 758, <sup>A10</sup>GTE (now Verizon) OSP Engineering, <sup>A10</sup> and TIA 758.

##### C. System Performance:

1. OSP shall have adequate plugs and devices to avoid entrance of water to buildings.

#### 1.05 SUBMITTALS: The following shall be submitted for substantiation purposes:

- A. **Design:** The following shall be in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.05 D.:
  1. Critical path method (CPM) diagram, with monthly updates.
  - <sup>A3</sup>2. <sup>A3</sup> Descriptive literature.
  3. Drawings <sup>A3</sup>, with geo-referenced duct line information. <sup>A3</sup>
  4. Specifications.

- B. **Re-Submittals Just Prior to Purchasing Materials:** All items in A. above that have changed from original submittal shall be resubmitted in a design conference in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.05.
- C. **Upon Receipt of Shipped Items in Panama:**
  - 1. Packing lists.
- D. **Prior to Issuance of Taking-Over Certificate:**
  - 1. <sup>A17</sup>As-Built drawings, including duct line markers and OSP identifiers. <sup>A17</sup>
  - 2. Test reports.

**1.06 QUALITY ASSURANCE:** Shall include the following in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.06:

- A. **Final <sup>A3</sup>Field Inspection Tests <sup>A3</sup> (FFIT):**
  - 1. **General:**
    - a. The Contractor shall test a minimum of 10% sampling of new ducts for air tightness, clearance, and internal sizing conformance, as recommended by the manufacturer for review by the Employer's Representative. Sample duct sections shall be chosen at random by the Employer's Representative.
    - b. Unless otherwise recommended by the manufacturer, tests shall be conducted to pressures up to 862 kPa (100 psi).
    - c. The Employer's Representative shall review each step in the tests and sign off after successful completion. Both parties shall report and sign off specific failures, if any. After the Contractor has corrected all differences, both parties shall retest and sign-off, as appropriate.
    - d. The Contractor shall take all necessary safety measures to avoid injury and damages.
    - e. These tests shall apply to both permanent and temporary telecommunications pathways.
  - 2. **Air Tightness or Leak Tests:** The Contractor shall gradually blow pressurized air into chosen duct sections and measure air pressure at the other end. In order for the test to be considered successful, measured pressure shall be within the manufacturer defined "acceptable air loss values" or tolerable pressure drop in a given diameter duct over a known distance, using a specific size compressor.

3. **Clearance Tests:** The Contractor shall blow a dart or swab into the chosen duct sections as if installing a fiber optic cable using the blowing method. The dart or swab shall reach the other end without foreign matter such as debris and water in order for the ducts to be considered clean, continuous, and obstruction free, and for the test to be considered successful.
4. **Internal Sizing Conformance:** The Contractor shall send a dart or sonde to verify that selected duct sections are not deformed. Unless otherwise recommended by the manufacturer, any conformance dart shall be approximately 80% of the actual duct inside diameter.

B. Warranty.

**END OF SECTION**