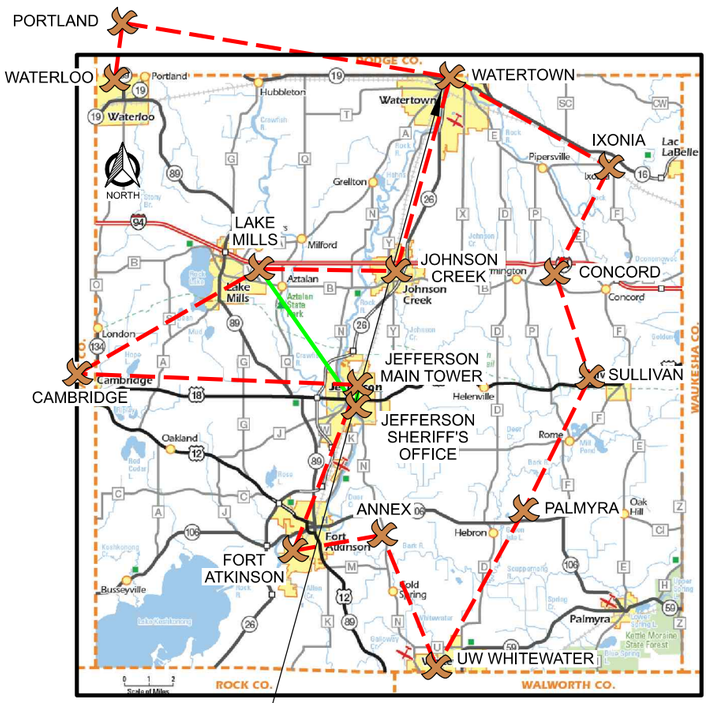


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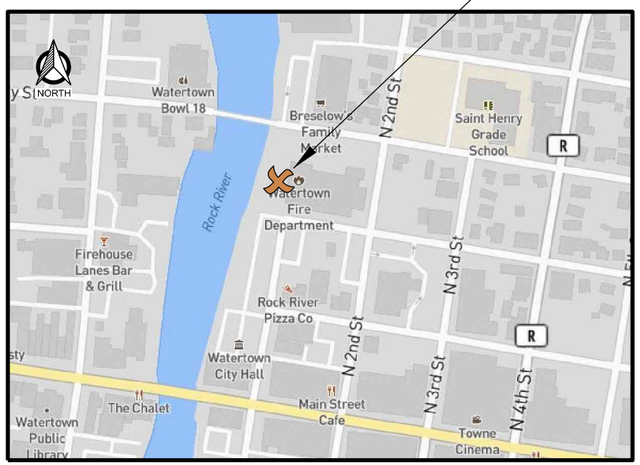



# WATERTOWN (27747)
# WATERTOWN, WISCONSIN
# 155' SELF-SUPPORT

## PROJECT DIRECTORY

ENGINEERING COMPANY:
EDGE CONSULTING ENGINEERS, INC.
624 WATER STREET
PRAIRIE DU SAC, WI 53578
CONTACT: ARLEN OSTRENG
PHONE: (608) 644-1449

OWNER
JEFFERSON COUNTY SHERIFF'S OFFICE
411 S CENTER AVE.
JEFFERSON, WI 53549-1703
CONTACT: (920) 674-7346
NAME: TODD LINDERT

TECHNOLOGY CONSULTANT:
TRUE NORTH CONSULTING GROUP
140 3RD STREET SOUTH
STILLWATER, MN 55082
CONTACT: (651) 705-1255
NAME: JOHN THOMPSON

RADIO SYSTEM VENDOR:
GENERAL COMMUNICATIONS
2880 COMMERCE PARK DR.
MADISON, WI 53719
CONTACT: (608) 271-4848
NAME: CHAD TOMASZEWSKI

ELECTRICAL SERVICE PROVIDER:
WE ENERGIES
231 W. MICHIGAN ST.
MILWAUKEE, WI 53203
CONTACT: (414) 221-2345

## PROJECT INFO

SITE ADDRESS:
106 JONES ST
WATERTOWN, WI 53094

PROPERTY OWNER:
CITY OF WATERTOWN
PO BOX 477
WATERTOWN, WI 53094

TOWER OWNER:
CITY OF WATERTOWN
PO BOX 477
WATERTOWN, WI 53094

TOWER COORDINATES (PER PREVIOUS DRAWINGS):
LAT (NAD83/91): 43°-11'-45.91" N (43.196086)
LONG (NAD83/91): 88°-43'-25.76" W (-88.723822)
GROUND ELEVATION (NAVD 88): 822'
ASR NUMBER: 1220585

PLSS INFORMATION
PART OF NW 1/4 OF THE NE 1/4
SECTION 04, T8N, R15W
CITY OF WATERTOWN
JEFFERSON COUNTY
WISCONSIN

PARCEL ID: 291-0815-0412-093

## SHEET INDEX



TO OBTAIN LOCATION OF PARTICIPANTS' UNDERGROUND FACILITIES BEFORE YOU DIG IN WISCONSIN, CALL DIGGERS HOTLINE

TOLL FREE: 1-800-242-8511
FAX A LOCATE: 1-800-242-5811

WI STATUTE 182.0175 (1974) REQUIRES MIN. OF 3 WORK DAYS NOTICE BEFORE YOU EXCAVATE

ENGINEER SEAL:

I HEREBY CERTIFY THAT THIS PLAN SET WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION OTHER THAN THE EXCEPTIONS NOTED IN THE SHEET INDEX, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF WISCONSIN.

SIGNATURE: _____

DATE: _____


CONSULTANT:
Edge
Consulting Engineers, Inc.
624 WATER STREET
PRAIRIE DU SAC, WI 53578
608.644.1449 VOICE
608.644.1549 FAX
www.edgeconsult.com

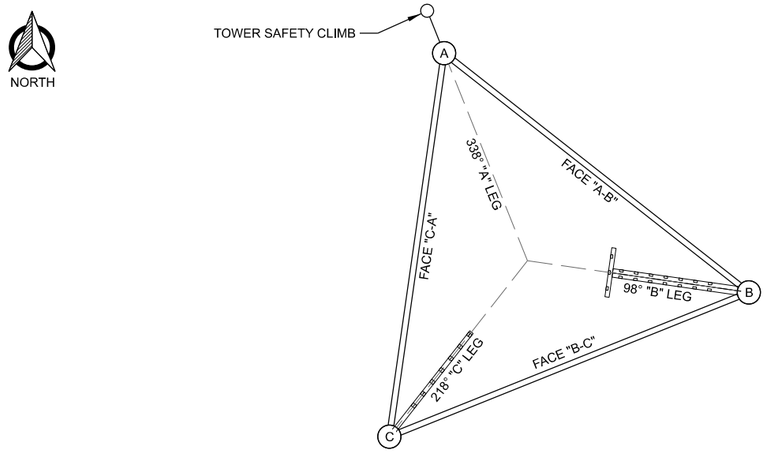

CLIENT:

TITLE SHEET
WATERTOWN (27747)
WATERTOWN, WISCONSIN

SUBMITTAL:

| INT. | DATE: | DESCRIPTION: |
|---|---|---|
| | | |

| | |
|---|---|
| CHECKED BY | AJO |
| PLOT DATE | 9/15/2021 |
| PROJECT NUMBER | 27747 |
| SET TYPE | PR |
| SHEET NUMBER | G-001 |




## A TOWER ORIENTATION

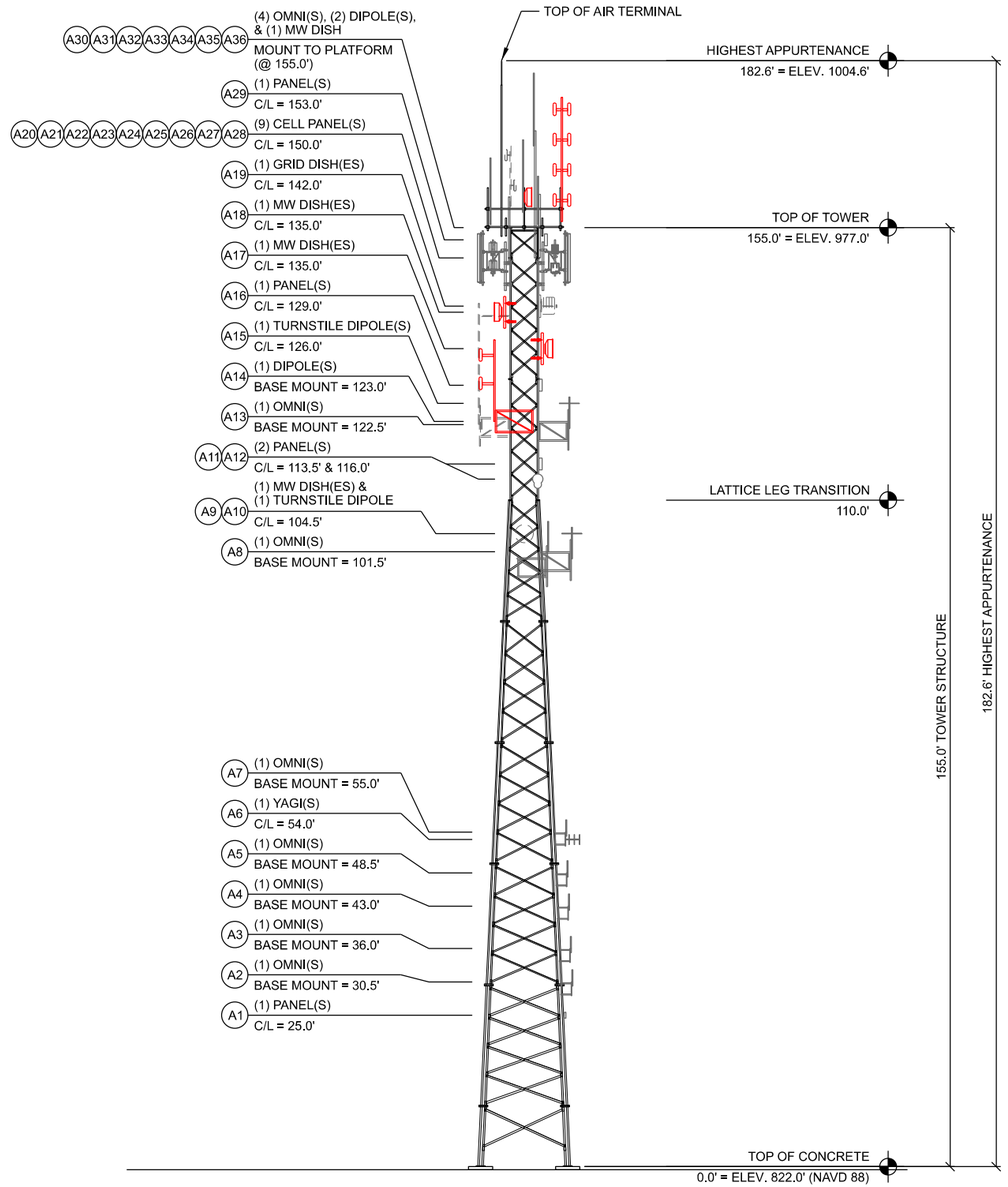
### TOWER LOADING

| ANTENNA ID | ANTENNA TYPE | (QTY.) ANTENNA MODEL SIZE & WCKG/FT | TOWER LEG | ANTENNA MOUNT SIZE & WCKG/FT | MOUNT HEIGHT (T.O.C.) | C/L HEIGHT (T.O.C.) | C/L ELEV. (NAVD 88) | ANTENNA AZIMUTH | TILT (+/-) | TxLINE (QTY.) SIZE | FREQUENCY (MHz) | OWNER USE | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | Panel | (1) Motorola Canopy 2400SM | C | Leg Mounted | 25.0' | 25.0' | 847.0' | | | (1) 10mm | | Fire Department | Existing |
| A2 | Omni | (1) 2' Omni | C | Standoff | 30.5' | 31.5' | 853.5' | | | (1) 1/2" | | Fire Department | Existing |
| A3 | Omni | (1) 2' Omni | C | Standoff | 36.0' | 37.0' | 859.0' | | | (1) 1/2" | | Fire Department | Existing |
| A4 | Omni | (1) 2' Omni | C | Standoff | 43.0' | 44.0' | 866.0' | | | (1) 1/2" | | Fire Department | Existing |
| A5 | Omni | (1) 2' Omni | C | Standoff | 48.5' | 49.5' | 871.5' | | | (1) 1/2" | | Fire Department | Existing |
| A6 | Yagi | (1) 3' Yagi | C | Standoff | 54.0' | 54.0' | 876.0' | | | (1) 1/2" | | Fire Department | Existing |
| A7 | Omni | (1) 2' Omni | C | Standoff | 55.0' | 56.0' | 878.0' | | | (1) 1/2" | | Fire Department | Existing |
| A8 | Omni | (1) 5' Omni | B | Standoff | 101.5' | 104.0' | 926.0' | | | (1) 1/2" | | Fire Department | Existing |
| A9 | MW Dish | (1) 3' Dia. MW Dish | B | Pipe Mount | 104.5' | 104.5' | 926.5' | | | (1) 10mm | | Fire Department | To Be Removed |
| A10 | Turnstile Dipole | (1) UHF Dipole 2' Tall | C | Standoff | 104.5' | 104.5' | 926.5' | | | (1) 1/2" | | Fire Department | Existing |
| A11 | Panel | (1) Ubiquiti airFiber 24 | C | Leg Mounted | 113.5' | 113.5' | 935.5' | | | (1) 10mm | | Fire Department | Existing |
| A12 | Panel | (1) Cambium C050900D021A | C | Leg Mounted | 116.0' | 116.0' | 938.0' | | | (1) 10mm | | Fire Department | Existing |
| A13 | Omni | (1) 20' Omni | A | Standoff w/ tieback | 122.5' | 132.5' | 954.5' | | | (1) 7/8" | | Fire Department | To Be Removed |
| A14 | Dipole | (1) Commscope 872F-70-TM-1/4 13.5' Long, 2' Dipole 24 lbs. | B | Commscope HS-600 Standoff 42" High x 72" Long 107.4 lbs. | 123.0' | 129.8' | 951.8' | | | (1) 7/8" | 138 - 174 | Jefferson Co. | Proposed |
| A15 | Turnstile Dipole | (1) UHF Dipole 2' Tall | C | Standoff w/ tieback | 126.0' | 126.0' | 948.0' | | | (1) 1/2" | | Fire Department | Existing |
| A16 | Panel | (1) 2' Panel | C | Leg Mounted | 129.0' | 129.0' | 951.0' | | | (1) 10mm | | Fire Department | Existing |
| A17 | MW Dish | (1) radiowaves HP3-11R 3' Dia. 50 lbs. | C | Leg Mount (PM-SU4-63) 4" OD x 63" Mast Pipe 138 lbs. | 135.0' | 135.0' | 957.0' | 195.49° | | (1) 3/8" LDF2-50 | | Jefferson Co. To Johnson Creek | Proposed |
| A18 | MW Dish | (1) radiowaves HP3-11R 3' Dia. 50 lbs. | A | Leg Mount (PM-SU4-63) 4" OD x 63" Mast Pipe 138 lbs. | 141.0' | 141.0' | 963.0' | 279.34° | | (1) 3/8" LDF2-50 | 11200 | Jefferson Co. To Portland | Proposed |
| A19 | Grid Dish | (1) 4' Grid Dish | C | Pipe Mounted | 142.0' | 142.0' | 964.0' | | | (1) 10mm | | Fire Department | To Be Removed |
| A20 - A22 | Panel | (3) KMW AM-X-CW-18-65-00T-RET | A, B, C | (3) C10-857-777CDP V-Booms w/ tiebacks | 150.0' | 150.0' | 972.0' | 30 150 270 | | (6) 1-5/8" | | US Cellular | Existing |
| A23 - A28 | Panel | (6) Amphenol TWM658LU000G 8' Tall 98 lbs. / ea. | A, B, C | | 150.0' | 150.0' | 972.0' | 30 150 270 | | (3) 1-1/4" Hybrid | | US Cellular | Existing; (3) RRU 2205 (LAA) (3) RUSDC-6267-PF-48; (3) RRU 4449; (3) RRU 4415; (3) RRU 11 |
| A29 | Panel | (1) 2' Panel | N/A | 13' Low Profile Platform w/ Rail | 153.0' | 153.0' | 975.0' | | | (1) 1-5/8" | | Fire Department | Existing |
| A30 | Omni | (1) 11' Omni | N/A | Same as A29 | 155.5' | 161.0' | 983.0' | | | (1) 1-5/8" | | Fire Department | Existing |
| A31 | Omni | (1) 8' Omni | N/A | Same as A29 | 155.5' | 159.5' | 981.5' | | | (1) 1-1/4" | | Fire Department | Existing |
| A32 | Dipole | (1) Commscope 884-70 20.5' Long, 8 Dipole 78 lbs. | N/A | Same as A29 3.5" OD x 108" Mast Pipe | 156.0' | 166.3' | 988.3' | | | (1) 7/8" | 138 - 174 | Jefferson Co. | Proposed |
| A33 | Dipole | (1) 10' Dipole | N/A | Same as A29 | 158.5' | 163.5' | 985.5' | | | (1) 1-5/8" | | Fire Department | To Be Removed |
| A34 | Omni | (1) 12' Omni | N/A | Same as A29 | 158.5' | 164.5' | 986.5' | | | (1) 1-5/8" | | Fire Department | Existing |
| A35 | MW Dish | (1) radiowaves HP3-11R 3' Dia. 50 lbs. | N/A | Same as A29 4" OD X 108" Mast Pipe - | 160.0' | 160.0' | 982.0' | 119.55° | | (1) 3/8" LDF2-50 | | Jefferson Co. To Ixonia WT | Proposed |
| A36 | Omni | (1) 12' Omni | N/A | Same as A29 | 168.5' | 174.5' | 996.5' | | | (1) 1/2" | | Fire Department | Existing |

NOTES:

1. REFER TO ANTENNA MOUNTING DETAILS FOR ADDITIONAL INFO ON MOUNT DESIGN AND MOUNTING REQUIREMENTS.
2. EXISTING ANTENNA LOADING IS BASED ON USCC CONSTRUCTION DRAWINGS DATED 10/12/2020.
3. PROPOSED ANTENNA LOADING IS BASED ON DESIGN SUPPLIED BY GENERAL COMMUNICATIONS INC. DATED 08/31/2021.

## B TOWER LOADING SUMMARY




NOTES:

1. ALL DIMENSIONS SHOWN ARE REFERENCED FROM THE TOP OF TOWER FOUNDATION CONCRETE.
2. ALL ANTENNAS, DISHES, MOUNTS, ICE SHIELDS AND LINES SHALL BE SUPPLIED AND INSTALLED BY OTHERS (?????????).
3. TOWER MANUFACTURER: PIROD INC. MODEL #: U - 16.0 X 155' FILE#: A-116976 DATE: 04/2000

## C TOWER PROFILE (ELEVATION)

CONSULTANT:
Edge
Consulting Engineers, Inc.
624 WATER STREET
PRAIRIE DU SAC, WI 53578
608.644.1449 VOICE
608.644.1549 FAX
www.edgeconsult.com

CLIENT:
JEFFERSON COUNTY WI ESTABLISHED 1836

# TOWER LOADING / ELEVATION
## WATERTOWN (27747)
## WATERTOWN, WISCONSIN

SUBMITTAL:

| INT. | DATE: | DESCRIPTION: |
|---|---|---|
| | | |

| | |
|---|---|
| CHECKED BY | AJO |
| PLOT DATE | 9/15/2021 |
| PROJECT NUMBER | 27747 |
| SET TYPE | PR |
| SHEET NUMBER | T-201 |

NORTH

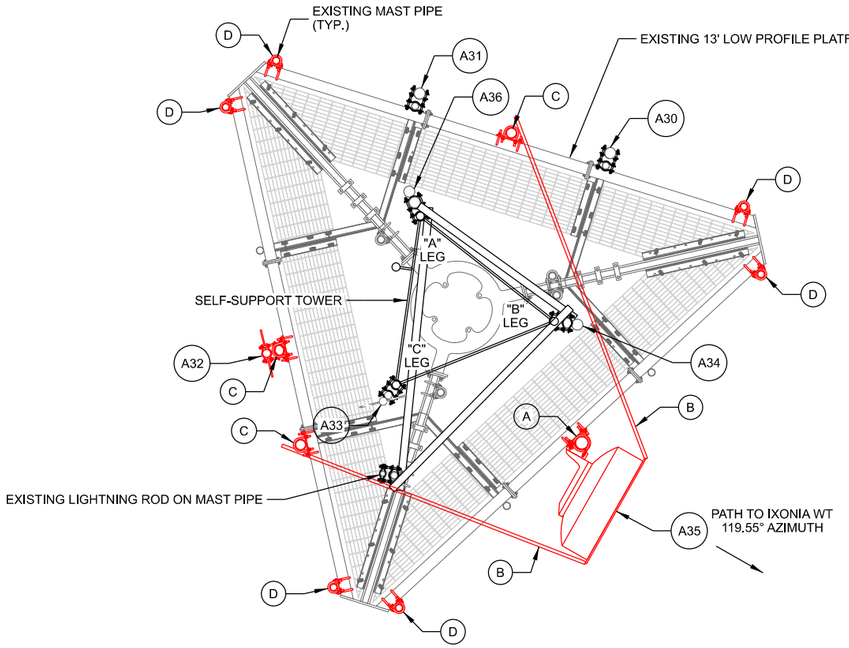
## KEYNOTES: (THIS SHEET)

A. 4" OD x 9' LONG GALV. DISH MOUNT MAST PIPE, (1) REQUIRED & (2) CROSSOVER PLATE KITS (SITE PRO 1 SCX SERIES, OR EQUIVALENT). CONNECT MAST PIPE TO PLATFORM AND HANDRAIL WITH CROSSOVER PLATES.

B. MICROWAVE SIDE STRUT SUPPORT, (2) REQUIRED. RADIOWAVES MODEL SST-4/6-10

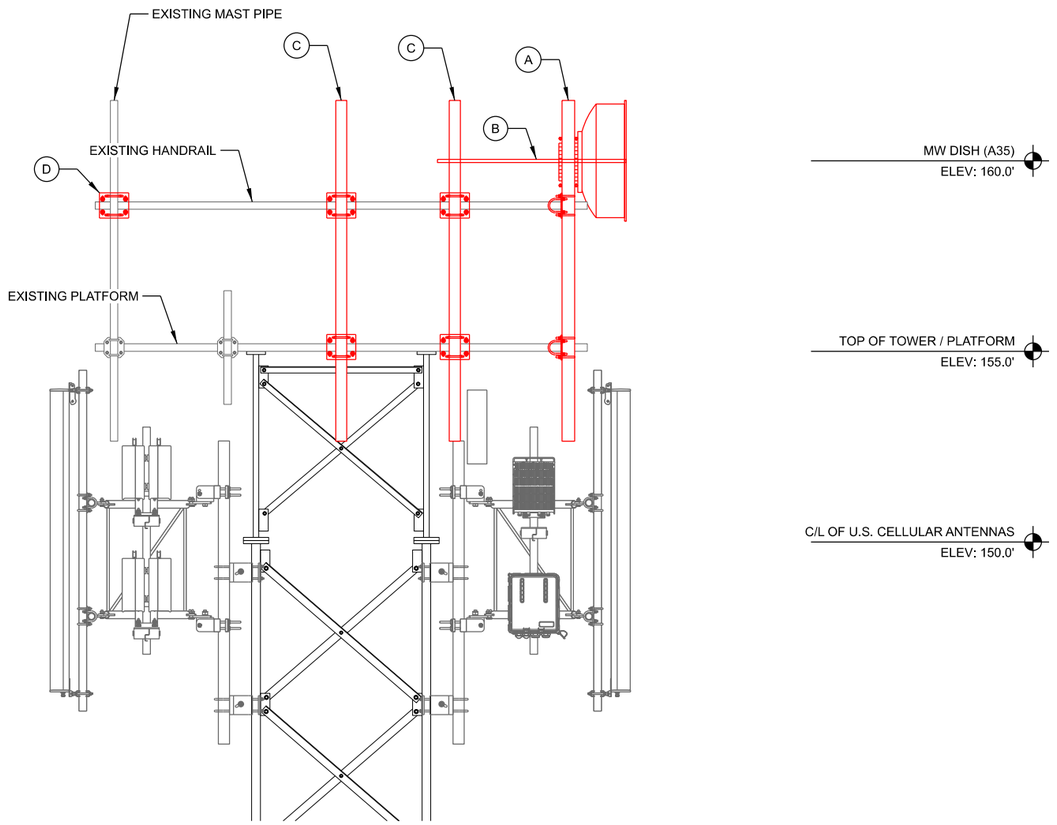
C. 3.5" OD x 9' LONG GALV. MAST PIPE, (3) REQUIRED & (2) CROSSOVER PLATE KITS (SITE PRO 1 SCX SERIES, OR EQUIVALENT.) CONNECT MAST PIPE TO PLATFORM AND HANDRAIL WITH CROSSOVER PLATES.

D. REPLACE EXISTING HANDRAIL TO MAST PIPE CONNECTION WITH CROSSOVER PLATE KIT (SITE PRO 1 SCX SERIES, OR EQUIVALENT), (6) KITS REQUIRED.




**A** **PLATFORM ANTENNA LAYOUT - PLAN VIEW**

SCALE: 11" x 17" - 1/4" = 1'-0"
22" x 34" - 1/2" = 1'-0"




**B** **PLATFORM ANTENNA LAYOUT - ELEVATION VIEW**

SCALE: 11" x 17" - 1/4" = 1'-0"
22" x 34" - 1/2" = 1'-0"


CONSULTANT:
Edge
Consulting Engineers, Inc.
624 WATER STREET
PRAIRIE DU SAC, WI 53578
608.644.1449 VOICE
608.644.1549 FAX
www.edgeconsult.com


CLIENT:

# ANTENNA MOUNTING DETAILS
WATERTOWN (27747)
WATERTOWN, WISCONSIN

SUBMITTAL:

| INT. | DATE: | DESCRIPTION: |
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| CHECKED BY | AJO |
| PLOT DATE | 9/15/2021 |
| PROJECT NUMBER | 27747 |
| SET TYPE | PR |
| SHEET NUMBER | T-501 |

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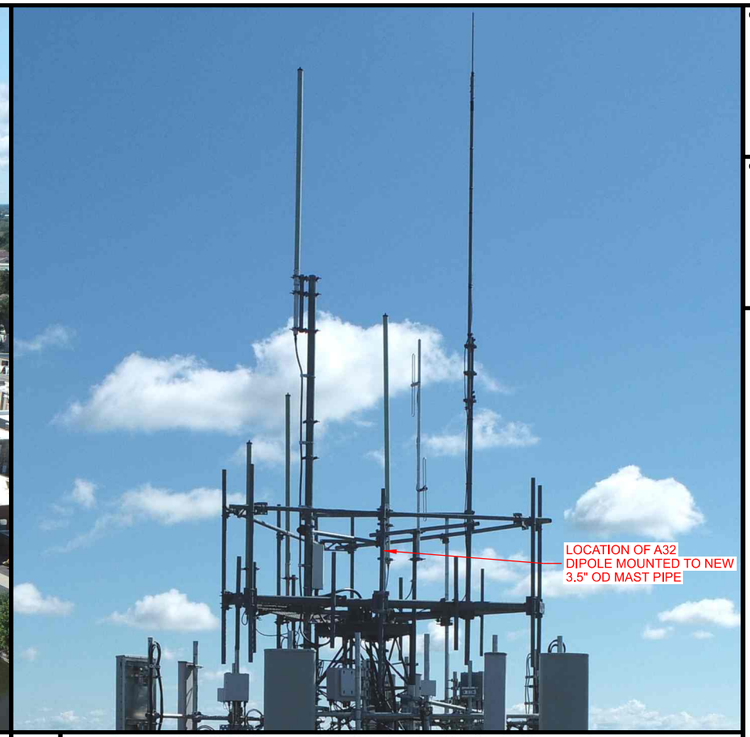
**A** EXISTING PLATFORM - FACE B-C

**B** EXISTING PLATFORM - FACE A-B




**C** EXISTING PLATFORM - FACE C-A

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CONSULTANT:
Edge
Consulting Engineers, Inc.
624 WATER STREET
PRAIRIE DU SAC, WI 53578
608.644.1449 VOICE
608.644.1549 FAX
www.edgeconsult.com

CLIENT:
JEFFERSON COUNTY WI
ESTABLISHED 1836

# SITE PHOTOS
WATERTOWN (27747)
WATERTOWN, WISCONSIN

| SUBMITTAL: | | |
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| CHECKED BY | AJO |
| PLOT DATE | 9/15/2021 |
| PROJECT NUMBER | 27747 |
| SET TYPE | PR |
| SHEET NUMBER | T-901 |

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PREPARED FOR:

U.S. Cellular

# STRUCTURAL ANALYSIS REPORT

155 FT SELF-SUPPORT TOWER
MODERNIZATION INSTALLATION
WATERTOWN DOWNTOWN (786369)
WATERTOWN, WISCONSIN

EDGE PROJECT NUMBER:
21726

OCTOBER 18, 2019

Edge
Consulting Engineers, Inc.

624 Water Street
Prairie du Sac, Wisconsin 53578
608.644.1449 Phone
608.644.1549 Fax
www.edgeconsult.com

Reliable
Comprehensive
Exceeding Expectations

# STRUCTURAL ANALYSIS REPORT

| | |
|---|---|
| **Site Location:** | Watertown Downtown<br>100 Jones St<br>Watertown, WI 53094 |
| **Tower ASR#:** | 1220585 |
| **Client:** | U.S. Cellular<br>8410 W. Bryn Mawr Ave., Suite 700<br>Chicago, IL 60631<br>Contact: Brian Buth |
| **Tower Owner:** | City of Watertown<br>P.O. Box 477<br>Watertown, WI 53094 |
| **Client Project Number:** | 786369 |
| **Consultant:** | Edge Consulting Engineers<br>624 Water Street<br>Prairie du Sac, WI 53578<br>Contact: Paul C. Molitor<br>Phone: (608) 644-1449<br><br>Midwest Engineering & Manufacturing Inc.<br>3206 West 11th Street<br>Yankton, SD 57078<br>Contact: William B. Wysuph, P.E.<br>Phone: (605) 661-8892 |
| **Edge Project Number:** | 21726 |
| **MEM Project Number:** | 1797-019 |
| **Date:** | October 20, 2019 |


William B. Wysuph, P.E.
Professional Engineer

10/20/19
Date

# TABLE OF CONTENTS



## FIGURES



## APPENDICES

# SECTION 1
# EXECUTIVE SUMMARY

**Site Name:** **Watertown Downtown**
**Site Location:** **Watertown, Wisconsin**
**Purpose:** **Modernization Installation**
**Tower Type:** **155 ft. Self-Support Tower**

Per your request, we have completed a structural analysis for the above described tower. One loading scenario was considered in the analysis. The loading condition takes into account the existing tower loading along with the proposed loading. The loading condition is described in Section 3.2, with reference to the feedline placement diagram (Figure 1).

Our analysis was completed per TIA-222-G. Under TIA-222-G requirements, the performed investigation is considered a rigorous analysis.

The results of our analysis indicate that the existing tower **is structurally adequate** to support the proposed change in loading. Refer to Section 3.5 for additional information regarding assumptions for this analysis.

Please refer to the report which follows this summary for further information. Feel free to contact us if you have any questions or concerns.

# SECTION 2
# INTRODUCTION

## 2.1 PURPOSE OF REPORT

Edge performed a structural analysis for the existing tower to determine whether the tower is structurally adequate to support both the existing and proposed loads pursuant to the Structural Standard for Antenna Supporting Structures and Antennas, ANSI/TIA-222-G. This assessment was completed using background information provided by the client and/or obtained in the field (where noted) and in conformance with current applicable codes, client directed protocols, and the judgment of the structural engineer.

## 2.2 SCOPE OF SERVICES

The scope of services for this project included a structural analysis and modeling of the tower structure and foundation systems in accordance with client supplied information. This type of analysis, under the TIA-222-G standard, is considered to be a “rigorous” analysis of the tower.

This report summarizes the structural analysis results.

# SECTION 3
# ANALYSIS

## 3.1 BACKGROUND INFORMATION

The subject tower is an existing PiRod 155 foot tall, U-16 self-support tower which was originally designed in April of 2000. It is our understanding that the tower geometry has not been altered from the original design. We were provided the following information at the project outset:

1. Tower & foundation drawings: PiRod Eng. File: A-116976 dated 4/27/2000
2. Structural analysis: Edge Eng. File: 10871 dated 8/11/2014
3. Tower inventory report: Edge Eng. File: 21726 dated 9/23/2019
4. Proposed antenna and feedline loading configuration
5. Geotechnical parameters per the PiRod foundation design, taken from the soils report by Ramaker: Eng. File: 4641 dated 2/9/2000

The tower was originally designed under TIA/EIA-222-D with an 80 mph basic wind speed and 1/2" of radial ice.

## 3.2 LOADING CONDITION

The listed heights for panel antennas and microwave dishes are representative of the antenna centerline. For omni and dipole antennas the listed heights represent the base of the antenna.

The following loading condition was considered during this analysis:

| Ant. Height | # | Manufacturer & Model # | Mounting Type | Technology / Notes | Coax (#) Size | Owner | Status |
|---|---|---|---|---|---|---|---|
| 168.5' | 1 | 12 ft. Omni | 13' Platform w/ Rail | Omni | (1) 1/2" | Fire Department | Existing |
| 158.5' | 1 | 12 ft. Omni | 13' Platform w/ Rail | Omni | (1) 1-5/8" | Fire Department | Existing |
| 158.5' | 1 | 10 ft. Dipole | 13' Platform w/ Rail | Dipole | (1) 1-5/8" | Fire Department | Existing |
| 156.5' | 3 | Kathrein 800 10766 | 13' Platform w/ Rail | LTE | (6) 1-5/8 **(Remove Coax)** | U.S. Cellular | Existing **(Remove Antennas)** |
| 156.5' | 3 | KMW KASCTPR82008 | 13' Platform w/ Rail | Bias-T | - | U.S. Cellular | Existing **(Remove Bias-Ts)** |
| 156.5' | 1 | Raycap RUSDC-6267-PF-48 | 13' Platform w/ Rail | SPD | (1) Hybrid **(Remove Coax)** | U.S. Cellular | Existing **(Remove SPD)** |
| 156.5' | 3 | Ericsson RRU-11 | 13' Platform w/ Rail | RRU | - | U.S. Cellular | Existing **(Remove RRUs)** |
| 155.5' | 1 | 8 ft. Omni | 13' Platform w/ Rail | Omni | (1) 1-1/4" | Fire Department | Existing |
| 155' | 1 | 12 ft. Omni | 13' Platform w/ Rail | Omni | (1) 1-5/8" | Fire Department | Existing |
| 153' | 1 | 2 ft Panel Antenna | 13' Platform w/ Rail | Panel | (1) 1-5/8" | Fire Department | Existing |
| **150'** | **6** | **Amphenol TWIN658LU000G** | **12' Sabre EHD V-Boom** | **LTE** | **-** | **U.S. Cellular** | **Proposed** |
| 150' | 3 | KMW AM-X-CW-18-65-00T-RET | 12' Sabre EHD V-Boom | CDMA | (6) 1-5/8" | U.S. Cellular | Existing |
| **150'** | **3** | **Ericsson RRU-2205** | **12' Sabre EHD V-Boom** | **LAA** | **-** | **U.S. Cellular** | **Proposed** |
| **150'** | **3** | **Raycap RUSDC-6267-PF-48** | **12' Sabre EHD V-Boom** | **SPD** | **(2) Hybrid (1) Power** | **U.S. Cellular** | **Proposed** |
| **150'** | **3** | **Ericsson RRU-4449** | **12' Sabre EHD V-Boom** | **RRU** | **-** | **U.S. Cellular** | **Proposed** |
| **150'** | **3** | **Ericsson RRUS-4415** | **12' Sabre EHD V-Boom** | **RRU** | **-** | **U.S. Cellular** | **Proposed** |
| **150'** | **3** | **Ericsson RRU-11** | **12' Sabre EHD V-Boom** | **RRU** | **-** | **U.S. Cellular** | **Proposed** |
| 142' | 1 | 4ft. Grid dish | Pipe Mount | Dish | (1) 10mm | Fire Department | Existing |
| 134' | 1 | Andrew PAR6-59W-PXA | Pipe Mount | Dish | (1) EW63 **(Remove Coax)** | U.S. Cellular | Existing **(Remove Dish)** |
| 129' | 1 | 2 ft Panel Antenna | Leg Mounted | Panel | (1) 10mm | Fire Department | Existing |
| 126' | 1 | UHF Dipole Antenna | Standoff | Dipole | (1) 1/2" | Fire Department | Existing |
| 120.5' | 1 | 20 ft. Omni | Standoff | Omni | (1) 7/8" | Fire Department | Existing |
| 116' | 1 | Cambium C050900D021A | Leg Mounted | Panel | (1) 10mm | Fire Department | Existing |
| 113.5' | 1 | Ubiquiti airFiber 24 | Leg Mounted | Panel | (1) 10mm | Fire Department | Existing |
| 104.5' | 1 | UHF Dipole Antenna | Standoff | Dipole | (1) 1/2" | Fire Department | Existing |
| 104.5' | 1 | 4ft. dish | Pipe Mount | Dish | (1) 10mm | Fire Department | Existing |
| 101.5' | 1 | 5 ft. Omni | Standoff | Omni | (1) 1/2" | Fire Department | Existing |
| 56' | 1 | 2 ft. Omni | Standoff | Omni | (1) 1/2" | Fire Department | Existing |
| 54' | 1 | 3 ft. Yagi | Standoff | Yagi | (1) 1/2" | Fire Department | Existing |
| 49.5' | 1 | 2 ft. Omni | Standoff | Omni | (1) 1/2" | Fire Department | Existing |
| 44' | 1 | 2 ft. Omni | Standoff | Omni | (1) 1/2" | Fire Department | Existing |
| 37' | 1 | 2 ft. Omni | Standoff | Omni | (1) 1/2" | Fire Department | Existing |
| 31.5' | 1 | 2 ft. Omni | Standoff | Omni | (1) 1/2" | Fire Department | Existing |
| 25' | 1 | Motorola Canopy 2400SM | Leg Mounted | Panel | (1) 10mm | Fire Department | Existing |

If the proposed loading condition is altered from that analyzed, this report shall be deemed obsolete and further analysis will be required.

The feedline placement associated with the proposed loading condition which was considered in this analysis is attached as Figure 1. The loading condition is further described in the Designed Appurtenance Loading table provided in Appendix B.

## 3.3 ANALYSIS CRITERIA

This analysis was performed in accordance with TIA-222-G per the current Wisconsin Commercial Building Code (IBC 2015). The basic wind speed for Jefferson County, Wisconsin is 90 mph with no ice, 40 mph with 0.75 inches of ice, and a 60 mph service wind speed for deflection calculations.

This analysis utilized the following Tower Structure Class, Topographic Category and Exposure Criteria:

Tower Structure Class: III
Topographic Category: 1
Exposure Criteria: C

These criteria were selected based on the location and use of the subject tower (per TIA-222-G). For this analysis, Structure Class III was selected since the tower is primarily utilized for essential communication (Public Safety/E911) purposes. The client and/or tower owner **must** review these criteria for applicability and notify Edge Consulting if a different tower structure class, topographic category, or exposure criteria are warranted.

Definitions of the different categories and criteria were taken from the TIA-222-G standard and are provided in Appendix A.

## 3.4 ANALYSIS METHOD

Structural analysis computations and modeling of the tower structure were performed using TNX Tower Version 8.0 software. TNX Tower is a general-purpose modeling, analysis, and design program created specifically for communications towers using the TIA-222-G (including Addenda No. 1 and 2) or any previous TIA/EIA Standards back to RS-222 (1959). Steel design is checked using the AISC ASD 9$^{th}$ Edition or the AISC LRFD Specifications. This program automatically generates nodes and elements for a subsequent finite element analysis (FEA) for standard tower types including self-support towers, guyed towers and monopoles. It allows entry of dishes, feedlines, discrete loads (loads from appurtenances) and user defined loads anywhere on the tower. TNX Tower uses wind effects from multiple directions and ice loads to develop pressure coefficients, wind pressures, ice loads and resulting forces on the tower per TIA code requirements.

The tower foundation system was also reviewed for the resulting applied forces due to the proposed change in loading. Items reviewed include checking the global overturning and shear of the foundation system. In addition, the anchor bolts and guy anchors (where applicable) were also reviewed for structural adequacy.

## 3.5 ASSUMPTIONS

For the purpose of this analysis, it has been assumed that the tower and foundation have been properly installed and maintained per the manufacturer's specifications and recommendations. Further limitations and restrictions have been provided in Section 5.

# SECTION 4
# RESULTS

## 4.1 TOWER STRUCTURE

The analysis results of the existing tower structure when considering the proposed loading condition indicate the tower structure **is structurally adequate**. Refer to Section 3.5 for additional information regarding assumptions for this analysis.

The results of the analysis are shown in the following table. The ratio listed for each tower element represents the capacity ratio calculated for the controlling member(s) for each element type.

| **Capacity - Results** | | |
|---|---|---|
| **Tower Structure Elements** | **Capacity Ratio (%)** | **Comment** |
| **Legs** | | |
| **100'-110'** | **89.2%** | **Adequate** |
| Diagonals | | |
| 130'-145' | 64.0% | Adequate |
| Horizontals | | |
| 110'-130' | 38.1% | Adequate |
| Girts | | |
| 152.5'-155' | 46.2% | Adequate |
| Bolts | | |
| 100'-110' (Diagonal Block Shear) | 75.2% | Adequate |

Diagrams of the tower's maximum deflection, tilt, and twist are provided in Appendix B.

## 4.2 TOWER FOUNDATIONS

The analysis results of the existing tower foundation when considering the proposed loading condition indicates the tower foundation system **is structurally adequate**. Refer to Section 3.5 for additional information regarding assumptions for this analysis.

The existing combined footing was evaluated for both overturning and bearing as per the soil properties indicated in the geotechnical report. It was determined that the proposed foundation reactions are less than the allowable. Therefore, the combined footing **is considered structurally adequate**.

The existing anchor bolts were evaluated for shear, tension, and concrete pullout as per the available information indicated in the foundation design documents. It was determined that the proposed anchor bolt forces are less than the allowable design parameters. Therefore, the anchor bolts **are considered structurally adequate**.

Refer to Appendix B for support calculations.

The reactions from the original tower design were compared against those calculated for the loading condition. The ratios of proposed to original reactions were computed and are shown in the following table.

| Tower Foundation Capacity Results | | | | |
|---|---|---|---|---|
| **Condition** | **Shear (Kips)** | **Moment (K-Ft)** | **Compression (Kips/Leg)** | **Uplift (Kips/Leg)** |
| Original | 49.0 | 4211.7 | 323.6 | 284.3 |
| Proposed | 36.0 | 3440.0 | 261.9 | 231.8 |
| Capacity Ratio | 73.4% | 81.7% | 80.9% | 81.5% |

The original design reactions have been multiplied by 1.35 per TIA-222-G. The percentages provided are only for reference. The results of the rigorous structural analysis are based on the provided calculation.

## 4.3 RECOMMENDATIONS

The client and tower owner shall closely review this report including assumptions made, analysis criteria selected and loading conditions modeled. Any questions or discrepancies with these items shall be clarified with the engineer.

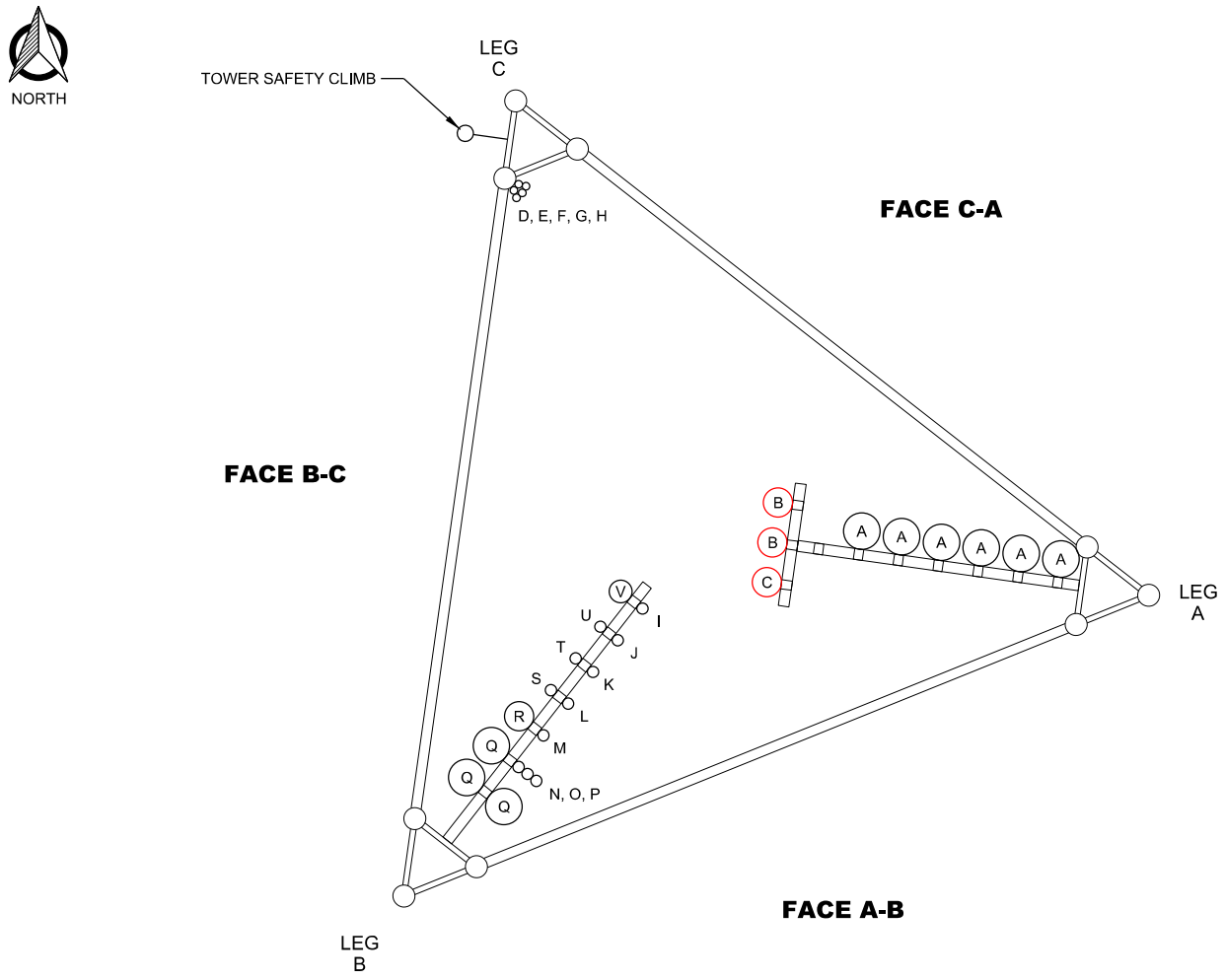
Edge recommends that qualified personnel assess the physical condition of the tower, in accordance with the guidelines and frequency provided in the TIA-222-G standard.

# SECTION 5
# LIMITATIONS AND RESTRICTIONS

1. This report was prepared in accordance with generally accepted structural engineering practices common to the tower industry and makes no other warranties, either expressed or implied, as to the professional advice provided under the terms of the agreement between Engineer and Client. This report has not been prepared for uses or parties other than those specifically named, or for uses or applications other than those enumerated herein. The report may contain insufficient or inaccurate information for other purposes, applications, and/or other uses.
2. This report is intended for the use of the client, and cannot be utilized or relied upon by other parties without the written consent of Edge Consulting Engineers.
3. Edge Consulting Engineers is not responsible for any, and all, tower modifications completed prior to, or hereafter, which Edge Consulting Engineers was not, or will not, be directly involved.
4. The model, conclusions, and recommendations contained within this report are based upon the supplied and attained information as described within the report and supplemented with historical information available to Edge Consulting Engineers. If it is known, or becomes known, that any item(s) are in conflict with what is described within this document, this report should be considered void and Edge Consulting Engineers should be contacted immediately.
5. Edge Consulting Engineers disclaims all liability for any information, conclusion, or recommendation that is not expressly stated or represented within this report.
6. Edge Consulting Engineers shall not be liable for any incidental, consequential, indirect, special or punitive damages arising out of any claim associated with the use of this report.
7. The scope of worked performed for this analysis is limited to the items in which we were furnished complete and accurate information.
8. Accessories and appurtenances such as antenna mounts, feed line ladders, climbing ladders, lighting mounts, etc. were not analyzed as part of this work, and Edge Consulting Engineers, Inc. makes no claim as to their adequacy of their design or their installation.
9. This analysis was performed under the assumption that all tower elements are in like new condition, free from rust and other deterioration. It is also assumed the tower was properly installed per construction documents, and that the tower and all associated appurtenances were originally designed and fabricated in accordance with all applicable codes and standards. Edge Consulting Engineers cannot account for, nor be held responsible, if tower elements are deteriorated, damaged, and/or missing.
10. This tower analysis was performed based upon the antenna, feed line and other appurtenance loading and placement as described within this report. Any alterations to the described loading or placement will require re-analysis of the tower, and the findings contained in this report are not valid.
11. The loading conditions utilized for this analysis is based on information provided by the client, and readily available manufacturer/vendor information (antenna and mount projected areas, weight and shape factors). However, if the described loading criteria and design assumptions within this report are not accurate, are altered, or changed in any form, this analysis shall be considered void and an additional analysis must be performed.
12. It is the responsibility of the client and the tower owner to thoroughly review the existing and proposed loading, and bring any discrepancy to the attention of Edge Consulting Engineers.
13. Modification designs are to be based upon a rigorous analysis per the TIA-222-G standard. As such designs assume any suggested modifications are installed as recommended and are not intended to address temporary conditions on the tower as modifications are being performed. It is strongly recommended that the Installer of any tower modification thoroughly assess installation procedures and how temporary conditions present while modifications are being performed influence tower members. Installer is responsible for sequence of operation and any required temporary bracing or strengthening of tower during modification operations.
14. Site-specific loading or local building code requirements may be more stringent than the minimum loading requirements specified in the Standard. These and other unique loads or loading combination requirements are to be specified by the owner (in the procurement specifications).
15. Supplementary rime ice and in-cloud ice loadings (including thickness, density, escalation with height and corresponding wind speed) are to be included in the procurement specification when appropriate for a given site location.
16. The service loads and deformation limits specified in the Standard are the minimum requirements for communication structures. When more stringent requirements are required for a specific application, the serviceability limit state basic wind speed and, if required, the serviceability limit state design ice thickness; the deformation limitations (twist, sway and horizontal displacement) and the location/elevation where the deformation limitations apply are to be included in the procurement specification.

# Figure 1

## Feedline Placement Diagram




| COAX SYMBOL | (#) SIZE | MOUNTING TYPE | CARRIER / OWNER | TERMINATION HEIGHT | STATUS |
|---|---|---|---|---|---|
| A | (6) 1-5/8" | SNAP-INS | U.S. CELLULAR | 150' | EXISTING |
| **B** | **(2) HYBRID** | **SNAP-INS** | **U.S. CELLULAR** | **150'** | **PROPOSED** |
| **C** | **(1) POWER** | **SNAP-INS** | **U.S. CELLULAR** | **150'** | **PROPOSED** |
| D | (1) 10mm | TAPED | FIRE DEPT. | 25' | EXISTING |
| E | (1) 10mm | TAPED | FIRE DEPT. | 116' | EXISTING |
| F | (1) 10mm | TAPED | FIRE DEPT. | 125' | EXISTING |
| G | (1) 10mm | TAPED | FIRE DEPT. | 113.5' | EXISTING |
| H | (1) 10mm | TAPED | FIRE DEPT. | 104.5' | EXISTING |
| I | (1) 1/2" | SNAP-INS | FIRE DEPT. | 126' | EXISTING |
| J | (1) 1/2" | SNAP-INS | FIRE DEPT. | 104.5' | EXISTING |
| K | (1) 3/8" | SNAP-INS | FIRE DEPT. | 50.5' | EXISTING |
| L | (1) 1/2" | SNAP-INS | FIRE DEPT. | 49.5' | EXISTING |
| M | (1) 1/2" | SNAP-INS | FIRE DEPT. | 44' | EXISTING |
| N | (1) 1/2" | SNAP-INS | FIRE DEPT. | 31.5' | EXISTING |
| O | (1) 1/2" | SNAP-INS | FIRE DEPT. | 54' | EXISTING |
| P | (1) 1/2" | SNAP-INS | FIRE DEPT. | 37' | EXISTING |
| Q | (3) 1-5/8" | SNAP-INS | FIRE DEPT. | 155' | EXISTING |
| R | (1) 1-1/4" | SNAP-INS | FIRE DEPT. | 155' | EXISTING |
| S | (1) 1/2" | SNAP-INS | FIRE DEPT. | 56' | EXISTING |
| T | (1) 1/2" | SNAP-INS | FIRE DEPT. | 101.5' | EXISTING |
| U | (1) 1/2" | SNAP-INS | FIRE DEPT. | 155' | EXISTING |
| V | (1) 7/8" | SNAP-INS | FIRE DEPT. | 132.5' | EXISTING |

# Appendix A

## TIA-222-G Analysis Criteria Definitions

**Feasibility Structural Analysis**

A feasibility structural analysis is used as a preliminary review to identify the impact of proposed changed conditions. This type of analysis determines the overall stability and the adequacy of the main structural members to support a proposed changed condition. A feasibility structural analysis does not include the evaluation of connections and may consider that the structure has been properly installed and maintained.

The reactions from a feasibility structural analysis may be compared to the original design reactions to identify the impact on foundations due to proposed changed conditions. When the original design reactions are based upon an Allowable Stress Design procedure, the original reactions shall be multiplied by a 1.35 factor for comparison to the reactions determined in accordance with this Standard.

**Rigorous Structural Analysis**

A rigorous structural analysis is used to determine the final acceptance of proposed changed conditions and/or required modifications. This type of analysis determines the overall stability and the adequacy of structural members, foundations and connection details. A rigorous structural analysis may consider that the structure has been properly installed and maintained.

For a rigorous analysis of a foundation, site specific geotechnical and foundation data are required.

Note: Certain foundation details and connection details (such as inside weld sizes of flanged leg connections) cannot be determined without dismantling the structure or extensive field nondestructive testing. The assumptions regarding these types of details shall be documented along with the results of the rigorous structural analysis.

**Tower Structure Class**:

Class I

Structures that due to height, use or location represent a low hazard to human life and damage to property in the event of failure and/or used for services that are optional and/or where a delay in returning the services would be acceptable.

Class II

Structures that due to height, use or location represent a substantial hazard to human life and/or damage to property in the event of failure and/or used for services that may be provided by other means.

Class III

Structures that due to height, use or location represent a high hazard to human life and/or damage to property in the event of failure and/or used primarily for essential communications.

**Topographic Categories:**

Category 1

No abrupt changes in general topography, e.g. flat or rolling terrain, no wind speed-up consideration shall be required.

Category 2

Structures located at or near the crest of an escarpment. Wind speed-up shall be considered to occur in all directions. Structures located vertically on the lower half of an escarpment or horizontally beyond 8 times the height of the escarpment from its crest, shall be permitted to be considered as Category 1.

Category 3

Structures located in the upper half of a hill. Wind speed-up shall be considered to occur in all directions. Structures located vertically on the lower half of a hill shall be permitted to be considered Category 1.

Category 4

Structures located in the upper half of a ridge. Wind speed-up shall be considered to occur in all directions. Structures located vertically on the lower half of a ridge shall be permitted to be considered as Category 1.

**Exposure Criteria:**

Exposure B

Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. Use of this exposure shall be limited to those areas for which terrain representative of Exposure B surrounds the structure in all directions for a distance of at least 2,600 ft. or twenty times the height of the structure, whichever is greater.

Exposure C

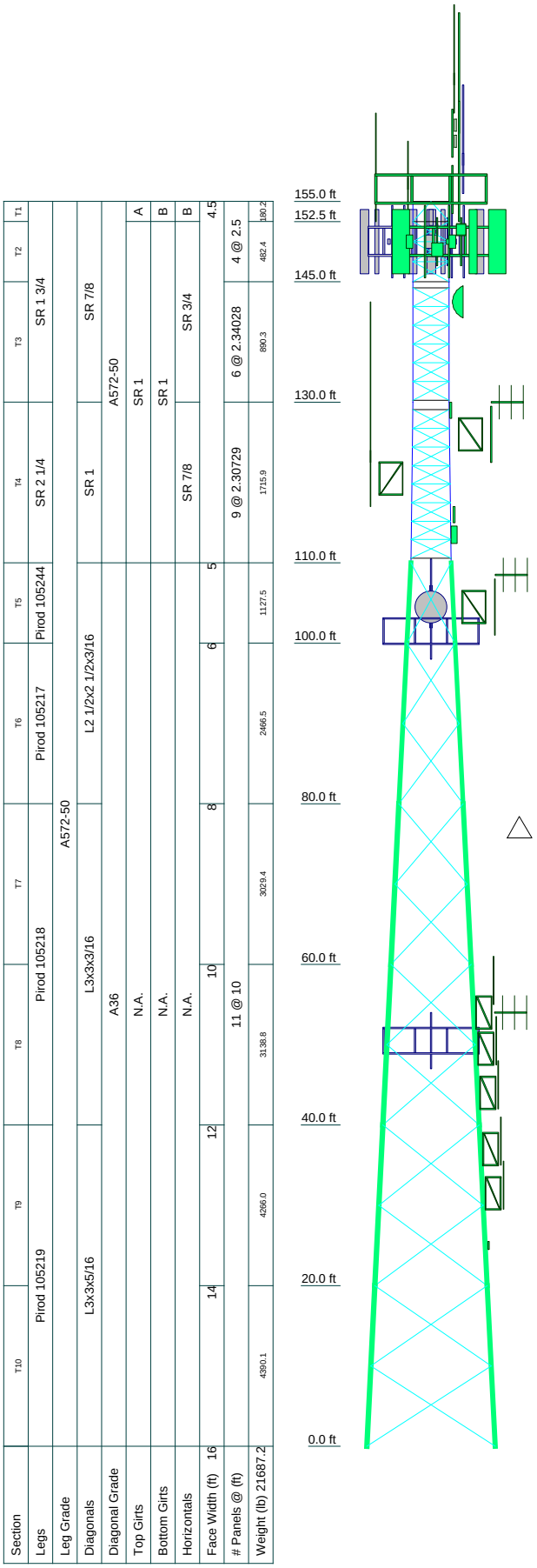
Open terrain with scattered obstructions having heights generally less than 30 ft. This category includes flat, open country, grasslands and shorelines in hurricane prone regions.

Exposure D

Flat, unobstructed shorelines exposed to wind flowing over open water (excluding shorelines in hurricane prone regions) for a distance of at least 1 mile. Shorelines in Exposure D include inland waterways, lakes and non-hurricane coastal areas. Exposure D extends inland a distance of 660 ft. or twenty times the height of the structure, whichever is greater. Smooth mud flats, salt flats and other similar terrain shall be considered as Exposure D.

# Appendix B

## Structural Calculations




## DESIGNED APPURTENANCE LOADING

| TYPE | ELEVATION |
|---|---|
| 5'x2" Antenna Mount Pipe (Fire Department) | 168.5 |
| 12 ft. Omnis (Fire Department) | 168.5 |
| 5'x2" Antenna Mount Pipe (Fire Department) | 158.5 |
| 12 ft. Omnis (Fire Department) | 158.5 |
| 6'x2 1/2" Pipe Mount (Fire Department) | 158.5 |
| 10 ft. Dipole (Fire Department) | 158.5 |
| PiROD 13' Rotatable Platform w/handrails (Lattice) (U.S. Cellular) | 156.5 |
| 5'x2" Antenna Mount Pipe (Fire Department) | 155.5 |
| 8 ft. Omnis (Fire Department) | 155.5 |
| 15'x2 1/2" Pipe Mount (Tower) | 155 |
| 5'x2" Antenna Mount Pipe (Fire Department) | 155 |
| 12 ft. Omnis (Fire Department) | 155 |
| Lightning Rod 5/8x4' (Tower) | 155 |
| 15'x2 1/2" Pipe Mount (Tower) | 155 |
| 2 ft Panel Antenna (Fire Department) | 153 |
| Sabre C10857111 (12' HD V-Frame, No Pipes) (U.S. Cellular) | 150 |
| Sabre C10857111 (12' HD V-Frame, No Pipes) (U.S. Cellular) | 150 |
| Sabre C10857111 (12' HD V-Frame, No Pipes) (U.S. Cellular) | 150 |
| TWIN658LU000G w/ Mount Pipe (U.S. Cellular) | 150 |
| TWIN658LU000G w/ Mount Pipe (U.S. Cellular) | 150 |
| TWIN658LU000G w/ Mount Pipe (U.S. Cellular) | 150 |
| AM-X-CW-18-65-00T-RET w/ Mount Pipe (U.S. Cellular) | 150 |
| AM-X-CW-18-65-00T-RET w/ Mount Pipe (U.S. Cellular) | 150 |
| AM-X-CW-18-65-00T-RET w/ Mount Pipe (U.S. Cellular) | 150 |
| 9' x 2.5" STD Mount Pipe (U.S. Cellular) | 150 |
| 9' x 2.5" STD Mount Pipe (U.S. Cellular) | 150 |
| 9' x 2.5" STD Mount Pipe (U.S. Cellular) | 150 |
| Ericsson RRU-2205 (U.S. Cellular) | 150 |
| Ericsson RRU-2205 (U.S. Cellular) | 150 |
| Ericsson RRU-2205 (U.S. Cellular) | 150 |
| 9' x 2.5" STD Mount Pipe (U.S. Cellular) | 150 |
| 9' x 2.5" STD Mount Pipe (U.S. Cellular) | 150 |
| 9' x 2.5" STD Mount Pipe (U.S. Cellular) | 150 |
| TWIN658LU000G w/ Mount Pipe (U.S. Cellular) | 150 |
| TWIN658LU000G w/ Mount Pipe (U.S. Cellular) | 150 |
| TWIN658LU000G w/ Mount Pipe (U.S. Cellular) | 150 |
| Raycap RUSDC-6267-PF-48 (U.S. Cellular) | 150 |
| Raycap RUSDC-6267-PF-48 (U.S. Cellular) | 150 |
| Raycap RUSDC-6267-PF-48 (U.S. Cellular) | 150 |

| TYPE | ELEVATION |
|---|---|
| 6'x2 1/2" Pipe Mount (U.S. Cellular) | 150 |
| 6'x2 1/2" Pipe Mount (U.S. Cellular) | 150 |
| 6'x2 1/2" Pipe Mount (U.S. Cellular) | 150 |
| 6'x2 1/2" Pipe Mount (U.S. Cellular) | 150 |
| 6'x2 1/2" Pipe Mount (U.S. Cellular) | 150 |
| 6'x2 1/2" Pipe Mount (U.S. Cellular) | 150 |
| Ericsson RRU-4449 (U.S. Cellular) | 150 |
| Ericsson RRU-4449 (U.S. Cellular) | 150 |
| Ericsson RRU-4449 (U.S. Cellular) | 150 |
| Ericsson RRUS-4415 (U.S. Cellular) | 150 |
| Ericsson RRUS-4415 (U.S. Cellular) | 150 |
| Ericsson RRUS-4415 (U.S. Cellular) | 150 |
| Ericsson RRU-11 (U.S. Cellular) | 150 |
| Ericsson RRU-11 (U.S. Cellular) | 150 |
| Ericsson RRU-11 (U.S. Cellular) | 150 |
| 4ft. grid dish (Fire Department) | 142.5 |
| 2 ft Panel Antenna (Fire Department) | 129 |
| Pirod 6' Side Mount Standoff (1) (Fire Department) | 126 |
| 7'x2" Antenna Mount Pipe (Fire Department) | 126 |
| UHF Dipole Antenna (Fire Department) | 126 |
| 20 ft. Omnis (Fire Department) | 120.5 |
| 7'x2" Antenna Mount Pipe (Fire Department) | 120.5 |
| Pirod 6' Side Mount Standoff (1) (Fire Department) | 120.5 |
| Cambium C050900D021A (Fire Department) | 116 |
| airFiber 24 (Fire Department) | 113.5 |
| 7'x2" Antenna Mount Pipe (Fire Department) | 104.5 |
| UHF Dipole Antenna (Fire Department) | 104.5 |
| 5'3"x4" Pipe Mount (Fire Department) | 104.5 |
| Pirod 6' Side Mount Standoff (1) (Fire Department) | 104.5 |
| 4ft. dish w/ Shroud (Fire Department) | 104.5 |
| 7'x2" Antenna Mount Pipe (Fire Department) | 101.5 |
| Pirod 6-8' Box Arm (1) (Fire Department) | 101.5 |
| 5 ft. Omni (Fire Department) | 101.5 |
| 2 ft. Omnis (Fire Department) | 56 |
| Pirod 3' Side Mount Standoff (1) (Fire Department) | 54 |
| 3 ft. Yagi (Fire Department) | 54 |
| Pirod 6-8' Box Arm (1) (Fire Department) | 50.5 |
| 7'x2" Antenna Mount Pipe (Fire Department) | 50.5 |
| Pirod 3' Side Mount Standoff (1) (Fire Department) | 49.5 |
| 2 ft. Omnis (Fire Department) | 49.5 |
| Pirod 3' Side Mount Standoff (1) (Fire Department) | 44 |
| 2 ft. Omnis (Fire Department) | 44 |
| Pirod 3' Side Mount Standoff (1) (Fire Department) | 37 |
| 2 ft. Omnis (Fire Department) | 37 |
| Pirod 3' Side Mount Standoff (1) (Fire Department) | 31.5 |
| 2 ft. Omnis (Fire Department) | 31.5 |
| Canopy 2400SM (Fire Department) | 25 |

## SYMBOL LIST

| MARK | SIZE | MARK | SIZE |
|---|---|---|---|
| A | 4x3/8 | B | N.A. |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| | | | |
|---|---|---|---|
| Job: ***Watertown DT (786369)*** | | | |
| Project: ***21726*** | | | |
| Client: U.S. Cellular | Drawn by: ajorenby | | App'd: |
| Code: TIA-222-G | Date: 10/14/19 | | Scale: NTS |
| Path: I:\21700\21726\Structural\2019-10-08_Tower Analysis\Tower Model\21726_Watertown DT_(786369)_TNX Tower_2019-10-08.eri | | | Dwg No. E-1 |

## SYMBOL LIST

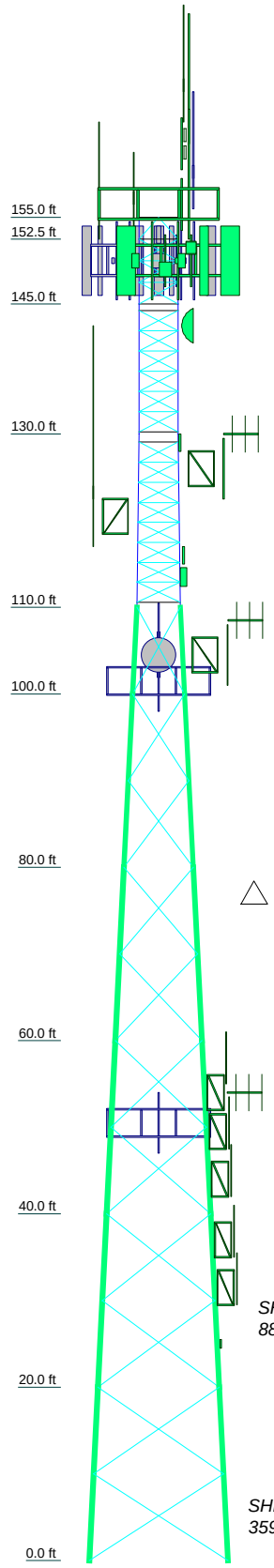
| MARK | SIZE | MARK | SIZE |
|---|---|---|---|
| A | 4x3/8 | B | N.A. |

## MATERIAL STRENGTH

| GRADE | Fy | Fu | GRADE | Fy | Fu |
|---|---|---|---|---|---|
| A572-50 | 50 ksi | 65 ksi | A36 | 36 ksi | 58 ksi |

## TOWER DESIGN NOTES

1. Tower is located in Jefferson County, Wisconsin.
2. Tower designed for Exposure C to the TIA-222-G Standard.
3. Tower designed for a 90 mph basic wind in accordance with the TIA-222-G Standard.
4. Tower is also designed for a 40 mph basic wind with 0.75 in ice. Ice is considered to increase in thickness with height.
5. Deflections are based upon a 60 mph wind.
6. Tower Structure Class III.
7. Topographic Category 1 with Crest Height of 0.000 ft
8. Weld together tower sections have flange connections.
9. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
10. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
11. Welds are fabricated with ER-70S-6 electrodes.
12. TOWER RATING: 89.2%




| Section | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Legs | | | | SR 1 3/4 | SR 2 1/4 | Pirod 105244 | Pirod 105217 | Pirod 105218 | Pirod 105219 | | | |
| Leg Grade | | | | | A572-50 | | | | | | | |
| Diagonals | | | | SR 7/8 | SR 1 | L2 1/2x2 1/2x3/16 | | L3x3x3/16 | | L3x3x5/16 | | |
| Diagonal Grade | | | | | A572-50 | | | A36 | | | | |
| Top Girts | A | | | | SR 1 | | | N.A. | | | | |
| Bottom Girts | B | | | | SR 1 | | | N.A. | | | | |
| Horizontals | B | | | SR 3/4 | SR 7/8 | | | N.A. | | | | |
| Face Width (ft) | 4.5 | 80.2 | 4 @ 2.5 | 6 @ 2.34028 | 9 @ 2.30729 | 5 | 6 | 8 | 10 | 12 | 14 | 16 |
| # Panels @ (ft) | | 482.4 | | 890.3 | 1715.9 | 1127.5 | 2466.5 | 3029.4 | 11 @ 10 | 3138.8 | 4266.0 | 4390.1 |
| Weight (lb) 21687.2 | | | | | | | | | | | | |

*ALL REACTIONS ARE FACTORED*

*MAX. CORNER REACTIONS AT BASE:*
*DOWN: 261932 lb*
*SHEAR: 24627 lb*

*UPLIFT: -231837 lb*
*SHEAR: 21921 lb*

*AXIAL 134614 lb*
*SHEAR 8822 lb*
*MOMENT 859293 lb-ft*
*TORQUE 3184 lb-ft*
*40 mph WIND - 0.750 in ICE*

*AXIAL 41032 lb*
*SHEAR 35953 lb*
*MOMENT 3439996 lb-ft*
*TORQUE 9863 lb-ft*
*REACTIONS - 90 mph WIND*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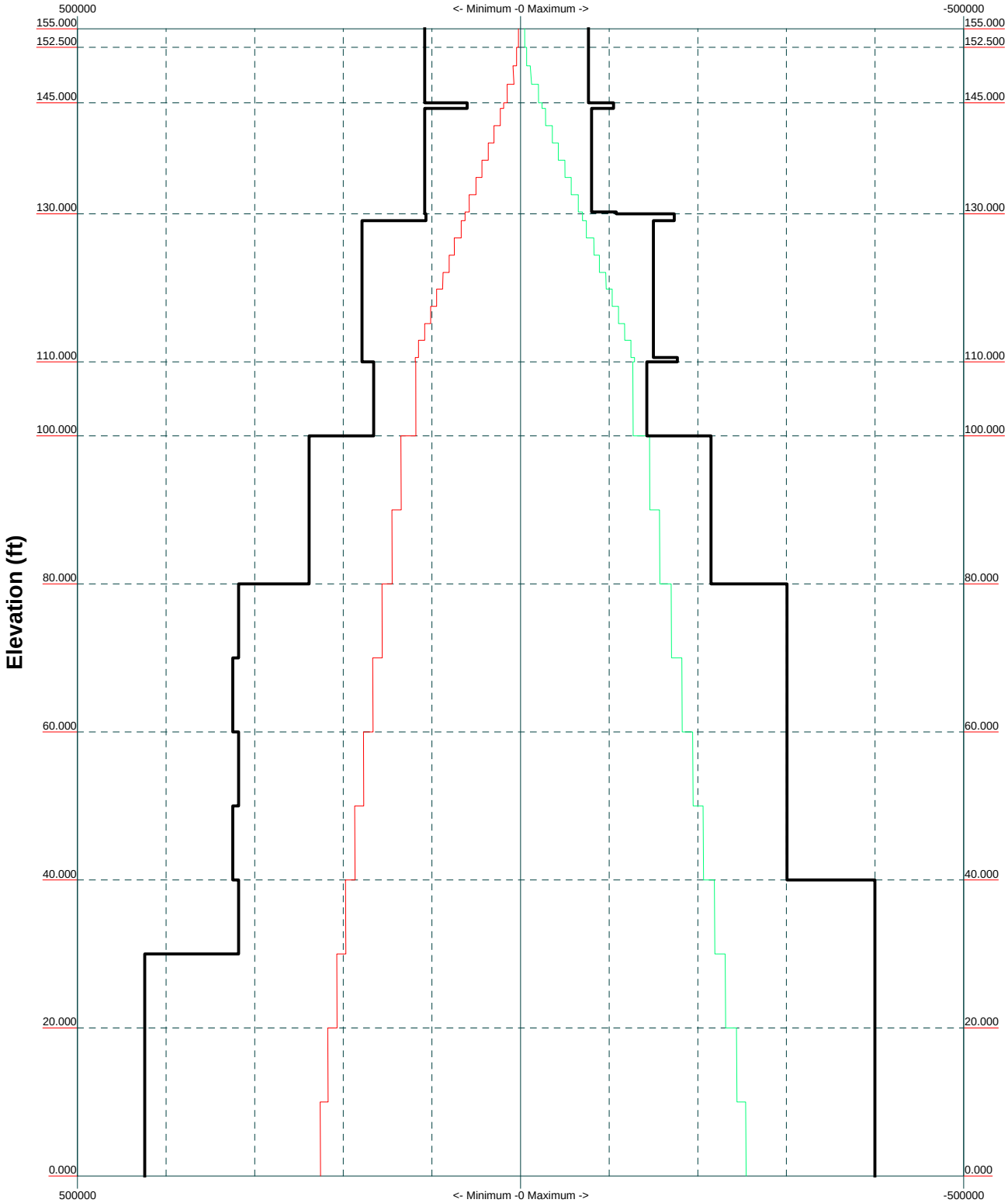
| | | | |
|---|---|---|---|
| Job: *Watertown DT (786369)* | | | |
| Project: *21726* | | | |
| Client: U.S. Cellular | Drawn by: ajorenby | App'd: | |
| Code: TIA-222-G | Date: 10/14/19 | Scale: NTS | |
| Path: I:\21700\21726\Structural\2019-10-08_Tower Analysis\Tower Model\21726_Watertown DT_(786369)_TNX Tower_2019-10-08.eri | | Dwg No. E-1 | |

## TIA-222-G - 90 mph/40 mph 0.750 in Ice Exposure C

**Leg Capacity** ——— **Leg Compression (lb)**





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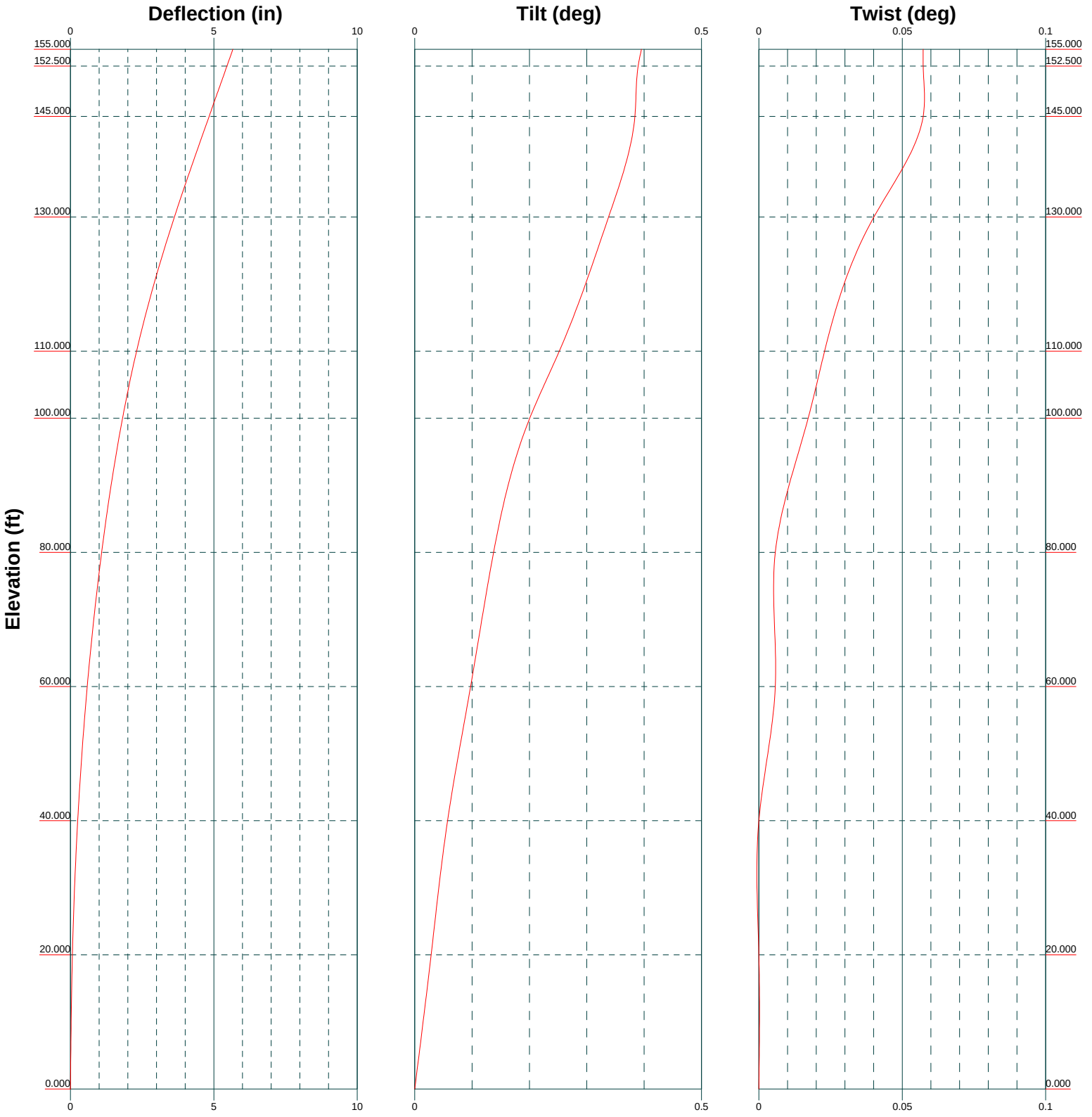
| | | | |
|---|---|---|---|
| Job: ***Watertown DT (786369)*** | | | |
| Project: ***21726*** | | | |
| Client: U.S. Cellular | Drawn by: ajorenby | | App'd: |
| Code: TIA-222-G | Date: 10/14/19 | | Scale: NTS |
| Path: I:\21700\21726\Structural\2019-10-08_Tower Analysis\Tower Model\21726_Watertown DT_(786369)_TNX Tower_2019-10-08.eri | | | Dwg No. E-3 |

## TIA-222-G - Service - 60 mph

**Maximum Values**




SA-4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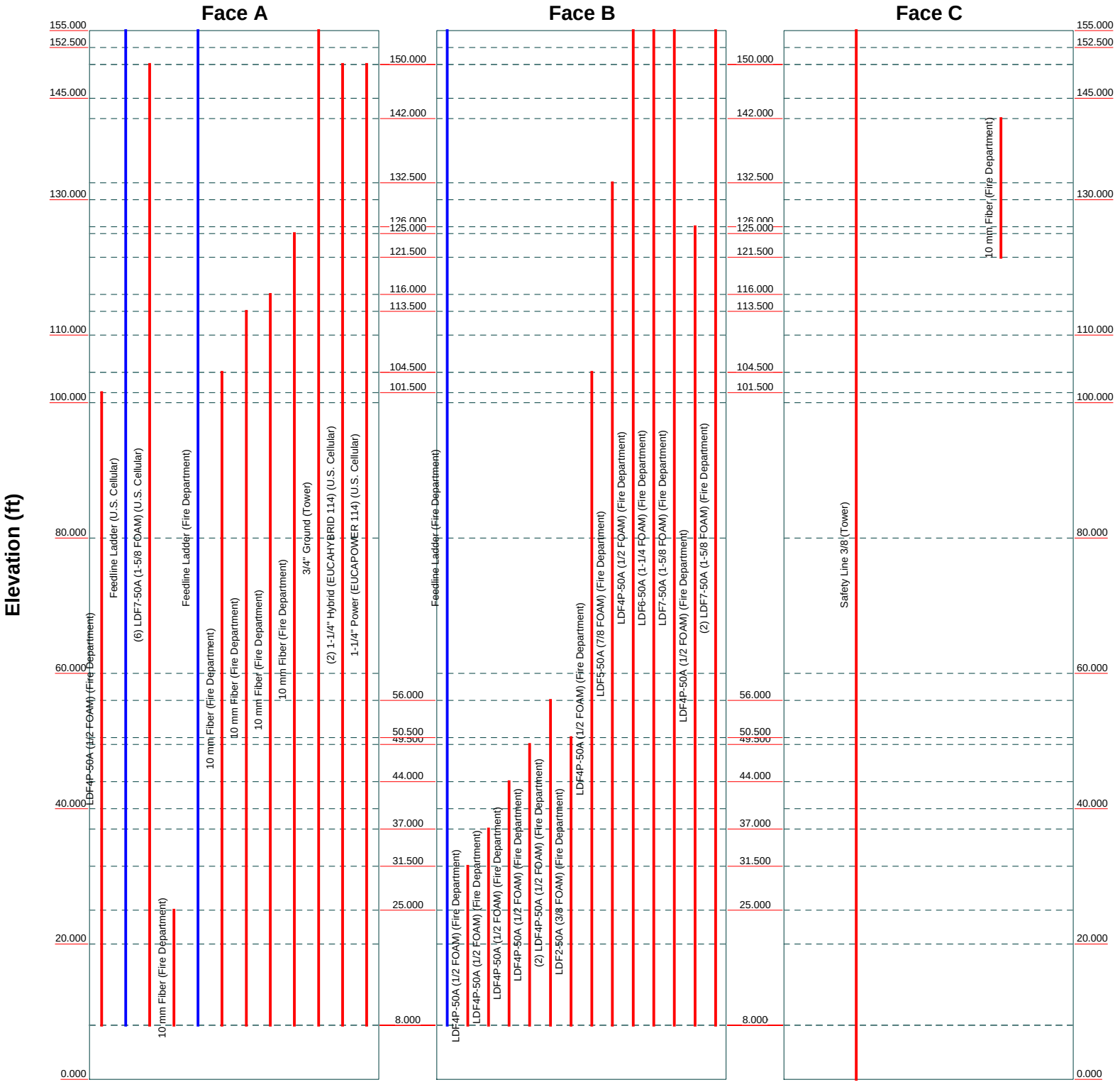
| | | | |
|---|---|---|---|
| Job: ***Watertown DT (786369)*** | | | |
| Project: ***21726*** | | | |
| Client: U.S. Cellular | Drawn by: ajorenby | | App'd: |
| Code: TIA-222-G | Date: 10/14/19 | | Scale: NTS |
| Path: I:\21700\21726\Structural\2019-10-08_Tower Analysis\Tower Model\21726_Watertown DT_(786369)_TNX Tower_2019-10-08.eri | | | Dwg No. E-5 |

# Feed Line Distribution Chart
## 0' - 155'

Round | Flat | App In Face | App Out Face | Truss Leg





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| Client: U.S. Cellular | Drawn by: ajorenby | App'd: | |
| Code: TIA-222-G | Date: 10/14/19 | Scale: NTS | |
| Path: I:\21700\21726\Structural\2019-10-08_Tower Analysis\Tower Model\21726_Watertown DT_(786369)_TNX Tower_2019-10-08.eri | | Dwg No. E-7 | |

# Anchor Rod Calculations

Project Name - Watertown Downtown (786369)
Watertown, Wisconsin
Edge #21726

Completed By: AGJ
Checked By: WBW

## Anchor Rod Parameters:

| | | | |
|---|---|---|---|
| Detail Type = | c | | *Per ANSI/TIA-222-G, Section 4.9.9 |
| Detail Factor ($\eta$) = | 0.55 | | |
| Number of Rods ($N_b$) = | 6 | | |
| Rod Diameter ($D_b$) = | 1.25 | in | |
| Coarse Threads Per Inch (n) = | 7.00 | | |
| Area of Rod ($A_b$) = | 1.23 | $in^2$ | |
| Rod Yield Stress ($F_y$) = | 105 | ksi | |
| Rod Tensile Strength ($F_u$) = | 120 | ksi | |
| Max Tension per Leg ($T_{max}$) = | 231.8 | kip/leg | |
| Max Compression per Leg ($C_{max}$) = | 261.9 | kip/leg | |
| Max Shear per Leg ($V_{max}$) = | 21.9 | kip/leg | |

$$A_n = \frac{\pi}{4}\left(D_b - \frac{.9743}{n}\right)^2$$

Area using Tensile Root Diameter ($A_n$) = 0.97 $in^2$

## Ultimate Anchor Rod Demand and Resistance

$$V_u = \frac{V_{max}}{N_b}$$

Applied Shear per Rod ($V_u$) = 3.65 kip/rod

$$P_u = \frac{P_{max}}{N_b}$$

Applied Axial per Rod ($P_u$) = 38.64 kip/rod

$$\phi R_{nt} = 0.8 \cdot (F_u \cdot A_n)$$

Available Tensile Strength ($\phi R_{nt}$) = 93.03 kip/rod

## Combined Shear and Tension Check:

$$Unity = \frac{P_u + \frac{V_u}{\eta}}{\phi R_{nt}}$$

Unity = 0.49 **OK**

# Self-Support Foundation Calculations

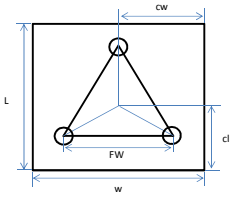
Project Name - Watertown Downtown (786369)
Watertown, Wisconsin
Edge #21726

Edge Consulting Engineers, Inc.

Completed By: AGJ
Checked By: WBW

## Applied Loads:

| | P (kip) | V (kip) | M (kip-ft) |
|---|---|---|---|
| Tower Dead Load (DL) = | 34.2 | 0.0 | 6.2 |
| Tower Ice Load (IL) = | 93.6 | 0.0 | 14.3 |
| Wind Load Without Ice ($W_o$) = | 0.0 | 22.5 | 2145.3 |
| Wind Load With Ice ($W_i$) = | 0.0 | 8.8 | 837.5 |




## Foundation Dimensions & Soil Properties:

| | | | |
|---|---|---|---|
| Tower Face Width (FW) = | 16.00 | ft | |
| Slab Length (L) = | 23.00 | ft | |
| Slab Width (w) = | 23.00 | ft | |
| Depth to Bottom of Foundation (h) = | 15.00 | ft | |
| Foundation Depth (d) = | 3.00 | ft | |
| Lengthwise Distance to Tower Center (cl) = | 9.19 | ft | |
| Width Distance to Tower Center (cw) = | 11.50 | ft | |
| Pier Diameter ($D_{pier}$) = | 3.50 | ft | |
| Pier Total Height ($H_{pier}$) = | 12.50 | ft | |
| Pier Height Above Ground Surface ($H_p$) = | 0.50 | ft | |
| Water Table Depth ($d_{wt}$) = | 20.00 | ft | *Per Geotech Report |
| $\gamma_{soil}$ = | 105.00 | lb/ft$^3$ | |
| $\gamma_{soil(sub)}$ = | 60.00 | lb/ft$^3$ | |
| $\varphi_{soil}$ = | 0 | ° | |
| $q_a$ = | 10000.00 | lb/ft$^2$ | **Net** |
| $\gamma_c$ = | 150.00 | lb/ft$^3$ | |
| $\gamma_{c(sub)}$ = | 87.6 | lb/ft$^3$ | *Concrete below the water table |
| $d_{(sub)}$ = | 0.0 | ft | |
| $H_{pier(sub)}$ = | 0.0 | ft | |

$$l = H_{pier} - H_p$$

Soil Wedge Length (l) = 12.00 ft

$$w_w = \tan \varphi_{soil} \cdot l$$

Soil Wedge Width ($w_w$) = 0.00 ft

## Foundation Weights:

$$W_{Pad} = L \cdot w \cdot d \cdot \frac{\gamma_c}{1000} - L \cdot w \cdot d_{(sub)} \cdot \frac{\gamma_c - \gamma_{c(sub)}}{1000}$$

Weight of Concrete Pad ($W_{Pad}$) = 238.1 kip

$$W_{Piers} = 3 \cdot \left( \frac{\pi}{4} \cdot D_{pier}^2 \cdot H_{pier} \cdot \frac{\gamma_c}{1000} - \frac{\pi}{4} \cdot D_{pier}^2 \cdot H_{pier(sub)} \cdot \frac{\gamma_c - \gamma_{c(sub)}}{1000} \right)$$

Weight of Concrete Piers ($W_{Piers}$) = 54.1 kip

$$W_{soil} = \left( (L \cdot w \cdot l) - \left( 3 \cdot \left( \frac{D_{pier}}{2} \right)^2 \cdot \pi \cdot l \right) + (w_w \cdot l) \cdot (L + w) \right) \cdot \frac{\gamma_{soil}}{1000} - \left( (L \cdot w \cdot H_{pier(sub)}) - \left( 3 \cdot \left( \frac{D_{pier}}{2} \right)^2 \cdot \pi \cdot H_{pier(sub)} \right) + (w_w \cdot H_{pier(sub)}) \cdot (L + w) \right) \cdot \frac{\gamma_{soil} - \gamma_{soil(sub)}}{1000}$$

Weight of Soil ($W_{soil}$) = 630.2 kip

## Load Combinations:

$S_1 = 1.0DL$
$S_2 = 1.0DL + 0.7IL$
$S_3 = 1.0DL + 1.0W_o$
$S_4 = 0.6DL + 1.0W_o$
$S_5 = 1.0DL + 0.7IL + 0.7W_i$
$S_6 = 0.6DL + 0.7IL + 0.7W_i$

## Overturning Check:

$$M_A = M + V \cdot (h + H_p)$$

$$M_R = (P \cdot c) + \left( W_{concrete} \cdot \frac{L}{2} \right) + \left( W_{soil} \cdot \frac{L}{2} \right)$$

$$Ratio = \frac{M_A}{M_R}$$

| | Ratio | Check |
|---|---|---|
| S1 | 0.00 | OK |
| S2 | 0.00 | OK |
| S3 | 0.23 | OK |
| S4 | **0.39** | OK |
| S5 | 0.06 | OK |
| S6 | 0.10 | OK |

## Bearing Check:

$$e = \frac{M_A}{P_{applied}}$$

$$If\ e \le \frac{w}{6} \quad q_{max} = \frac{P_{applied}}{A} \cdot \left( 1 + \frac{6e}{w} \right)$$

$$If\ e > \frac{w}{6} \quad q_{max} = \frac{P_{applied}}{A} \cdot \left( \frac{2}{1.5 - \frac{3e}{w}} \right)$$

$$Ratio = \frac{q_{max}}{q_a}$$

| | Ratio | Check |
|---|---|---|
| S1 | 0.03 | OK |
| S2 | 0.05 | OK |
| S3 | **0.16** | OK |
| S4 | 0.08 | OK |
| S5 | 0.09 | OK |
| S6 | 0.01 | OK |

*If Bearing is Net, Original Soil Pressure is Removed