APPENDIX A: STATE DOT SURVEY QUESTIONAIRE

The follow letter and questionnaire were sent to all 50 state DOTs. Responses were received from 40 states, and the results are tabulated in Chapter 3.

NCHRP Project 22 – 25: Development of Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems

Background

In 2007, the Texas Transportation Institute (TTI) completed work on NCHRP Project 20-7(210) which included a comprehensive survey of all state agencies to gather detailed information on the selection and use of cable barrier systems in their respective States and on the effectiveness of their field installations. Responses were received from 29 states. This survey provided a snapshot of the extent of use of cable barrier systems and the state-of-the-practice relative to the design, selection, installation, and maintenance through 2005. The National Crash Analysis Center (NCAC) of the George Washington University has been awarded the contract for NCHRP Project 22-25 "Development of Guidance on the Selection, Use, and Maintenance of Cable Barrier Systems" in May 2008.

The enclosed survey is intended to update the information in the earlier TTI survey and to offer those who did not respond to the initial survey an opportunity to provide input based on their knowledge and experiences with cable barrier. Information should be provided only on those cable barrier systems, both generic and proprietary, that have been successfully crash-tested under NCHRP Report 350 (or subsequent) guidelines. Although the primary focus of this study is on cable barriers installed in the median of a divided highway to minimize cross-over crashes, information on recent use of cable as a roadside (non-median) barrier should also be included where appropriate.

The following is a list of questions that will assist us in identifying critical issues related to cable barriers and in developing guidelines for their selection, use, and maintenance. It is not expected that all requested information will be available from all states and for all systems. Please complete the survey with all readily available information. It is important to the success of this project that we gather responses from most states; consequently, we would greatly appreciate your response to the survey even if limited information is available and not all questions are answered. Please list or attach any references used in answering the questions or any additional relevant information (see question 20).

Any questions regarding the survey may be addressed to Dr. Dhafer Marzougui at 703-726-8532. Please send survey responses via e-mail to dmarzoug@ncac.gwu.edu or using the website link at http://www.ncac.gwu.edu/nchrp/survey/. Electronic copies of guidelines, specifications or drawings can also be sent via e-mail or uploaded to the web site address above. Non-electronic information such as State guidelines, specifications or drawings can be mailed to:

Dhafer Marzougui
The National Crash Analysis Center, The George Washington University, VA Campus
20101 Academic Way, Ashburn, VA 20147, USA

Name of Survey Participant: _____ Phone: _____
E-Mail: _____ State: _____

Survey Questions:

1. Approximately how many miles of cable barrier are in place or are currently being installed in your state? For each cell, please enter the number of miles in your state (if available), enter "0" if a particular system is not used in your state, leave blank or enter "N/A" if the information is not available.

	Total (miles)	Miles By Test Level			Miles By Number of Cables			Miles By Placement	
		TL3 (miles)	TL4 (miles)	Other (miles)	3 Cable (miles)	4 Cable (miles)	Other (miles)	Median (miles)	Roadside (miles)
Brifen									
CASS									
Gibraltar									
Nucor									
Safence									
Low-Tension									
Other									

2. Please estimate the median slopes that exist in your state for which cable median barriers have been or are planned to be installed to reduce cross median crashes? (Total should add to 100%)

Slope	10:1	8:1	6:1	4:1	Other
Percent (%)					

3. Please check the typical median geometry used in conjunction with the different cross slopes used in your state. For each cell, enter "X" for each configuration where a cable barrier is installed. More than one median shape can be checked for each slope. If available, the number of miles can be entered instead.

Slope	10:1	8:1	6:1	4:1	Other
V-Shape					
Flat-Bottom					
Rounded-Bottom					
Non-Symmetric					
Other					

4. Please estimate the median widths (from one break or hinge point to the other) associated with the different cross slopes used in your state.

Slope	10:1	8:1	6:1	4:1	Other
Minimum Width (ft)					
Average Width (ft)					
Maximum Width (ft)					

5. For the flat-bottom and rounded-bottom median configurations (if used), please specify the typical width of the flat/rounded section.

Slope	10:1	8:1	6:1	4:1	Other
Width of flat or rounded section (ft)					

6. What criteria are used to decide if a barrier is warranted?

   For median application:

   _____
   _____
   _____

   For roadside application:

   _____
   _____
   _____

7. What criteria are generally used to select a cable barrier system over a rigid or semi-flexible system in locations and conditions where any system can be used?

   For median application:

   _____
   _____
   _____

   For roadside application:

   _____
   _____
   _____

8. What criteria, if any, are generally used to select a specific cable barrier system, i.e. Brifen, CASS, Gibraltar, Nucor, Safence, or Generic Low-Tension?

   ____ System specific bid document
   ____ Low-bid open to all NCHRP Report 350 approved systems
   ____ Bid restricted to previously specified vendors
   ____ Other (please specify) _____

9. Does your state have specific standards/guidelines for the system design, alignment, construction, and/or maintenance of cable barriers?

   System design (soil testing/properties, end-terminal loads, etc.) ____ yes ____ no
   Alignment (lateral placement, adjustment at drainage structure, etc.) ____ yes ____ no
   Construction (post foundation, anchor foundation, tolerances, etc.) ____ yes ____ no
   Maintenance (re-tensioning, anchor monitoring, re-installation, etc.) ____ yes ____ no

10. Approximately, every year, how many reported crashes into cable barriers occur on average in your state?

	Total (median and roadside)	In median	In roadside
Number of Crashes Per Year			

11. Approximately how many of these reported cable barrier crashes resulted in vehicular penetration (Penetration is defined as an impact where the vehicle completely passed through the system)?

		Median & Roadside	In median	In roadside
Number of Crashes Per Year	Total			
	Over-ride			
	Under-ride			
	Other			

12. If data is available, please give the number of cable barrier penetrations that have resulted in crashes into opposite-direction traffic?

	2005	2006	2007	2008	2009
Number of crashes into opposite traffic					

Who should we follow up with to receive copies of the crash reports?

_____

13. Based on the penetrations you experienced, is there a factor or factors that most likely contributed to the penetrations (e.g., barrier type, median feature, impact condition, barrier placement, etc.)?

In median:

_____
_____
_____

In roadside:

_____
_____
_____

14. Are you aware of any crashes into cable barriers by motorcyclists? If so, please summarize the number, circumstances, and severity of such crashes.

_____
_____
_____

15. Have you experienced any significant or recurring repair or maintenance concerns? If so, please elaborate by cable barrier type as appropriate.

_____
_____
_____

16. Please list the most critical issues that you believe need to be addressed in the guidelines for design, selection, installation, and maintenance of cable barriers. List the most critical first.
    1-_____
    2-_____
    3-_____
    4-_____

17. Please answer the following design/construction-related cable barrier questions:

    Do you have typical guidelines for cable barrier placement?

    _____

    Is barrier performance better when placed near the shoulder instead of in the median area?

    _____

    Do you have requirements for placement near median ditches; drainage inlets and dikes?

    _____

    Do you provide soil data during request for procurement?

    _____

    Do you require contractor to repair/replace anchors when excess movement of anchor occurs?

    _____

    Do you have requirements on the type of ends used on the cables?

    _____

    Do you require pull testing of fully fitted splices to determine breaking strength?

    _____

    Do you require expected deflection values when anchor-to-anchor length is greater than the crash tested length?

    _____

    Do you have inspection requirements?

    _____

    Do you have construction tolerance limits?

    _____

    What design and placement considerations are complementary with effective maintenance?

    _____

    What practices have you found to make maintaining the roadside around where cable barriers are installed easier?

    _____

18. Please answer the following maintenance related questions:

    Typically, how often do you inspect cable barrier system? _____ times a year
    Typically, how long after impact is the barrier repaired? _____ days
    Typically, how many posts are replaced per impact? _____
    What is a typical cost of repair per impact? $ _____
    Do you use mow strips? __yes __no; if yes, what is the additional cost? $ ____ per ft
    Do you utilize used parts in repairs? __yes __no; if yes, has this caused problems? _y __n

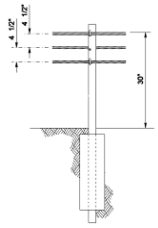
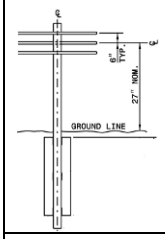
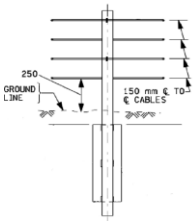
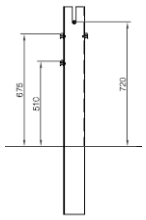
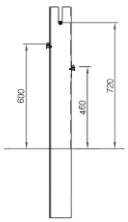
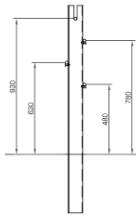
19. Please indicate (yes/no) if you are aware of any of the following occurring in your state:

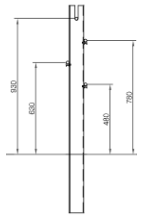
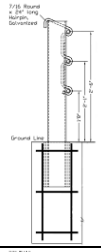
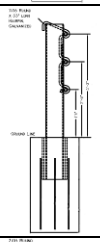
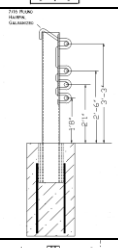
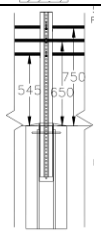
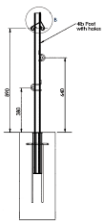
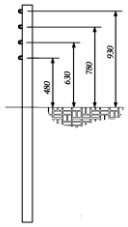
Cable failure during impact ____ yes ____ no
Failure at end of cable connections (cable extension) ____ yes ____ no
Failure at connection between cables and end-anchors ____ yes ____ no
Excess barrier defection during impact due to horizontal curvature ____ yes ____ no
Excess barrier deflection due to long anchor-to-anchor segments ____ yes ____ no
Penetrations/excess deflection due to long post spacing ____ yes ____ no
Penetration/excess deflection due to cable spacing or number cables ____ yes ____ no
End-anchor pull-out due to soil condition ____ yes ____ no
Post foundation pull-out due to soil condition ____ yes ____ no

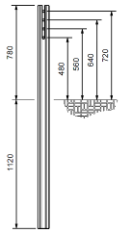
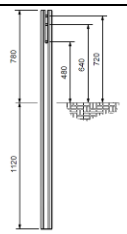
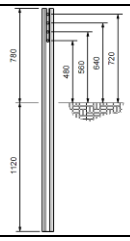
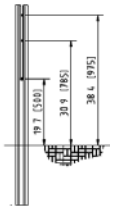
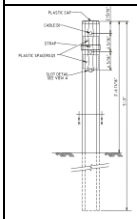
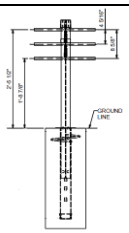
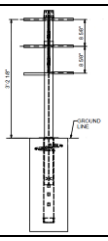
20. Please list or upload any references used in answering the survey questions or any additional related information:

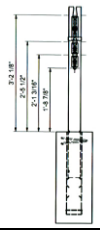
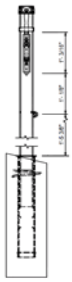
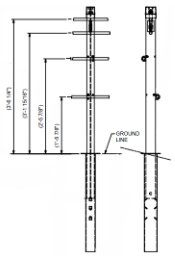
_____
_____
_____
_____
_____

APPENDIX B: AVAILABLE CABLE BARRIER SYSTEMS

	System	Acceptance Letter	Test Level	Post	Post Spacing	Post Embedment	Cables	Cable Heights
	Generic low-tension	B64, B64 Supp	TL3	Steel S75x8, Steel U-channel, or weakened round timber posts	16 ft	Driven posts with Soil Plate	Three 3/4" Non-pre-stretched	21" 25.5" 30"
	Generic low-tension	B64	TL3	Steel S75x8	16 ft	Driven posts with Soil Plate	Three 3/4" Non-pre-stretched	21" 27" 33"
	Generic low-tension	B161	TL3	Steel S75x8	16 ft (12 ft 8 ft 4ft)	Driven Posts with Soil Plate	Four 3/4" Non-pre-stretched	10" 16" 22" 28"
	Brifen high-tension	B82 B82A	TL3	S-shaped post (100 mm x 32 mm x 6 mm)	10.5 ft	Driven or Socketed Posts	Four 3/4" Pre or Non-pre-stretched Woven	20" 26.57" 26.57" 28.35"
	Brifen high-tension	B82C B82C1	TL3	S-shaped post (100 mm x 32 mm x 6 mm)	10.5 ft and 7.9 ft	Driven or Socketed Posts	Three 3/4" Pre or Non-pre-stretched Woven	18" 23.5" 28.4"
	Brifen high-tension	B82B B82B1	TL4 TL3	Z-shape posts, (100 mm x 55 mm x 4.55 mm)	10.5 ft	Driven or Socketed Posts	Four 3/4" Pre or Non-pre-stretched Woven	18.9" 24.8" 30.7" 36.6"

	Brifen high-tension	B82D	TL4 TL3	Z-shape posts, (100 mm x 55 mm x 4.55 mm)	21 ft	Driven or Socketed Posts	Four 3/4” Pre or Non-pre-stretched Woven	18.5 in 30.5 in 24.5 in 36.5 in
	Gibraltar high-tension	B137	TL3	C-channel post (83 mm x 63.5 mm x 3.8 mm)	15 ft	Driven or Socketed Posts On alternate sides of the cables	Three 3/4” Pre or Non-pre-stretched	20” 25” 30”
	Gibraltar high-tension	B137A B137B B137C	TL4 TL3	C-channel post (83 mm x 63.5 mm x 3.8 mm)	14 ft 30 ft 20 ft 10 ft	Driven or Socketed Posts On alternate sides of the cables	Three 3/4” Pre or Non-pre-stretched	20” 30” 39”
	Gibraltar high-tension	B137A1	TL4	C-channel post (83 mm x 63.5 mm x 3.8 mm)	No test (10 ft -30 ft)	Driven or Socketed Posts On alternate sides of the cables	Four 3/4” Pre or Non-pre-stretched	20” 25” 30” 39”
	Nucor high-tension	B96 B96A B183	TL3	4 lb/ft U-Post	6.6 ft 12.5 ft 16.7ft	Driven or Socketed Posts	Three 3/4” Pre or Non-pre-stretched	21.5” 25.6” 29.5”
	Nucor high-tension	B167 B183 B184	TL4	4 lb/ft U-Post	20 ft	Driven or Socketed Posts	Four 3/4” Pre or Non-pre-stretched	15” 25” 35” * 35” *can be lowered to 31”
	Safence high-tension	B88	TL3	Elliptical-Shape Steel Post (4mm thick)	8 ft	Driven Posts	Four 3/4” Pre-stretched	18.9” 24.8” 30.7” 36.6”

	Safence high-tension	B88A B88B B88C	TL3	I-Shape Steel Post (4mm thick) Or C-Shaped Steel Post (4mm thick)	8 ft 6.5 ft 10 ft	Driven or Socketed Posts	Four 3/4” Pre-stretched	18.9” 22” 25.2” 28.3”
	Safence high-tension	B88D	TL4	C-Shaped Steel Post (4mm thick)	8 ft 6.5 ft 10 ft	Driven or Socketed Posts	Four 3/4” Pre-stretched	18.9” 25.2” 28.3”
	Safence high-tension	B88E	TL4	C-Shaped Steel Post with Stiffener Plate (4mm thick)	13 ft 33 ft	Driven or Socketed Posts	Four 3/4” Pre-stretched	18.9” 21.2” 25.2” 28.3”
	Safence high-tension	B88F	TL3 (MASH)	C-Shaped Steel Post Stiffener Plate (4mm thick)	16 ft	Driven or Socketed Posts	Three or Four 3/4” Pre-stretched	19.7” 30.9” 34.6”* 38.4” *Optional
	Trinity (CASS) high tension	B119 B119A B119B B141E	TL3	C-Shaped Steel Post	6.5 ft 10 ft 16 ft	Driven or Socketed Posts	Three or four 3/4” Pre or Non-pre-stretched	21” 23”* 25.2” 29.5” *Optional
	Trinity (CASS) high tension	B141 B141A B141B	TL3	Weakened I-beam Steel Post (S4x7.7)	20 ft 30 ft	Driven or Socketed Posts	Three 3/4” Pre or Non-pre-stretched	21” 25.2” 29.5”
	Trinity (CASS) high tension	B141	TL4	Weakened I-beam Steel Post (S4x7.7)	20 ft	Driven or Socketed Posts	Three 3/4” Pre or Non-pre-stretched	21” 29.5” 38”

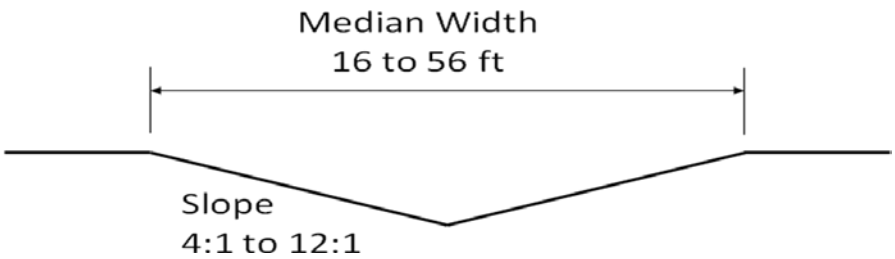
	Trinity (CASS) high tension	B157	TL4	Weakened I-beam Steel Post (S4x7.7)	20 ft	Driven or Socketed Posts	Four 3/4” Pre or Non-pre-stretched	21” 25.2” 29.5” 38”
	Trinity (CASS) high tension	B141C B141D	TL3 TL4	Weakened I-beam Steel Post (S4x7.7)	6.67 ft 20 ft	Driven or Socketed Posts	Three or four 3/4” Pre or Non-pre-stretched	17.5” 29.3” 37.4”* 41.7” *Optional
	Trinity (CASS) high tension	B141F	TL3 TL4	Steel I-beam S3 x 5.7	10.5ft 21 ft	Driven or Socketed Posts	Four 3/4” Pre-stretched	17.9" 29.9" 38" 42.25"

APPENDIX C: CABLE BARRIER LATERAL PLACEMENT PLOTS

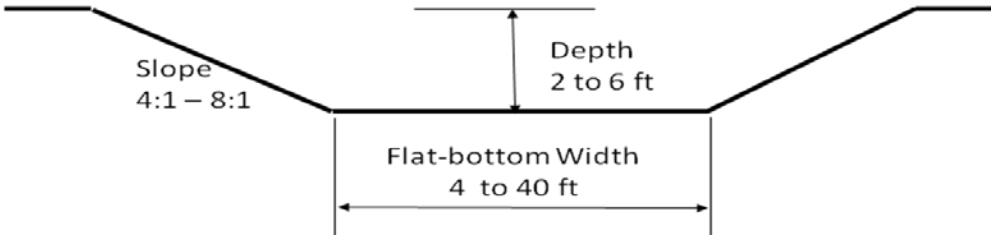
The research considered a wide range of median profiles. The medians varied in shape, slope, and width. The results from the symmetric v-shaped and flat-bottom medians are presented in this appendix. For the v-shaped medians varied in side slopes (4H:1V, 6H:1V , 8H:1V, and 12H:1V) and median widths (5 to 17 m, 16 to 56 ft). Similarly, the flat-bottom medians varied in side slopes (4H:1V, 6H:1V and 8H:1V), depths (0.6 to 1.8 m, 2 to 6 ft), and flat-bottom section widths (1.2 to 12.2 m, 4 to 40 ft).

For each median profile, simulations were performed using five vehicle models (820C, 2000P, 1100C, 2270P, and a mid-size sedan represented by the Ford Crown Victoria), three impact speeds 50, 70 and 100 km/hr (31, 43, and 62 mi/hr), and five approach angles, 5, 10, 15, 20, and 25 degrees.

Underride and override limit plots from the analysis are presented in the following pages. Two plots are included for each median profile. The cable barrier used in the first plot consisted of a generic three-cable barrier system with cable heights set at 533, 647, and 762 mm (21, 25.5, and 30 in) from ground level. This system has one of the narrowest cable spreads. The system used in the second plot was a generic four-cable system with cable heights set at 343, 610, 876, and 1143 mm (13.5, 24, 34.5 and 45 in) from ground level. This system has one of the widest cable spreads.



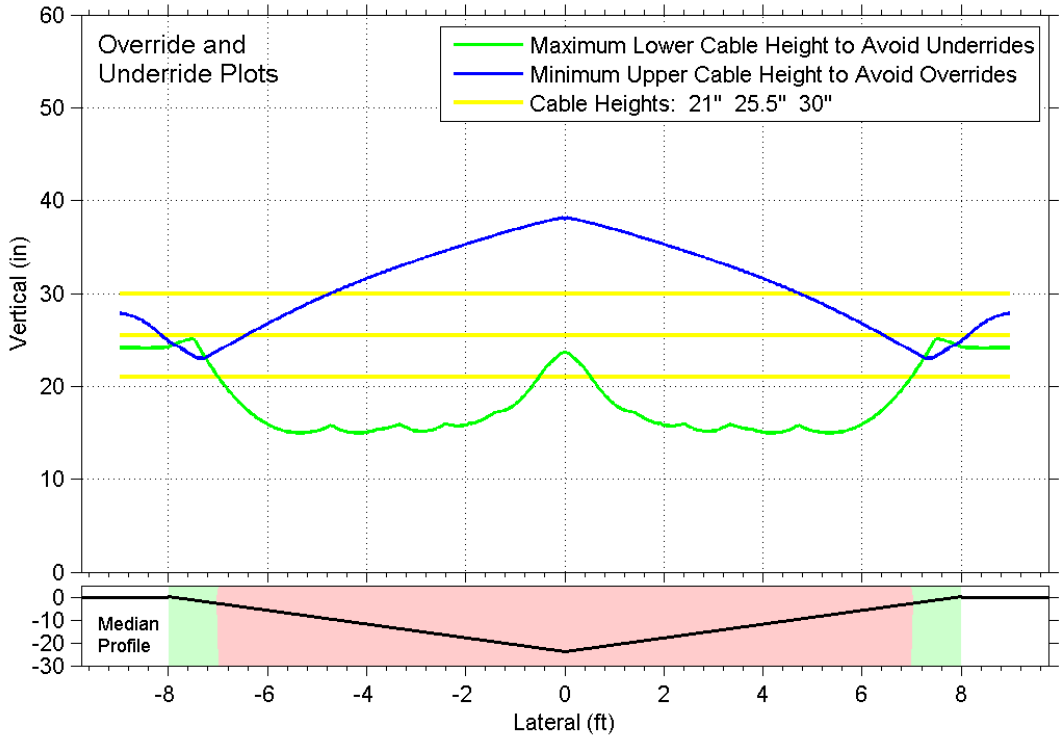
Symmetric V-shaped Medians Analyzed

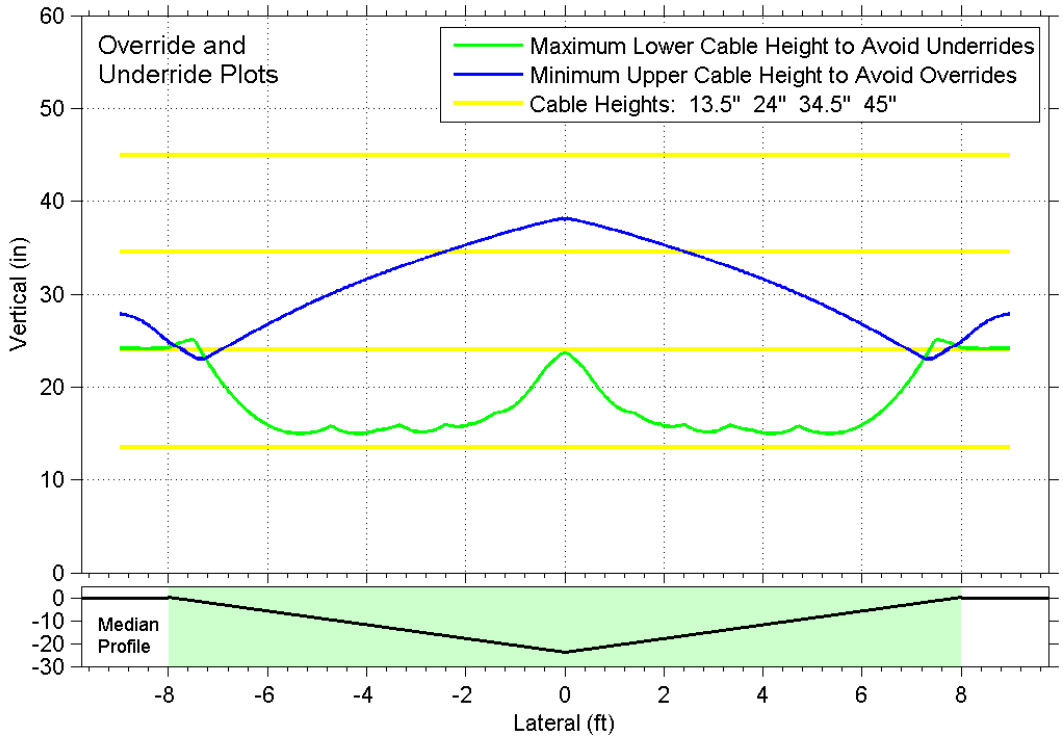


Symmetric Flat-bottom Medians Analyzed

Symmetric V-Shaped Medians

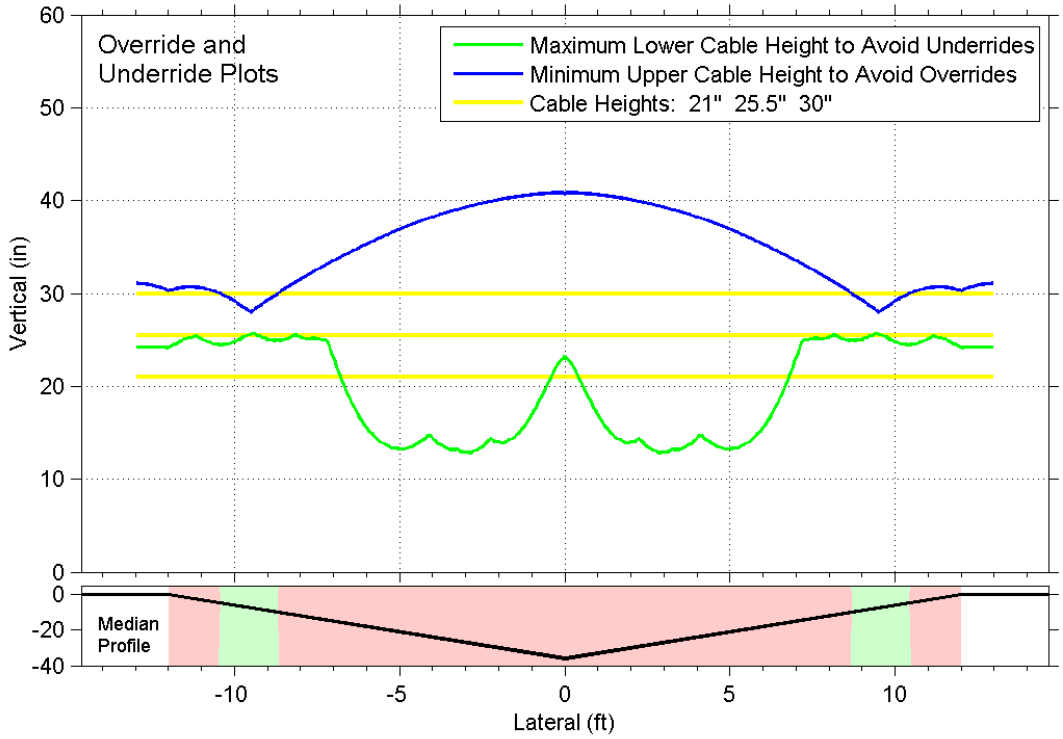
V-shaped Median - 4H:1V Slope - 16ft Width

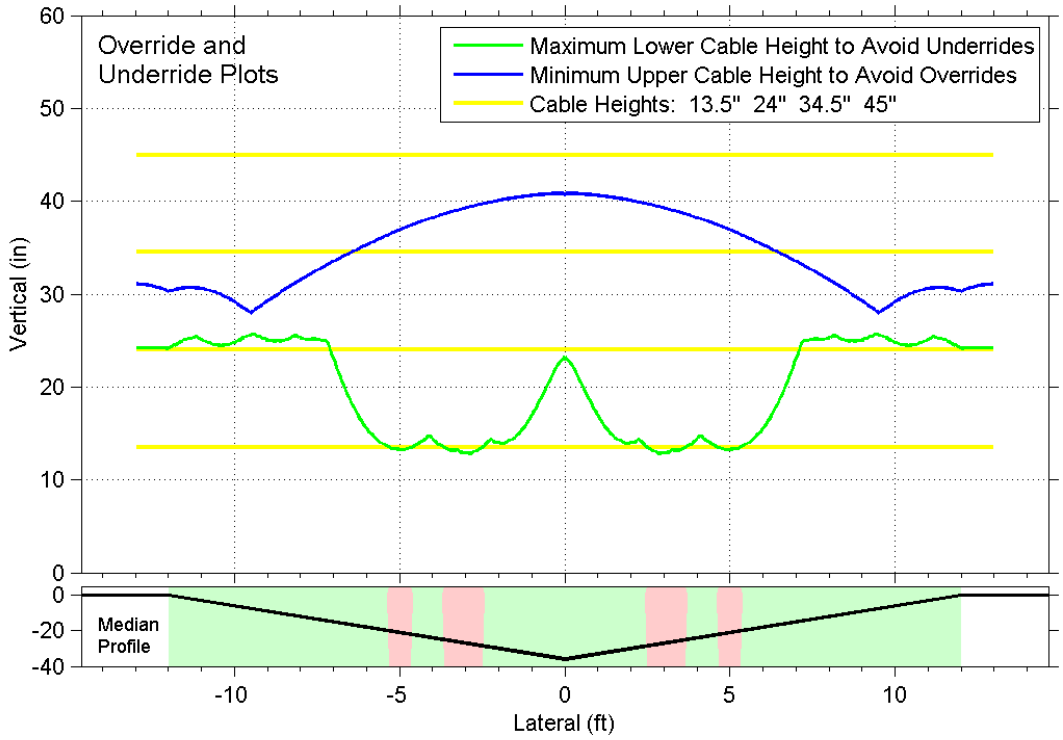




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

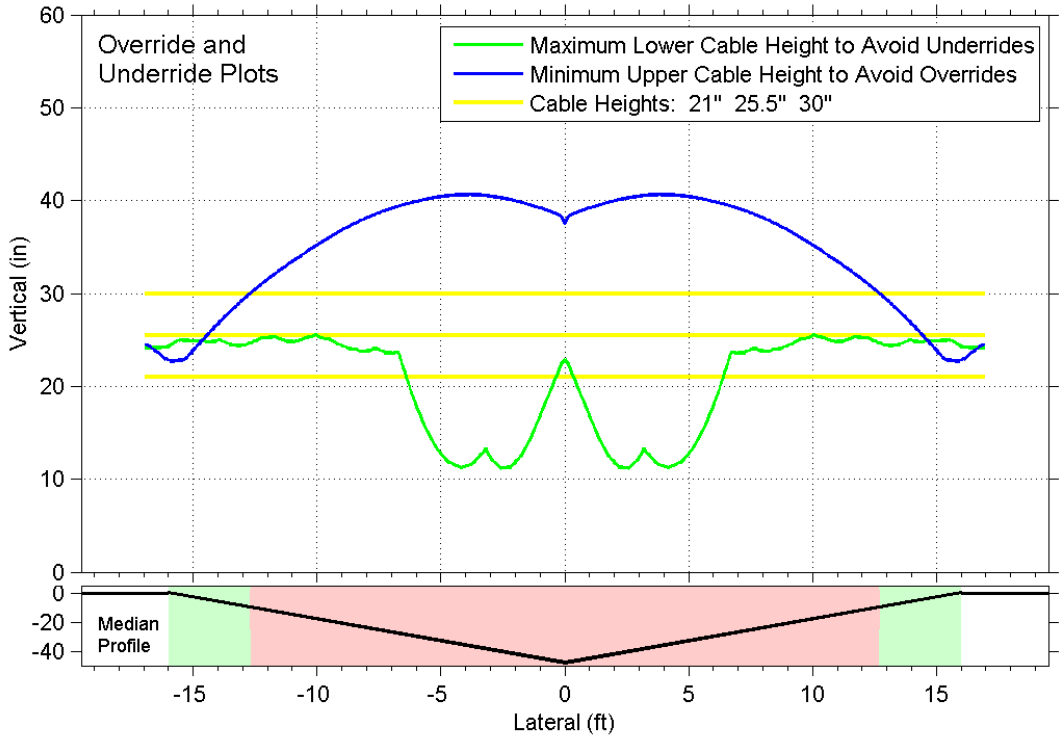
V-shaped Median - 4H:1V Slope - 24ft Width

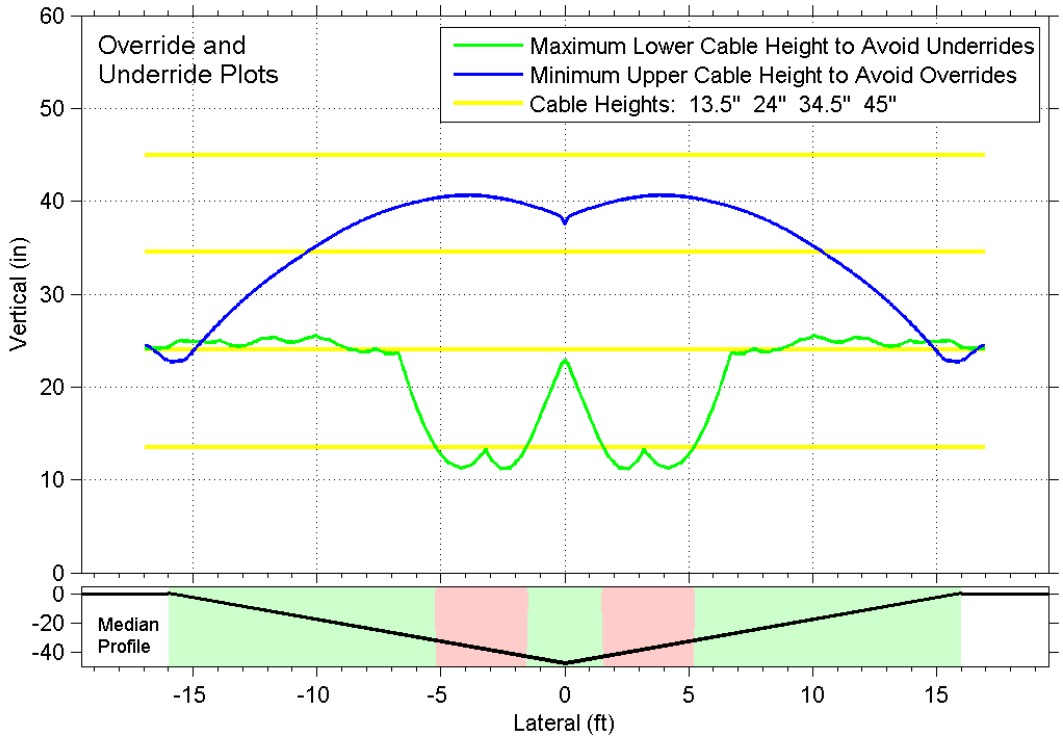




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

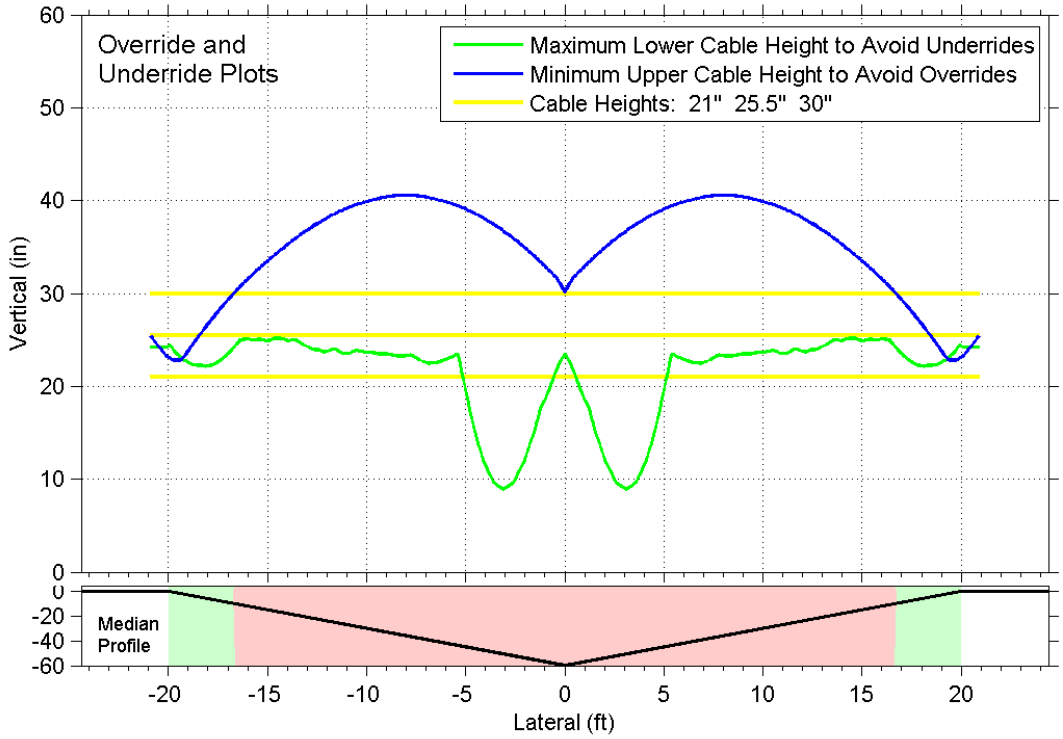
V-shaped Median - 4H:1V Slope - 32ft Width

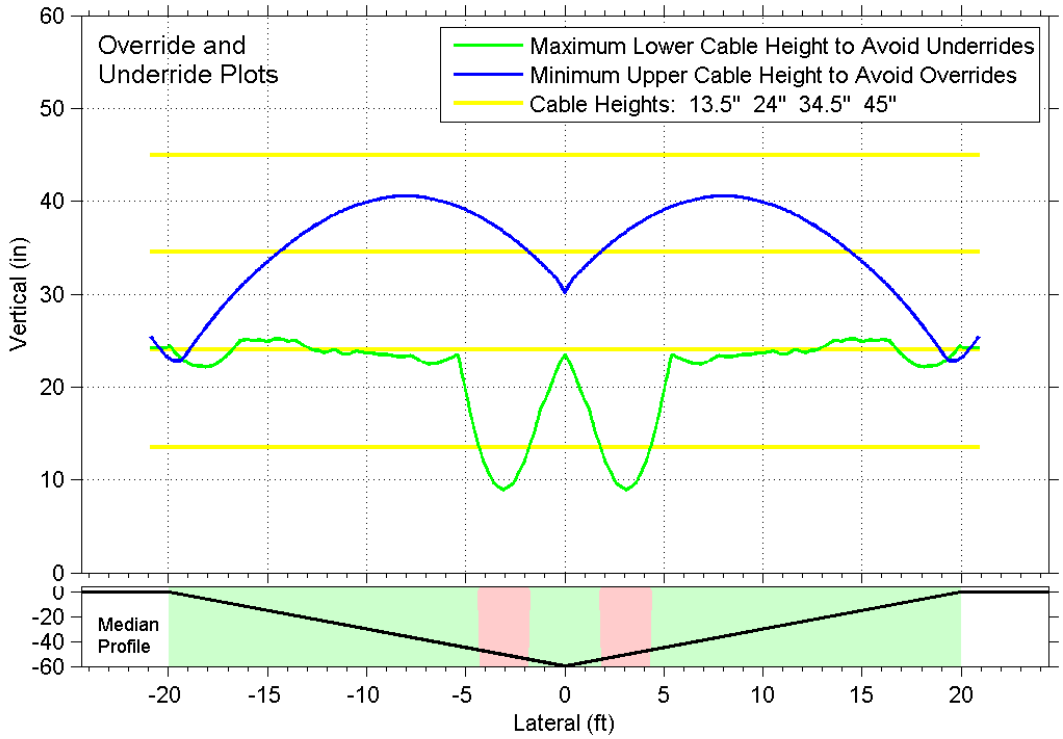




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

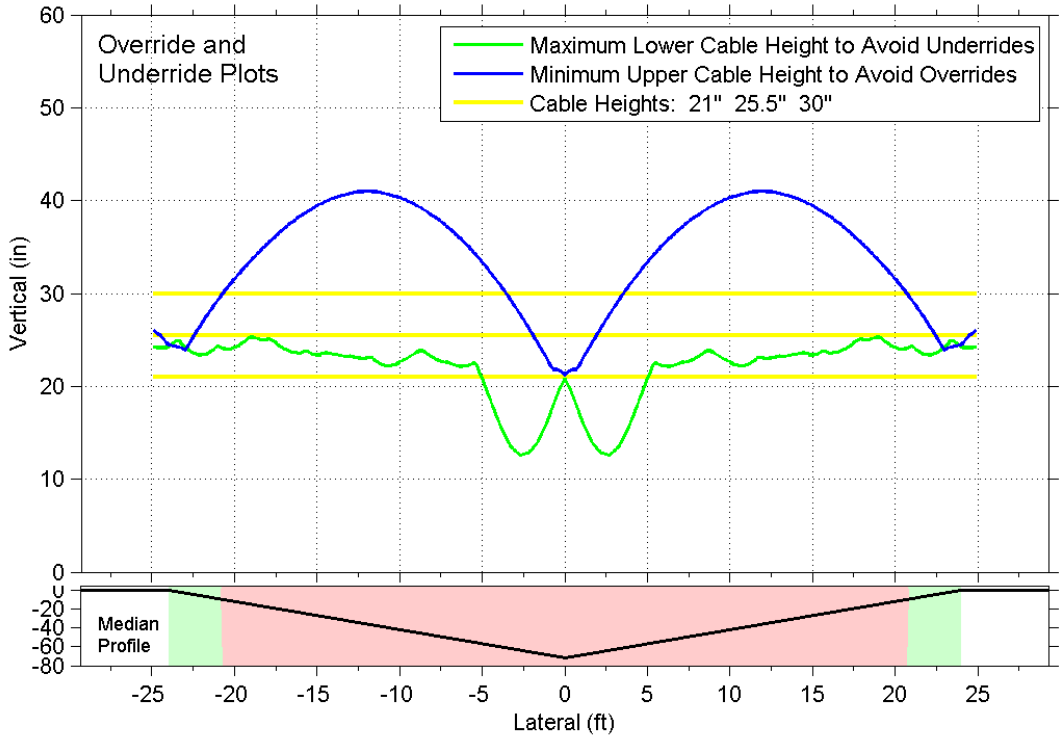
V-shaped Median - 4H:1V Slope - 40ft Width

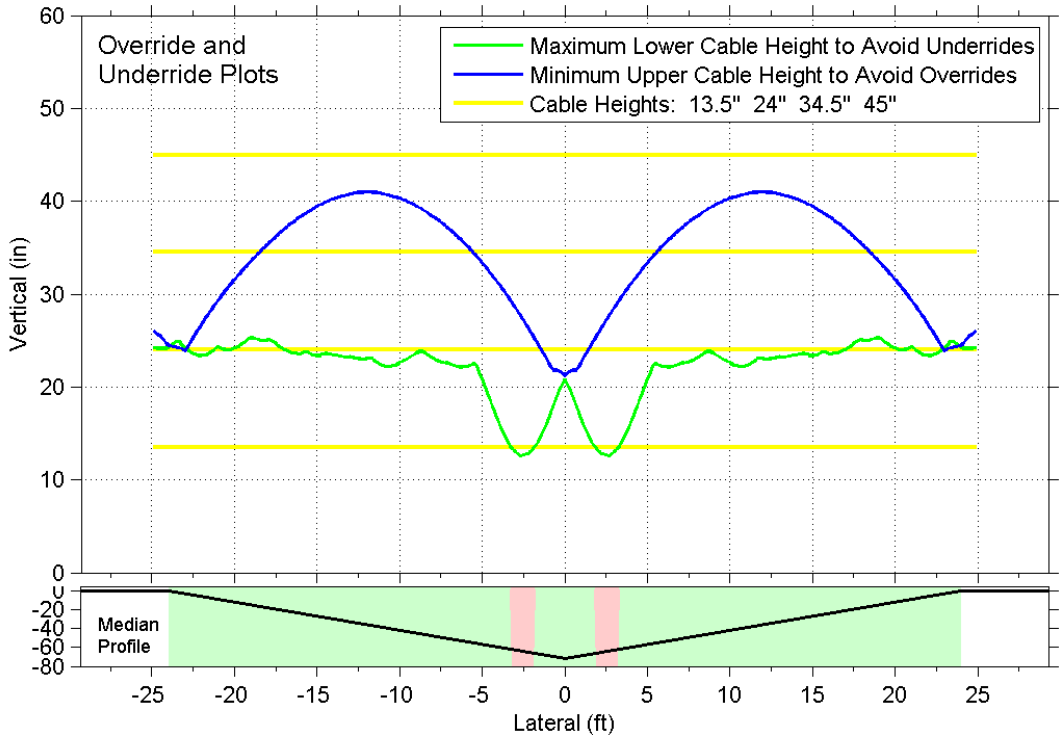




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

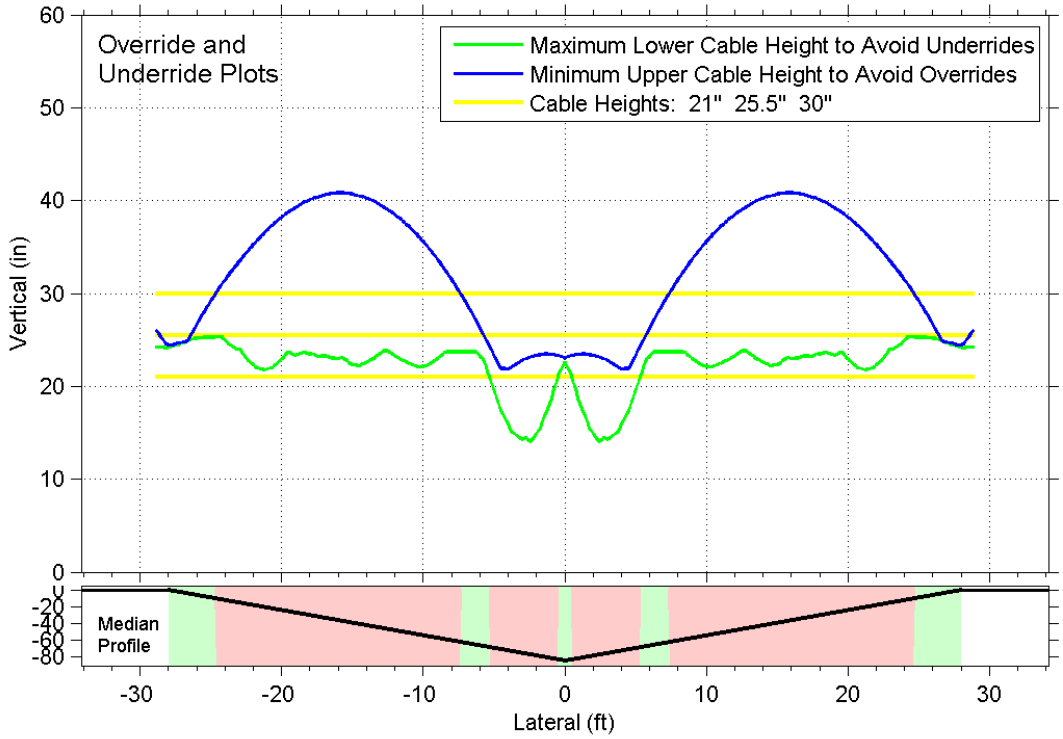
V-shaped Median - 4H:1V Slope - 48ft Width

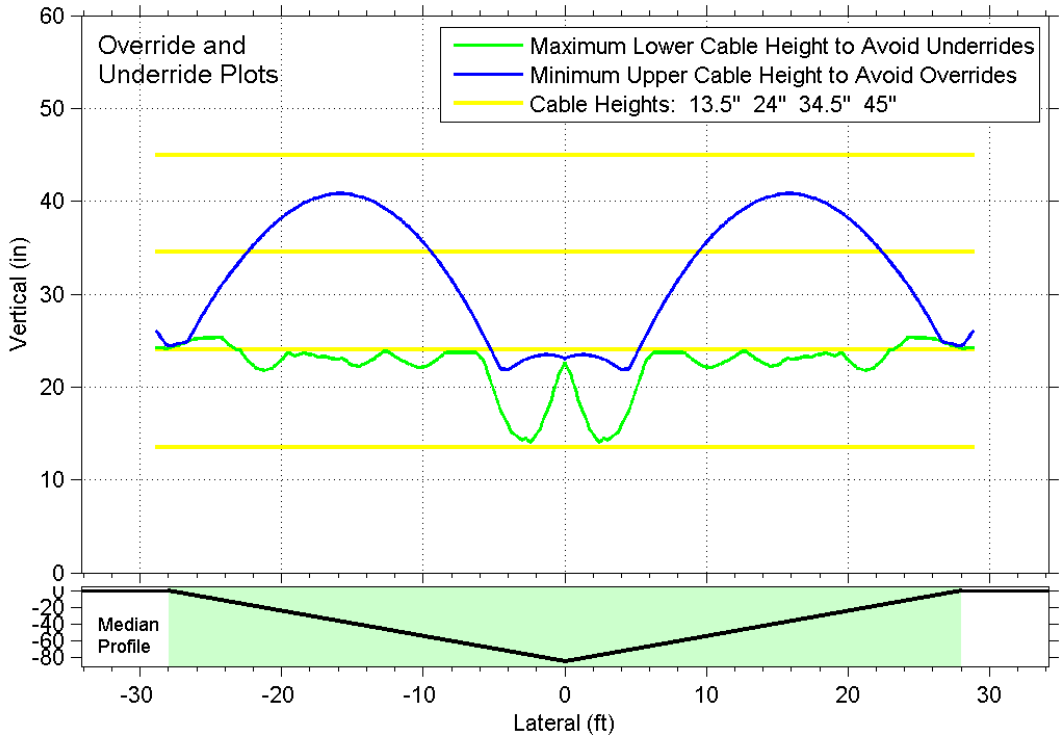




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

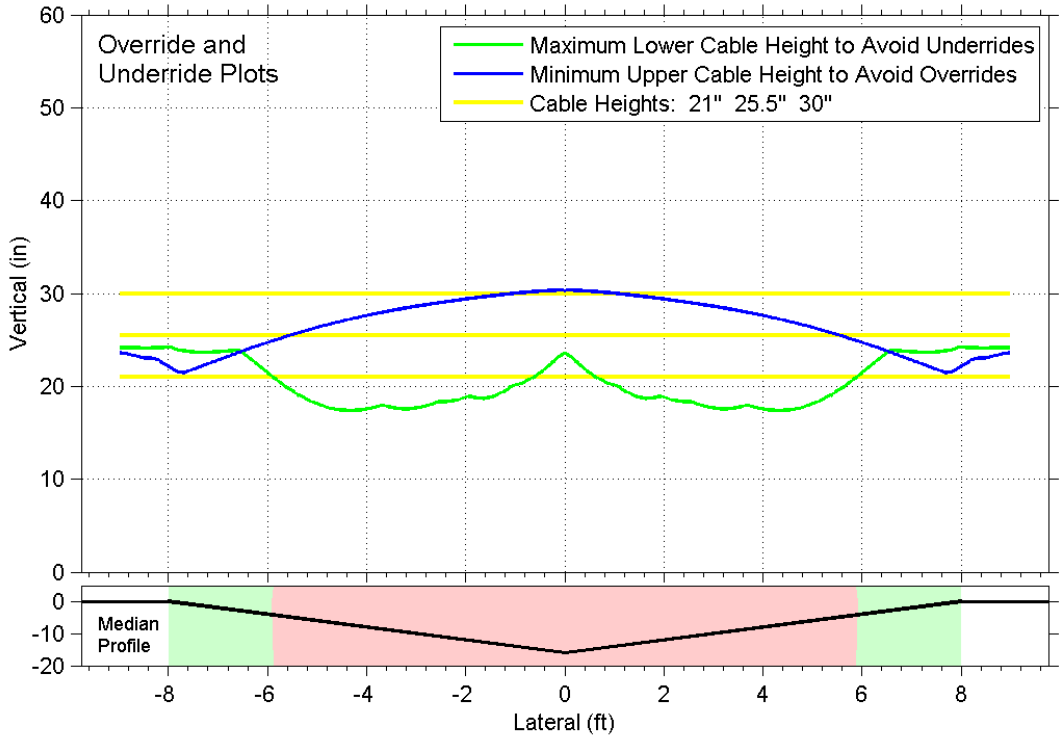
V-shaped Median - 4H:1V Slope - 56ft Width

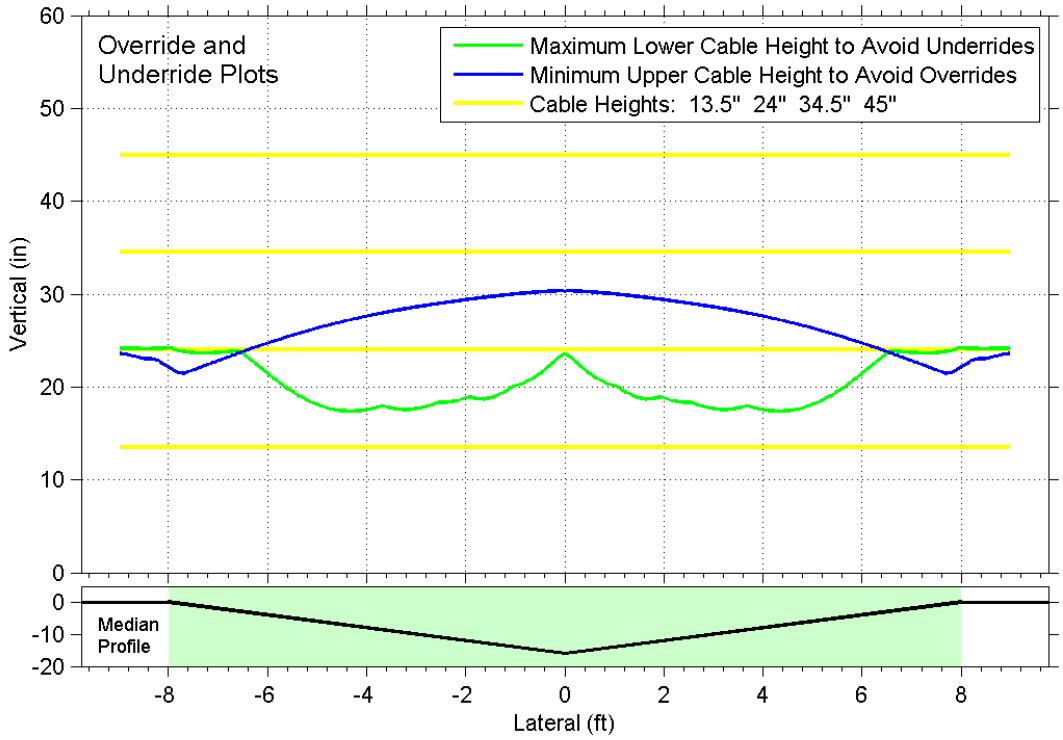




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

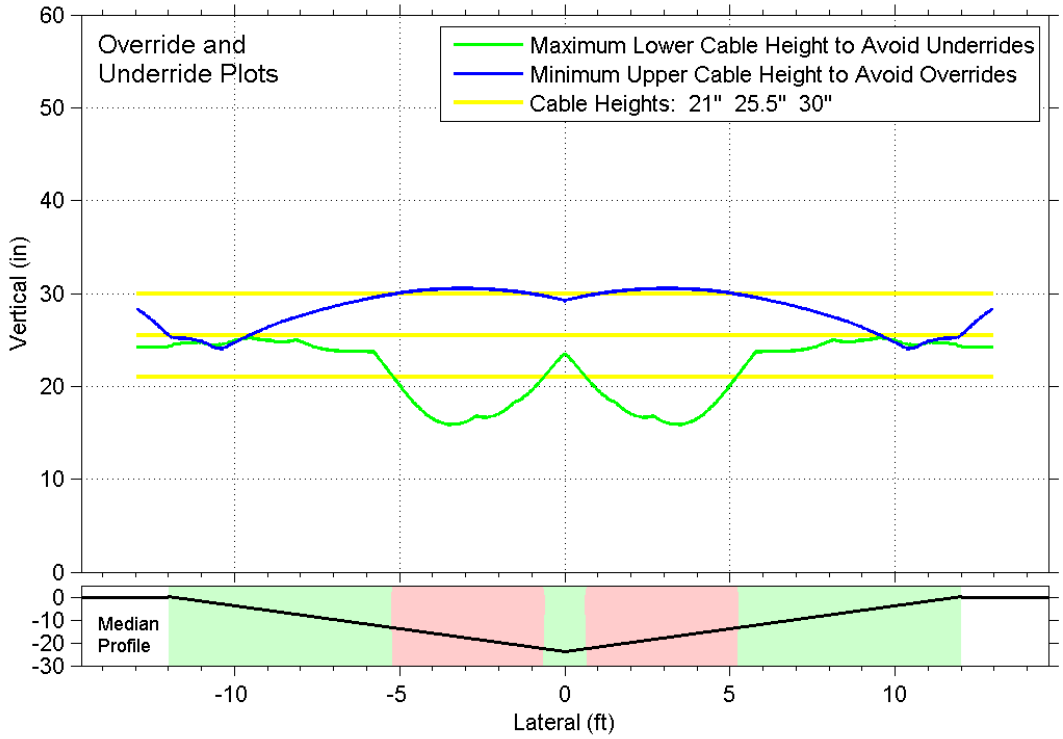
V-shaped Median - 6H:1V Slope - 16ft Width

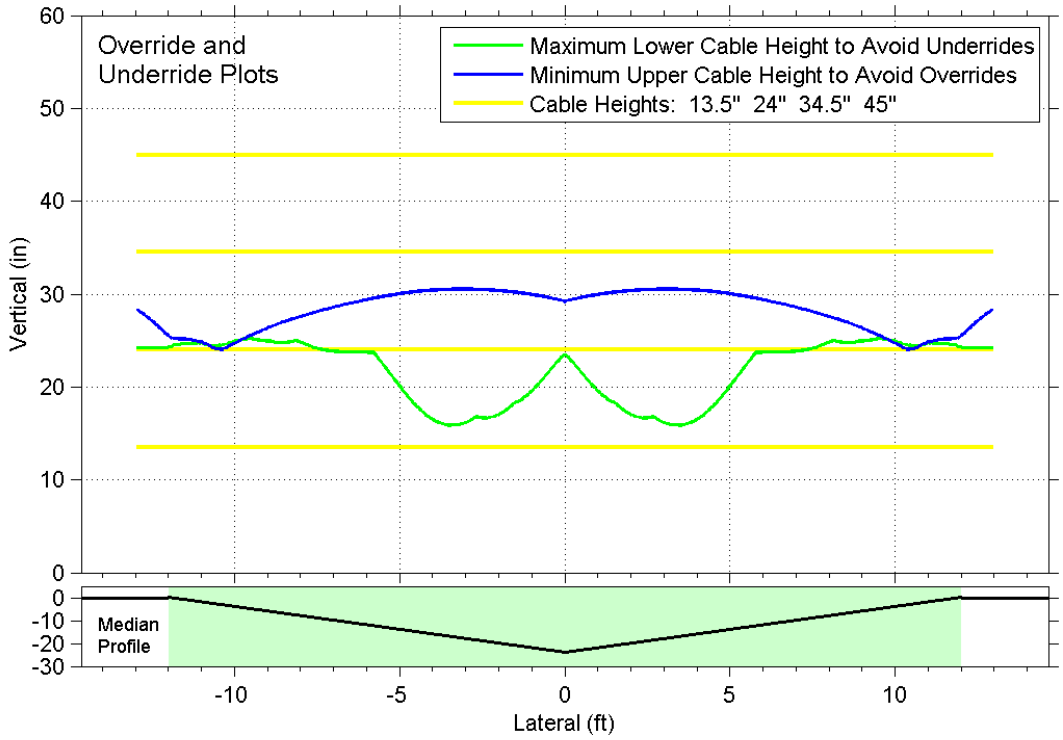




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

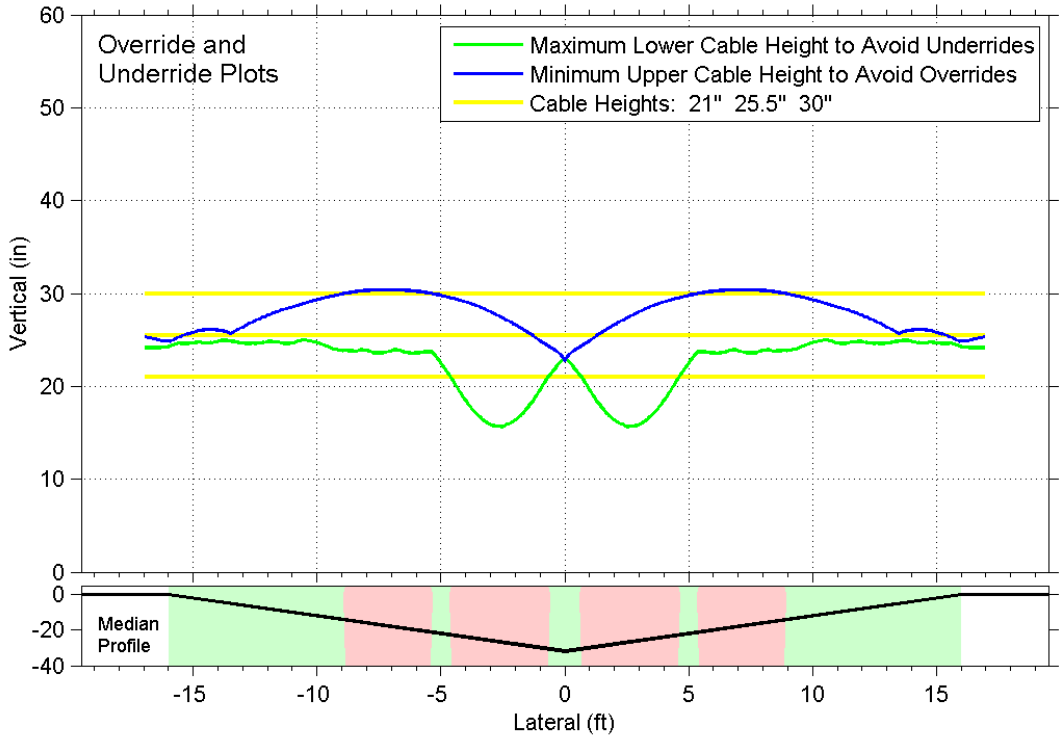
V-shaped Median - 6H:1V Slope - 24ft Width

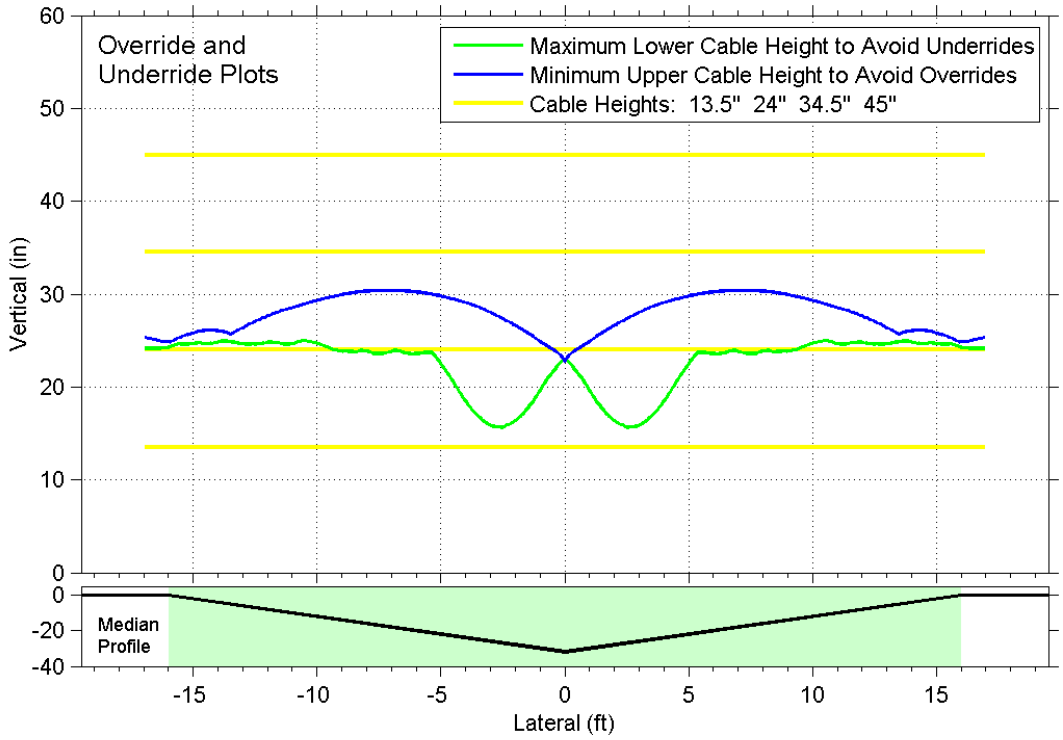




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

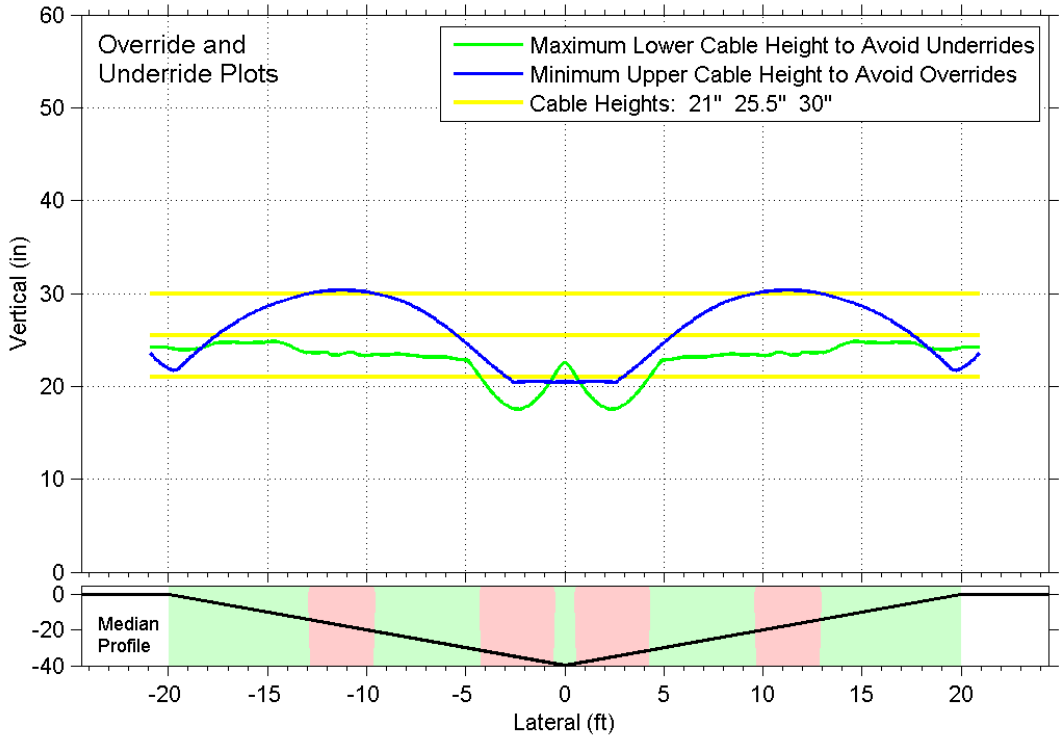
V-shaped Median - 6H:1V Slope - 32ft Width

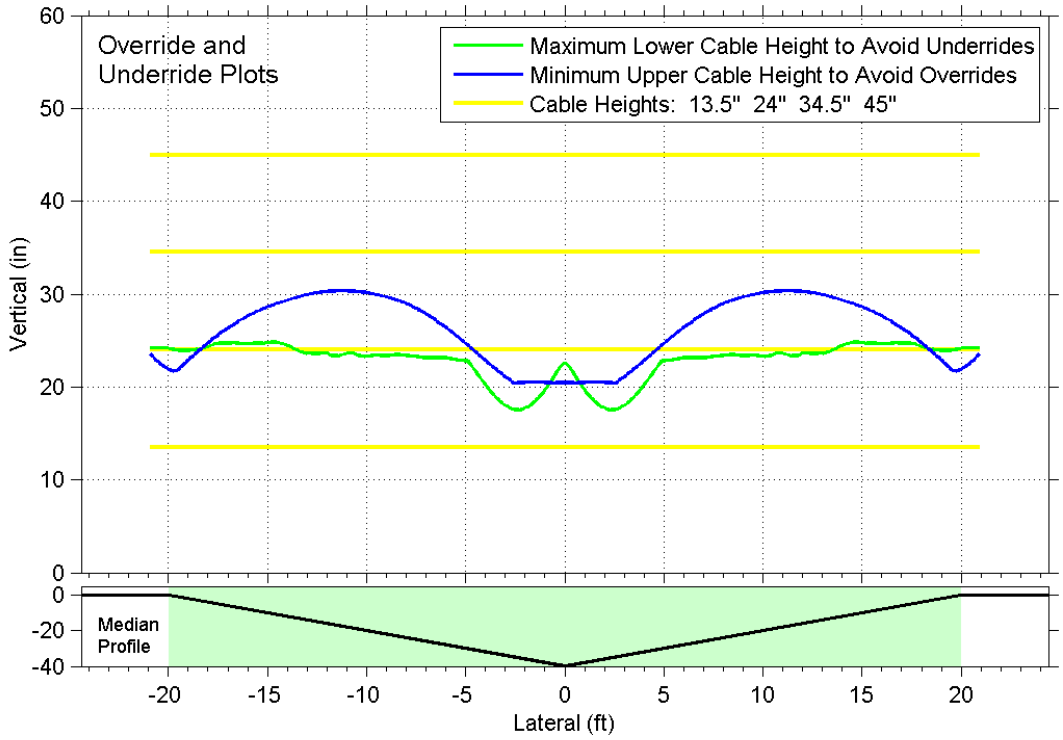




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

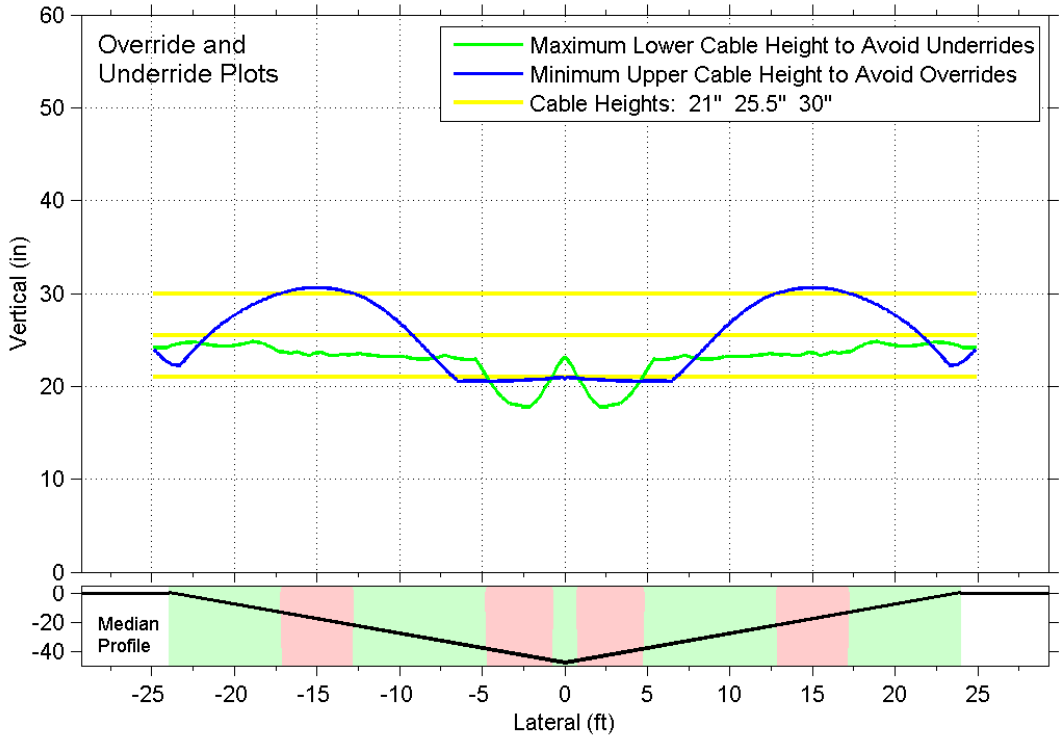
V-shaped Median - 6H:1V Slope - 40ft Width

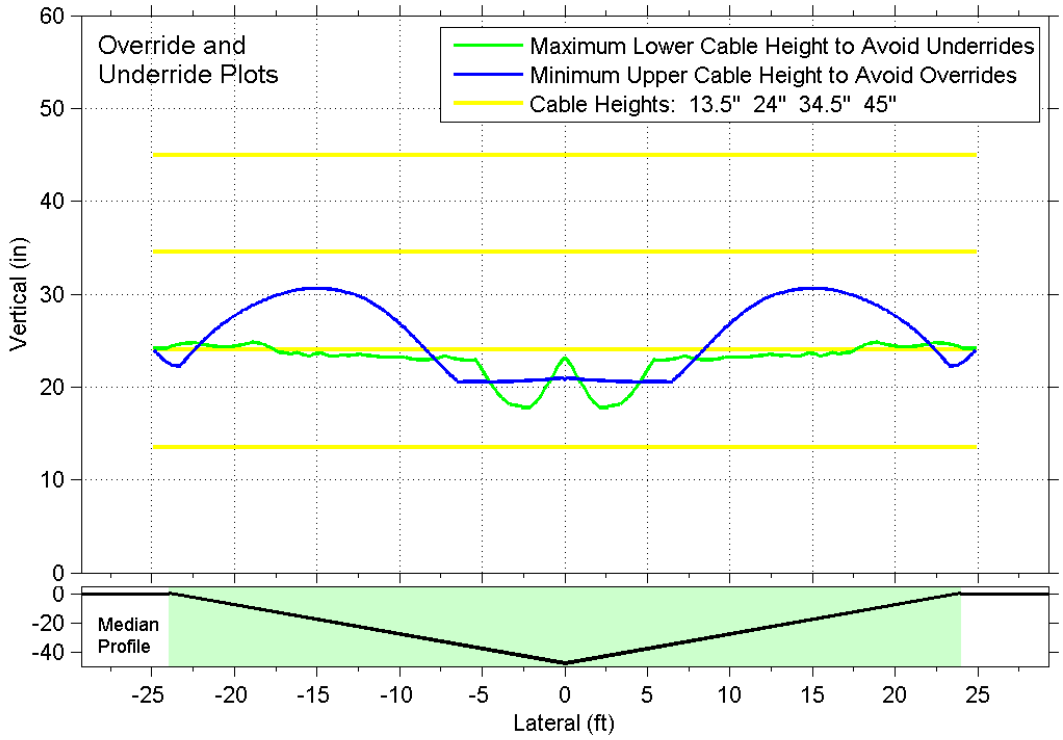




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

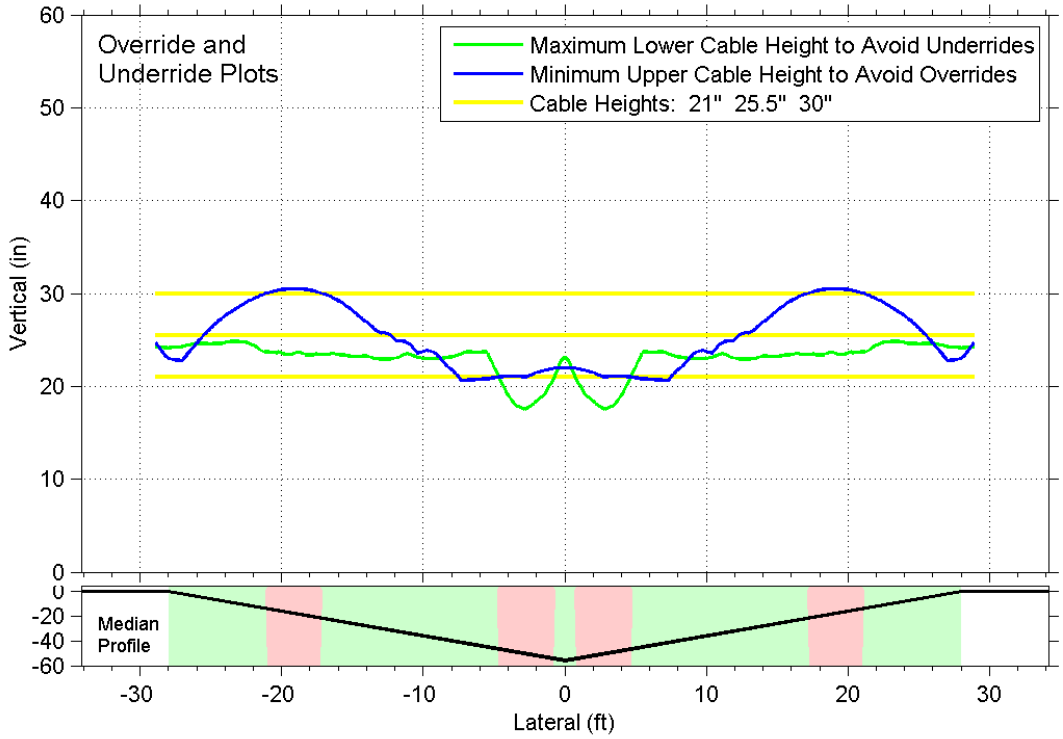
V-shaped Median - 6H:1V Slope - 48ft Width

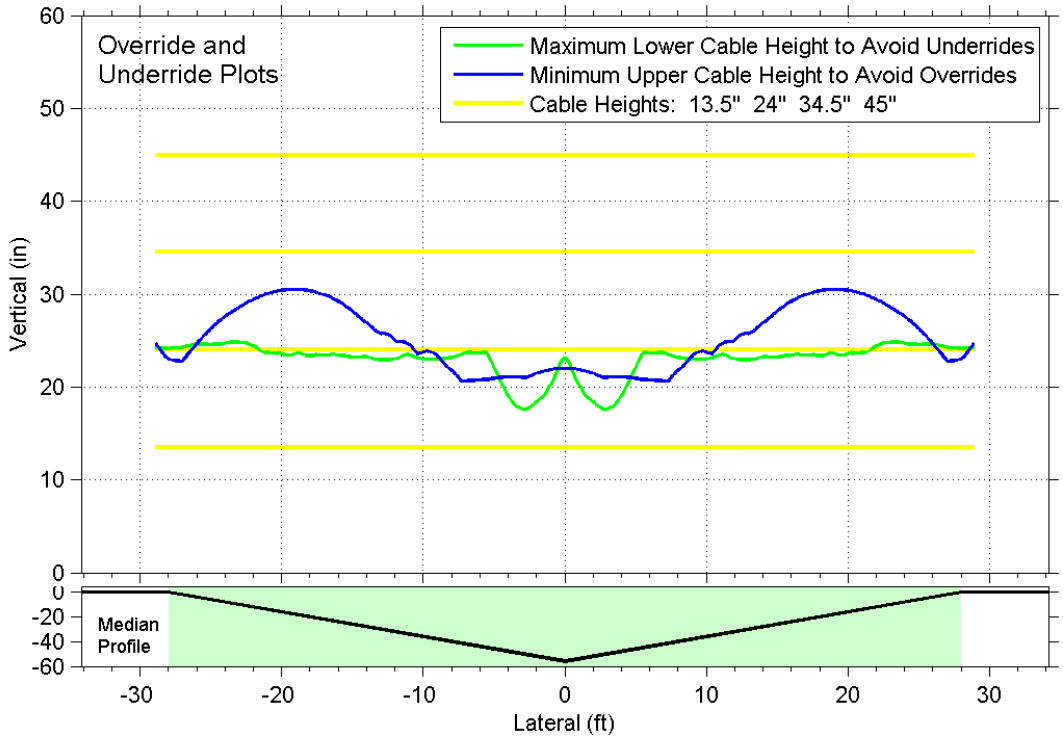




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

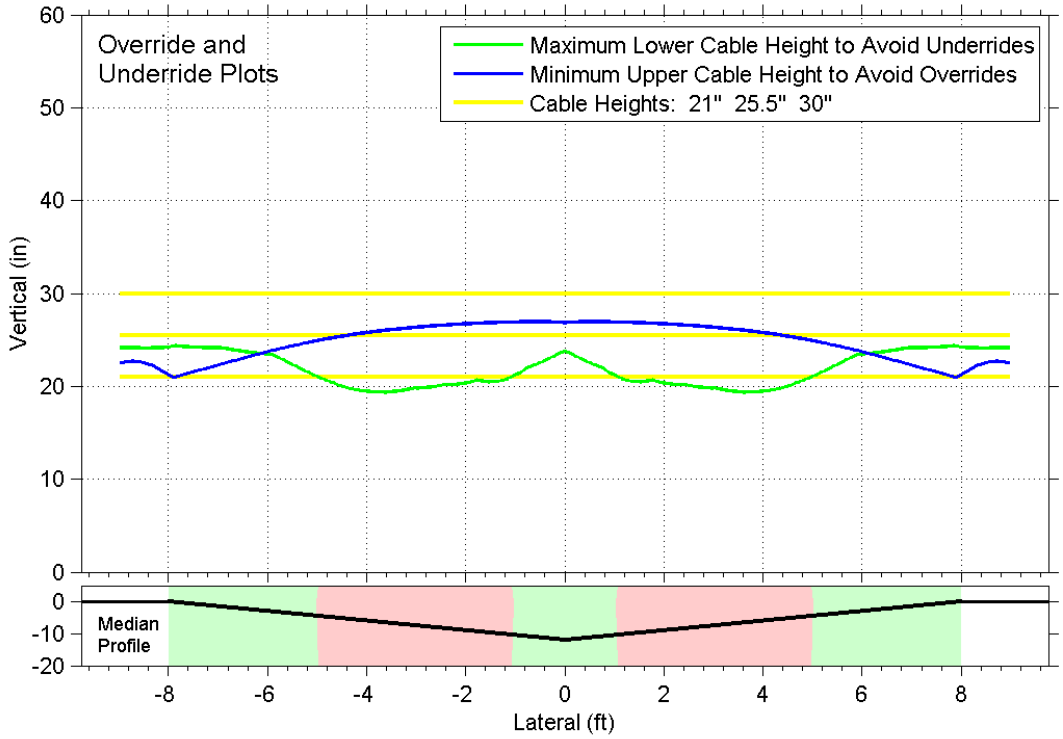
V-shaped Median - 6H:1V Slope - 56ft Width

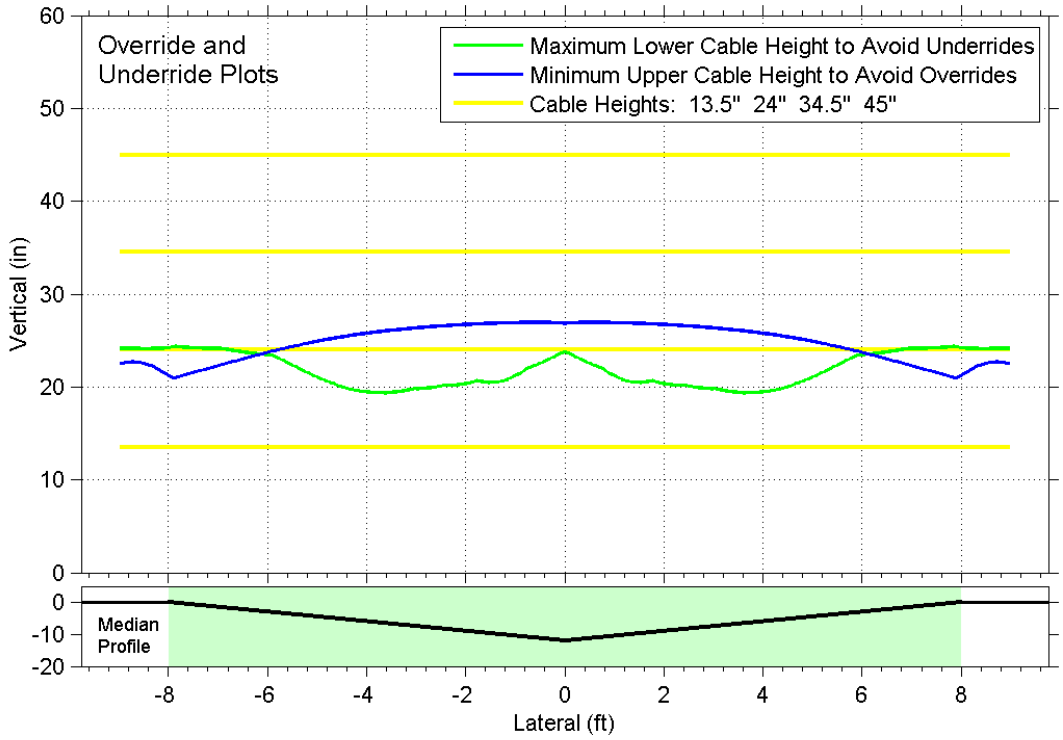




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

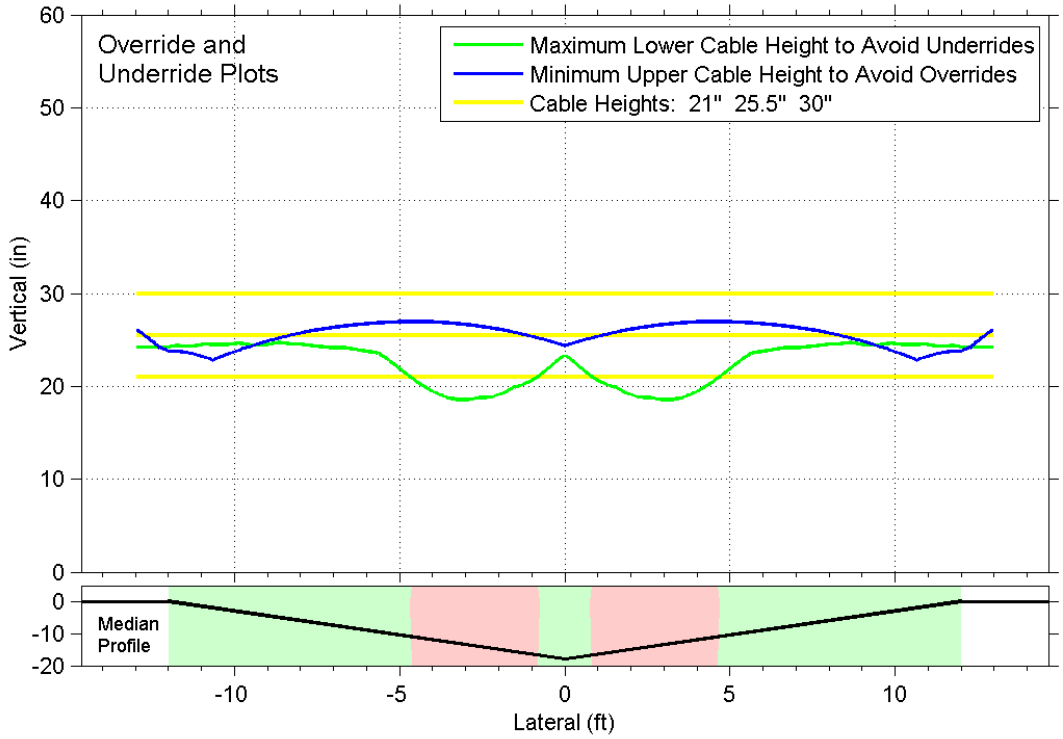
V-shaped Median - 8H:1V Slope - 16ft Width

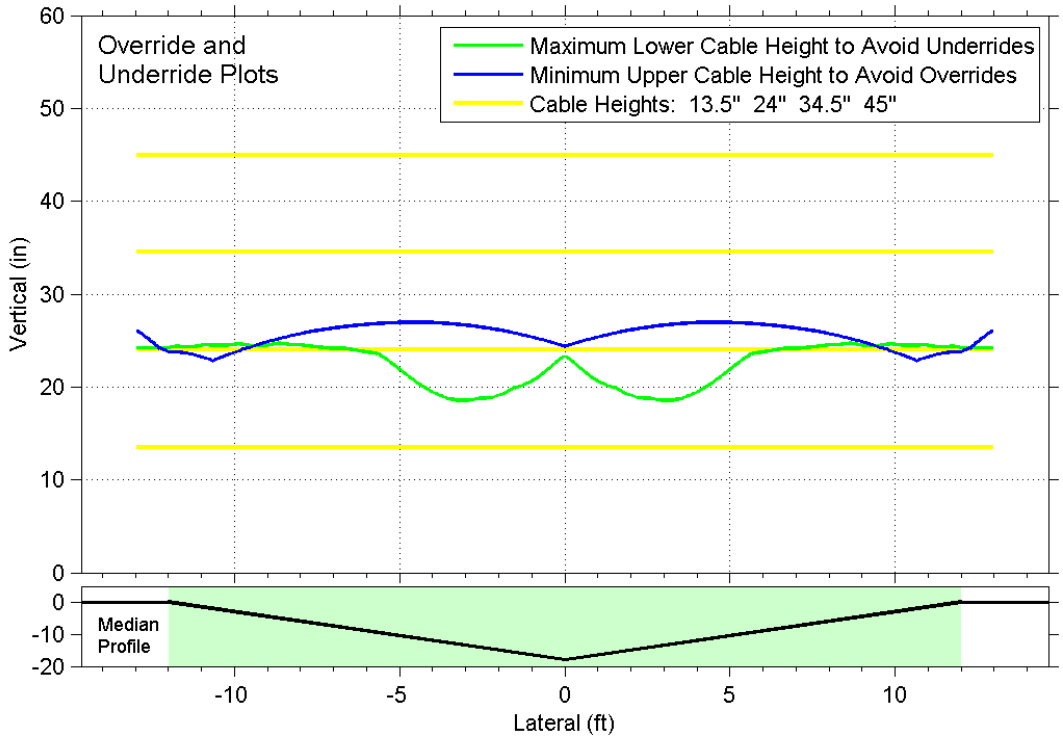




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

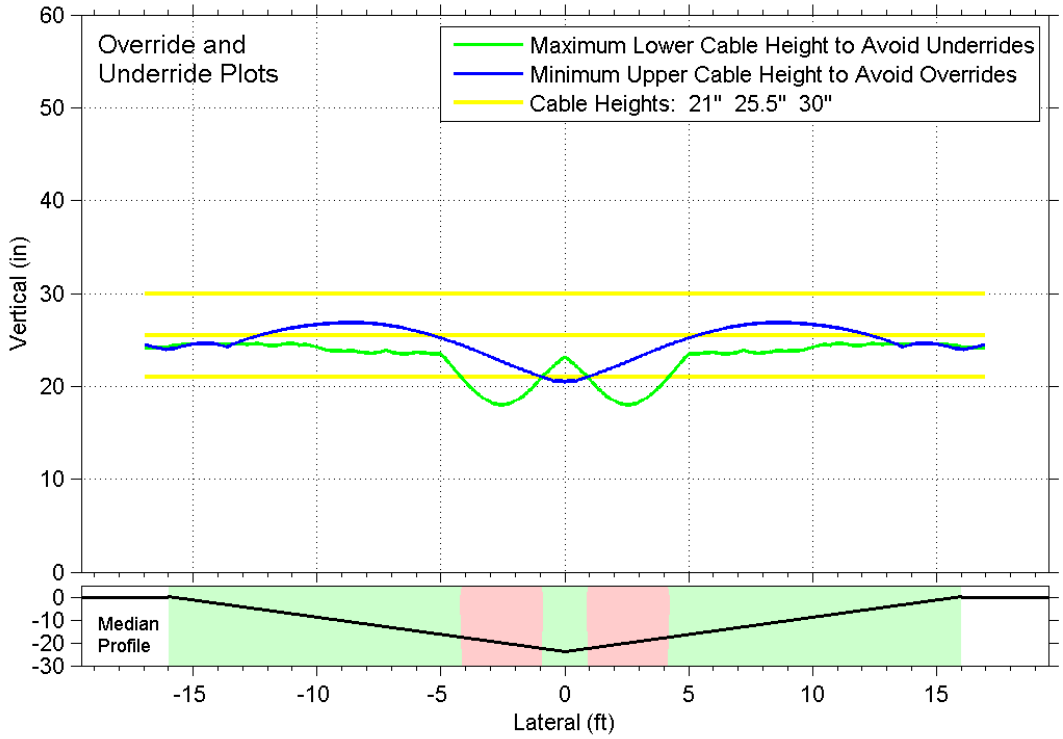
V-shaped Median - 8H:1V Slope - 24ft Width

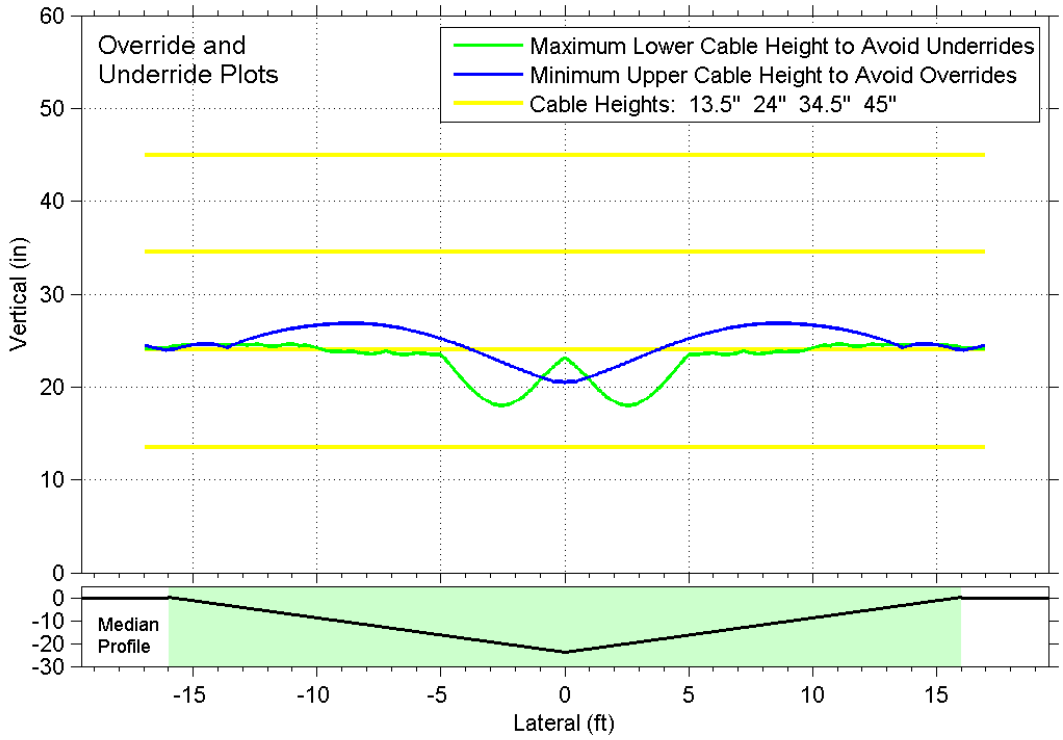




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

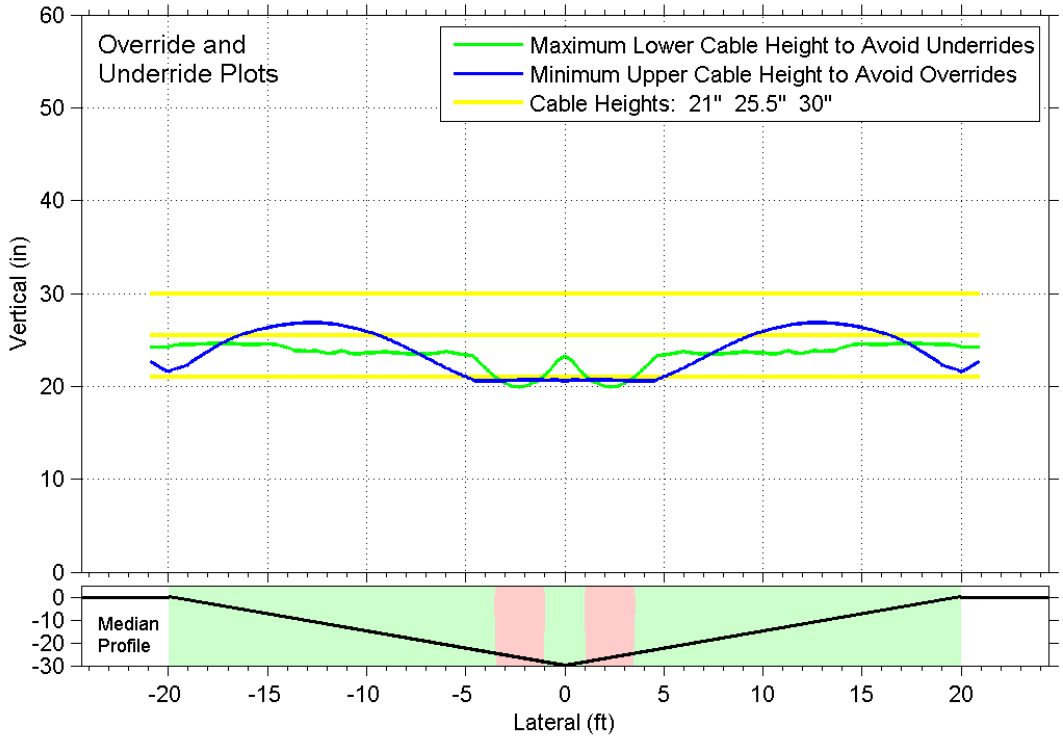
V-shaped Median - 8H:1V Slope - 32ft Width

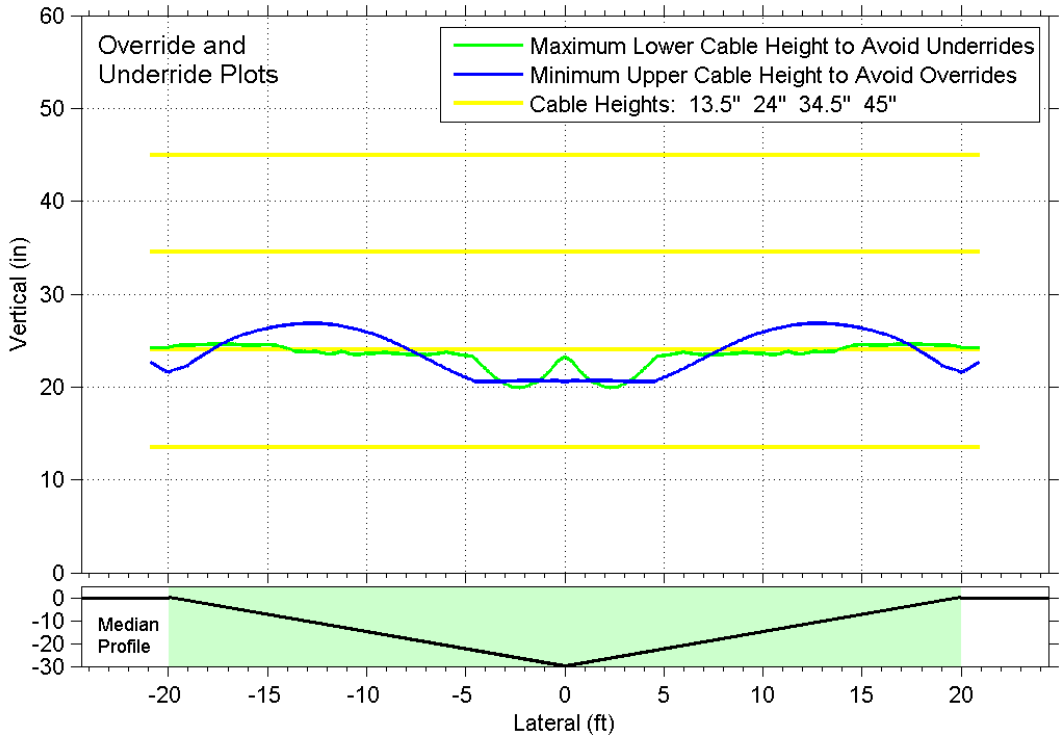




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

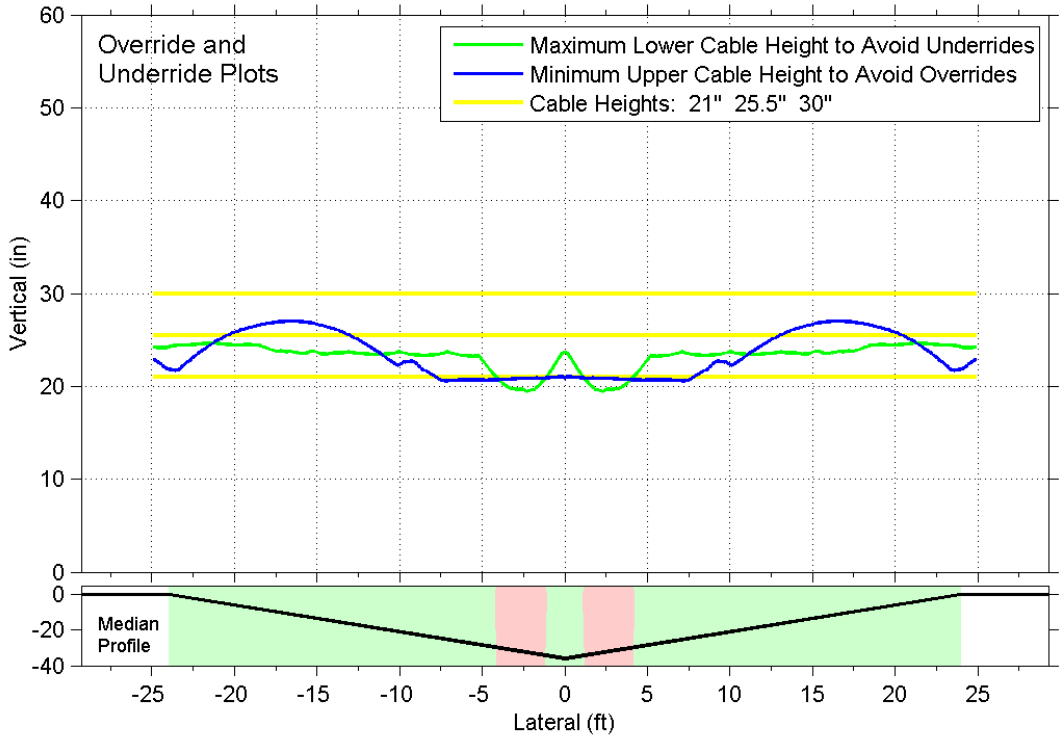
V-shaped Median - 8H:1V Slope - 40ft Width

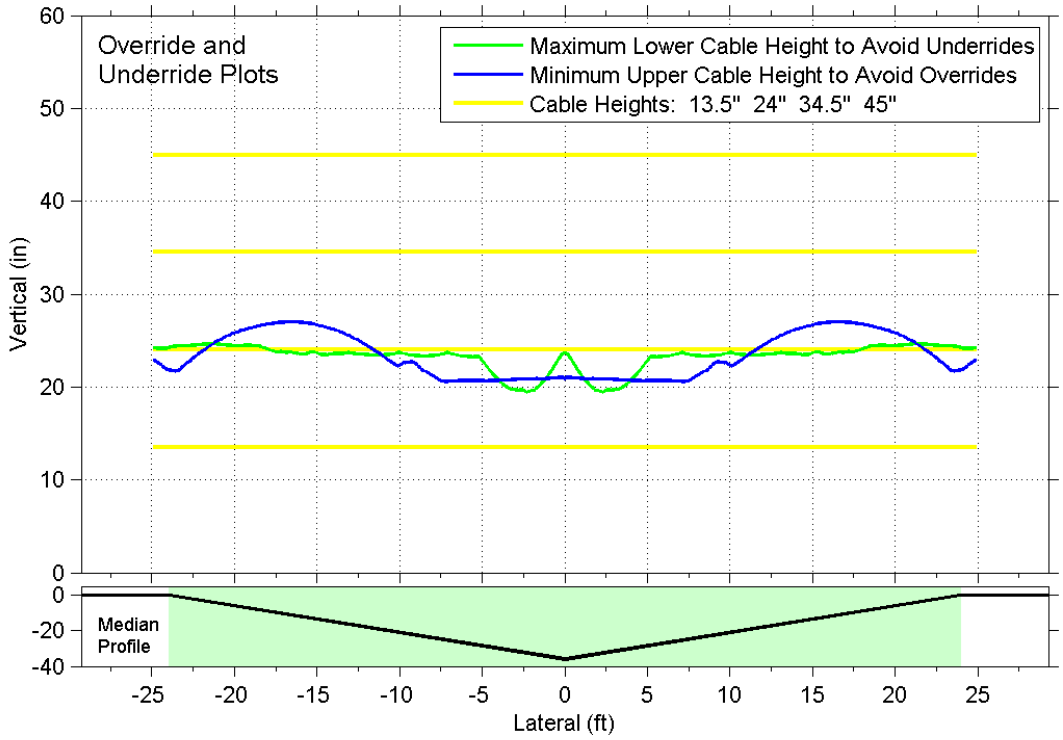




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

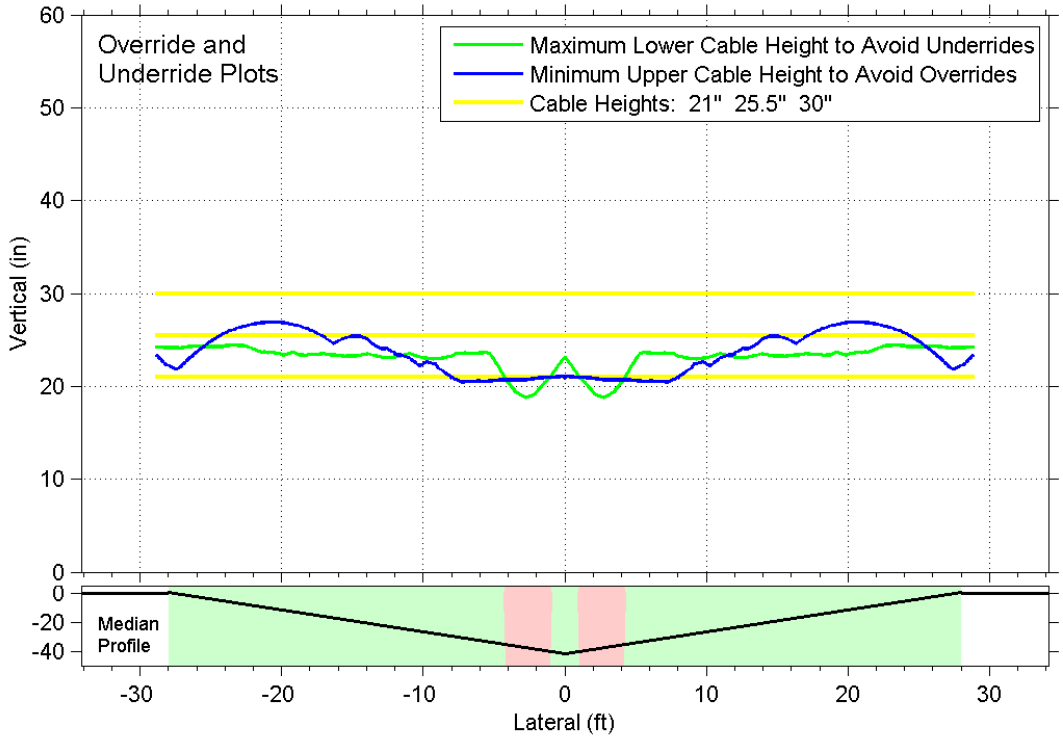
V-shaped Median - 8H:1V Slope - 48ft Width

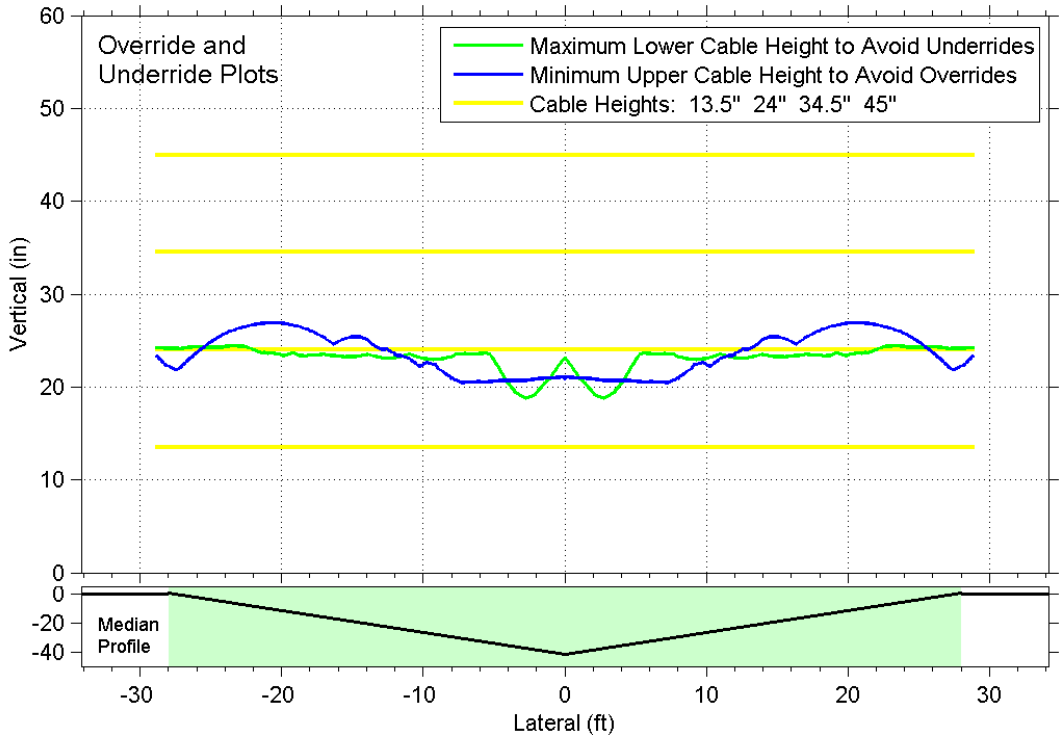




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

V-shaped Median - 8H:1V Slope - 56ft Width

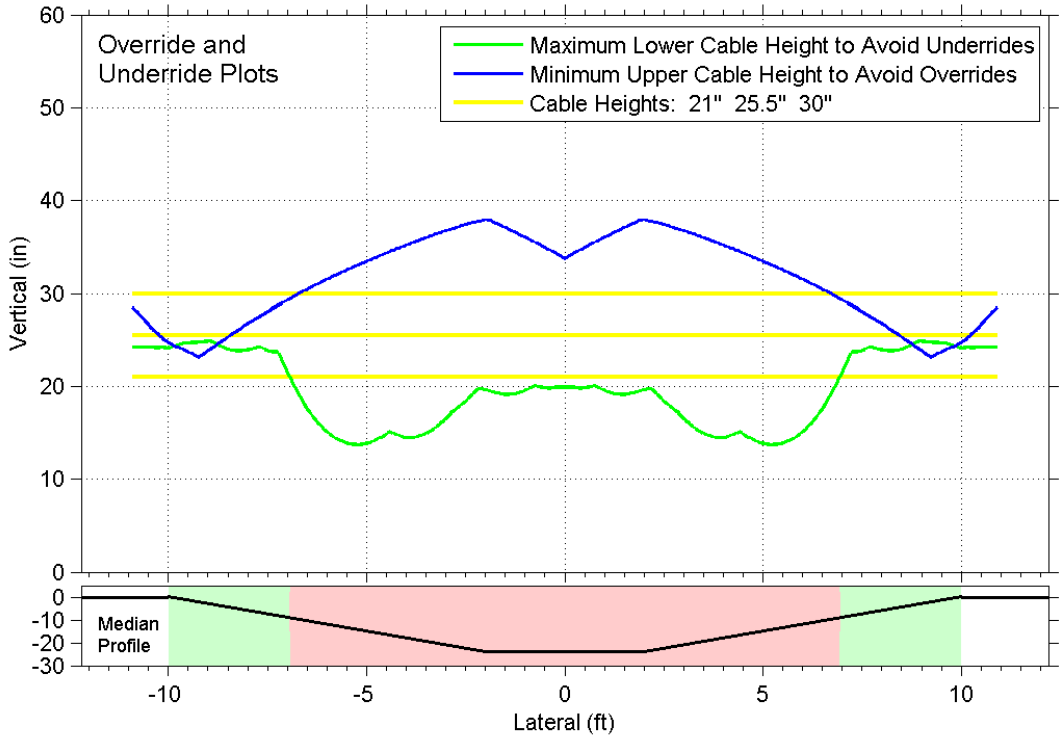


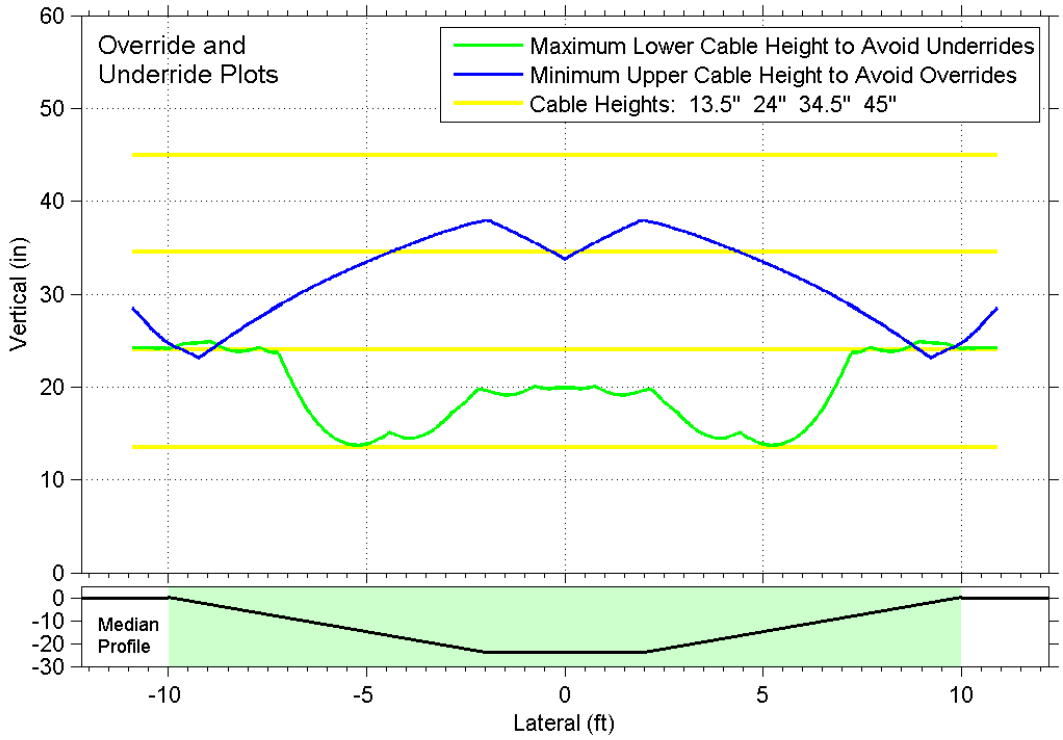


Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

Symmetric Flat-bottom Medians

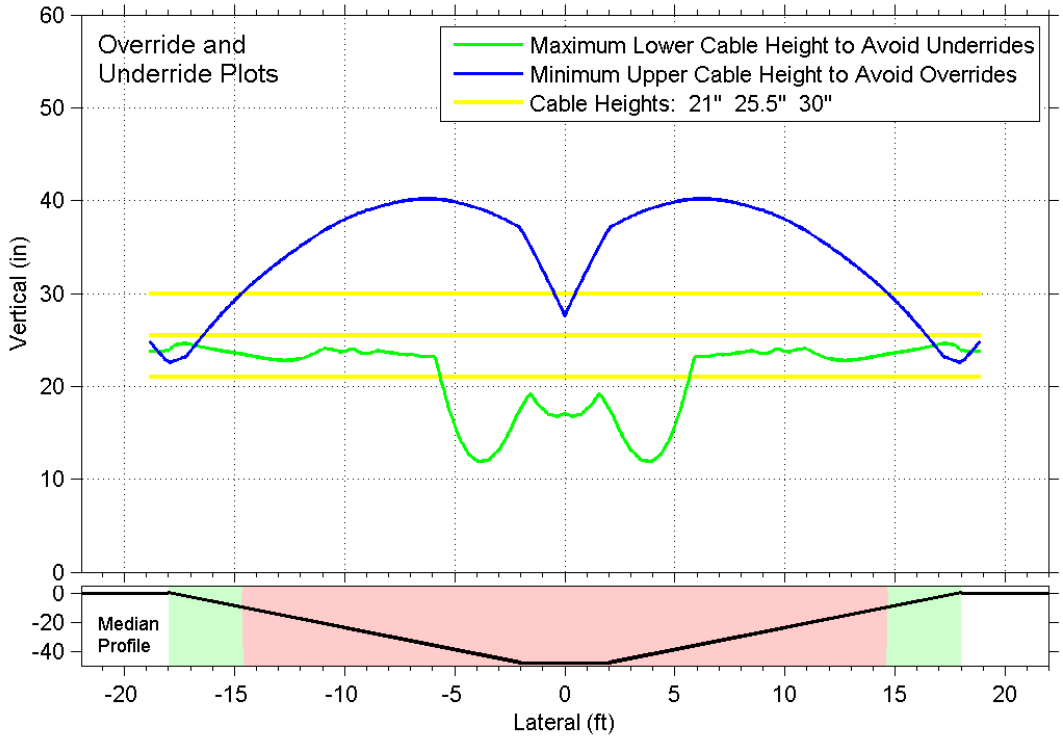
Flat-bottom Median - 4H:1V Slope - 4ft FB Width - 2ft Depth

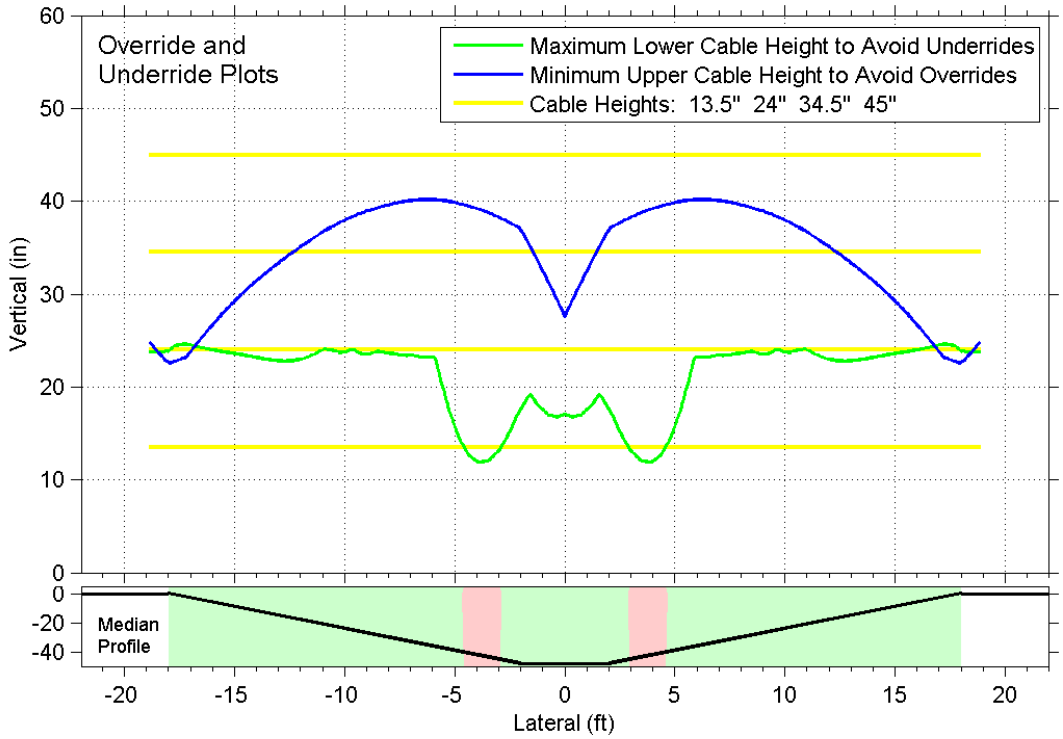




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

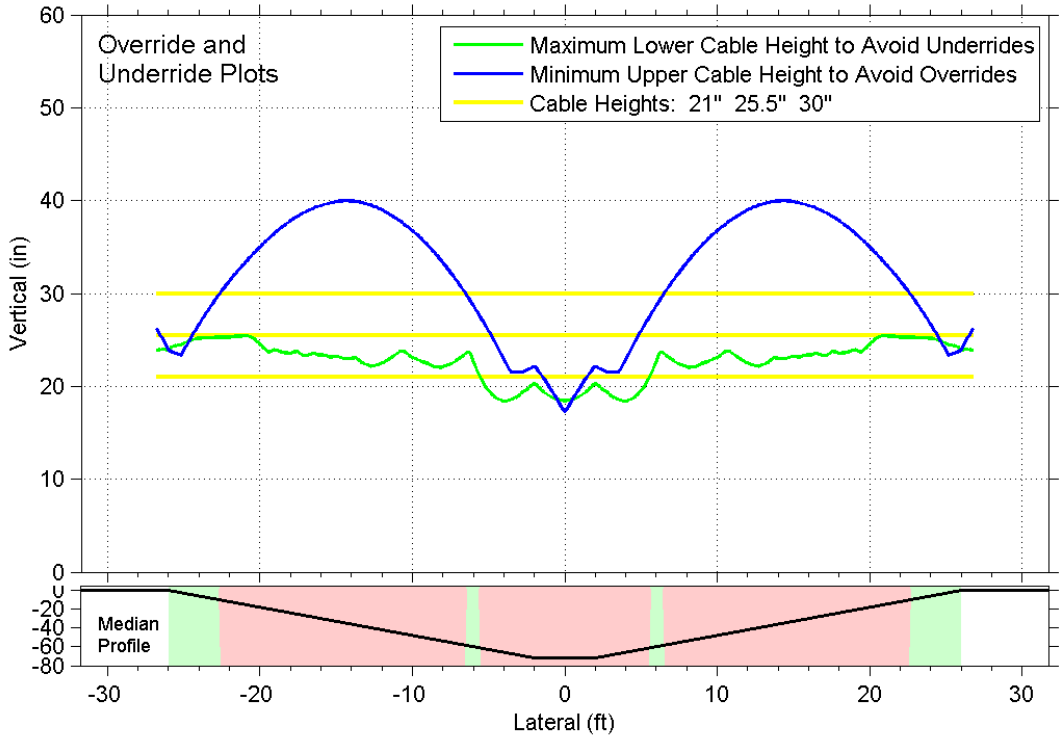
Flat-bottom Median - 4H:1V Slope - 4ft FB Width - 4ft Depth

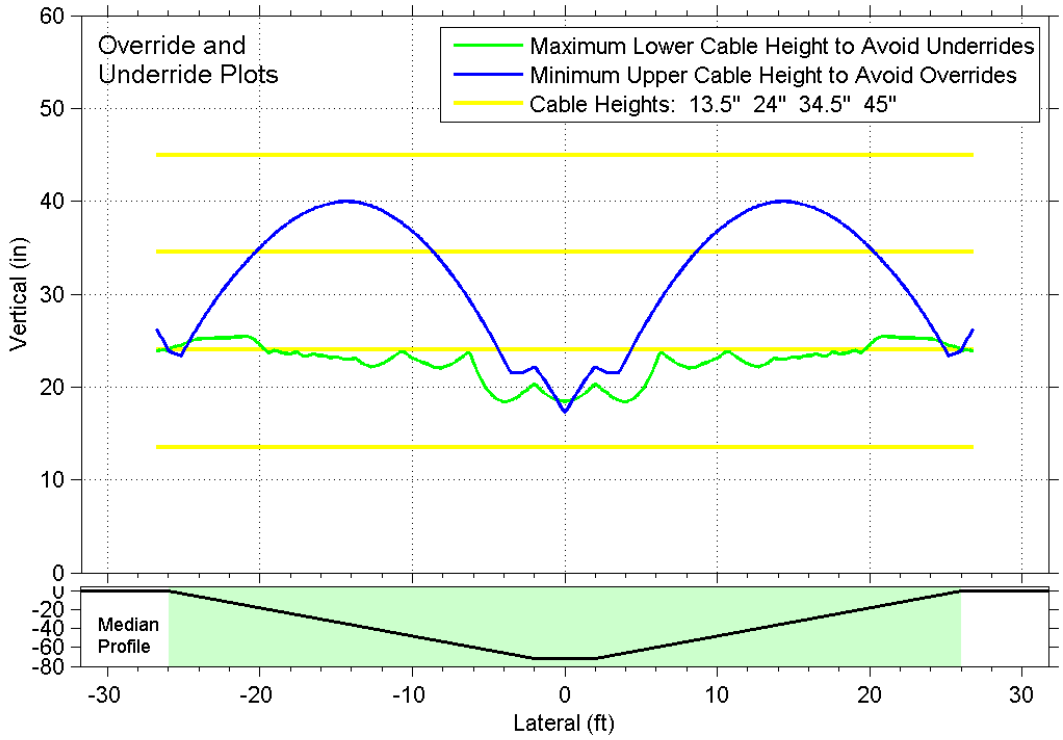




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

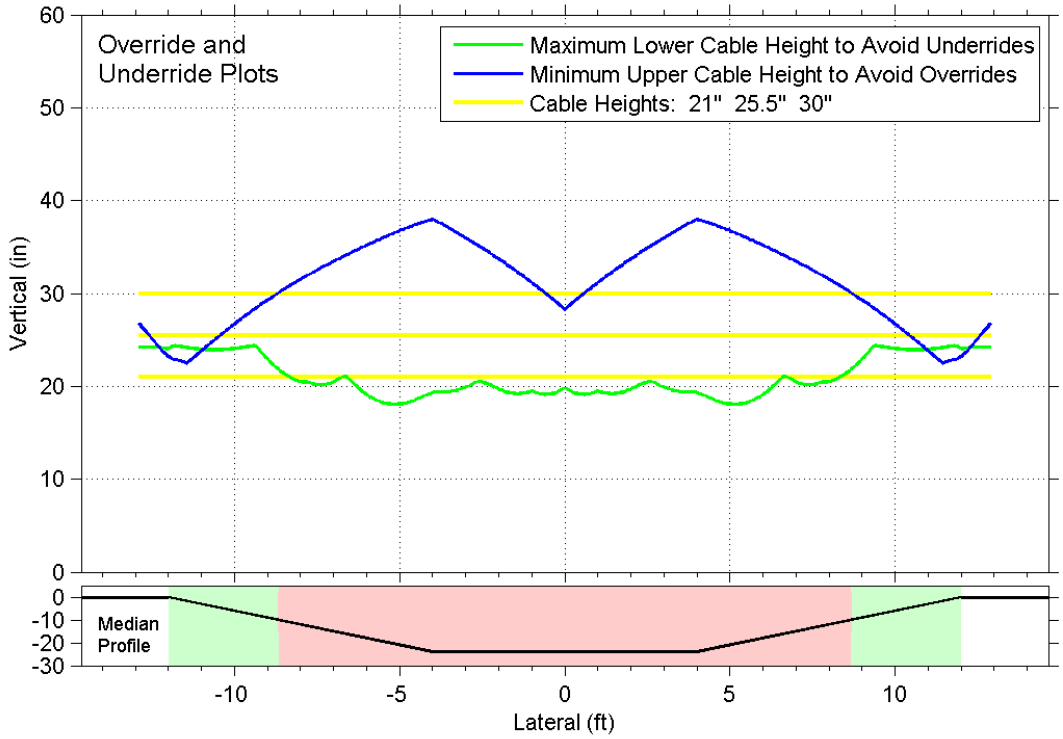
Flat-bottom Median - 4H:1V Slope - 4ft FB Width - 6ft Depth

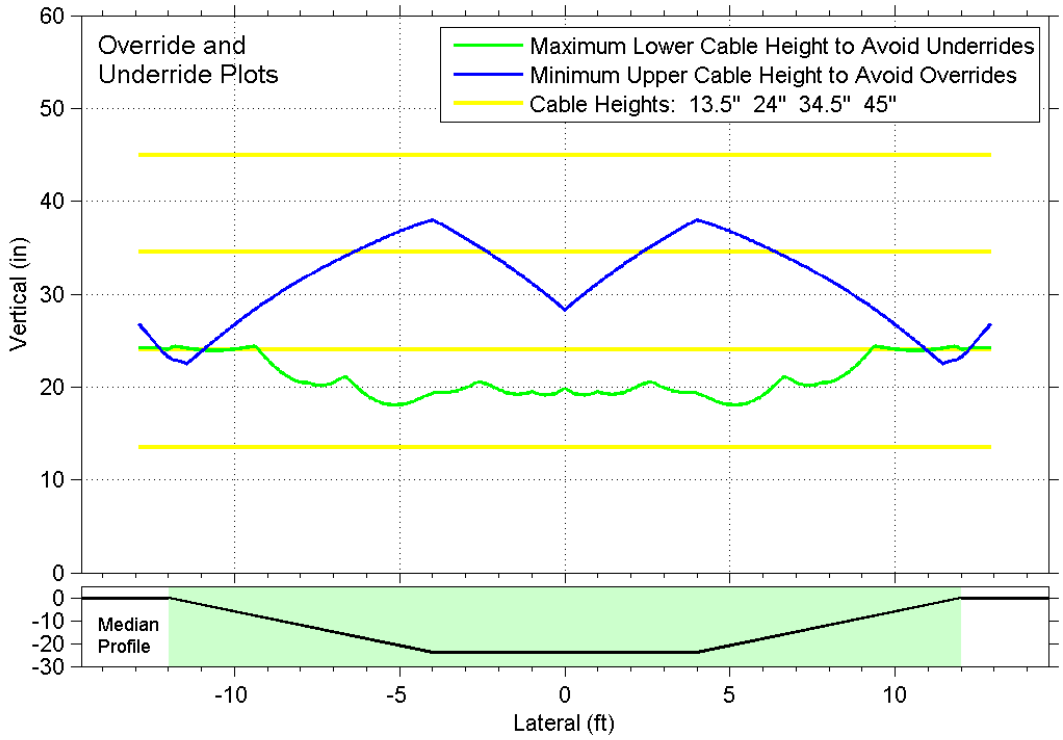




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

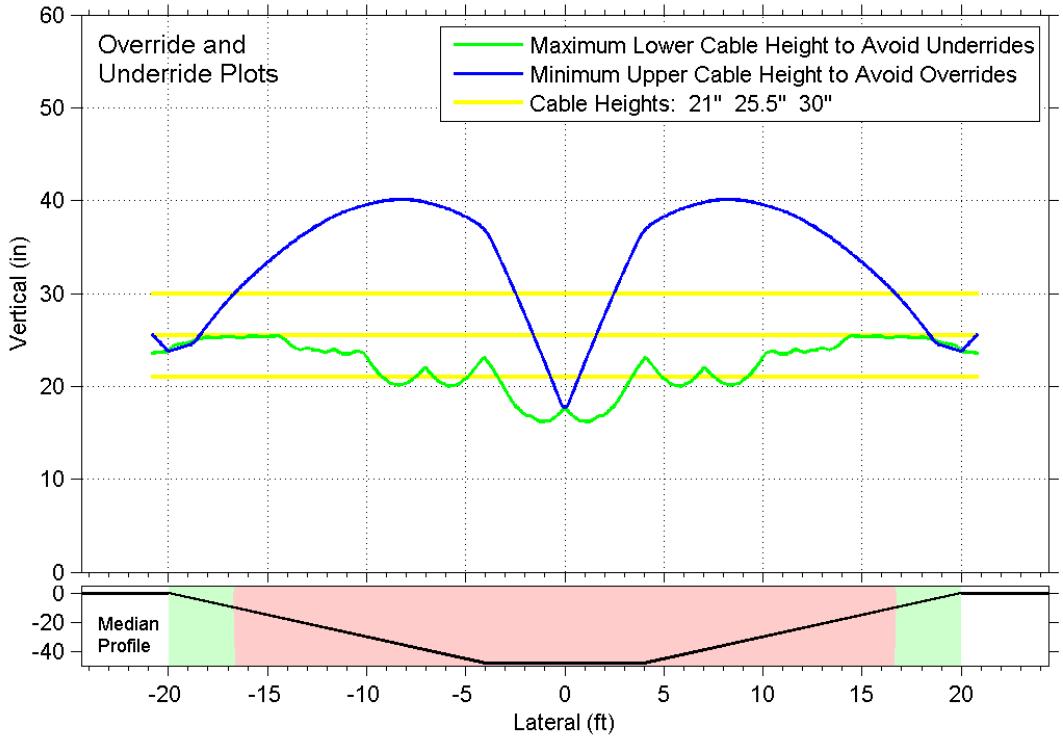
Flat-bottom Median - 4H:1V Slope - 8ft FB Width - 2ft Depth

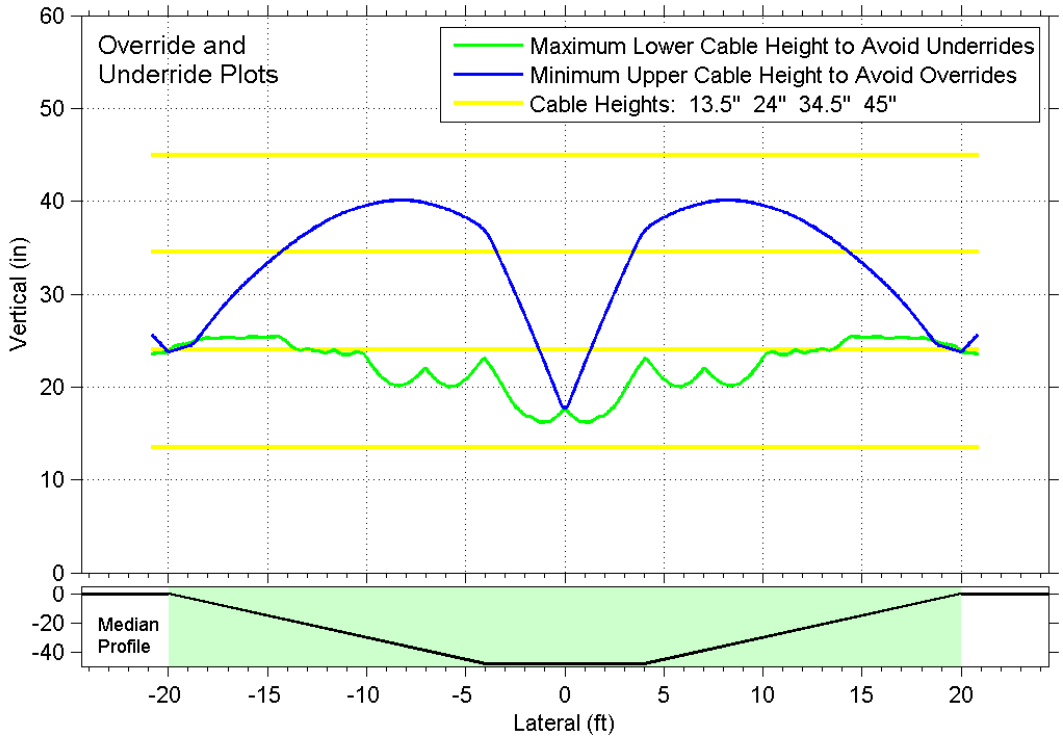




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

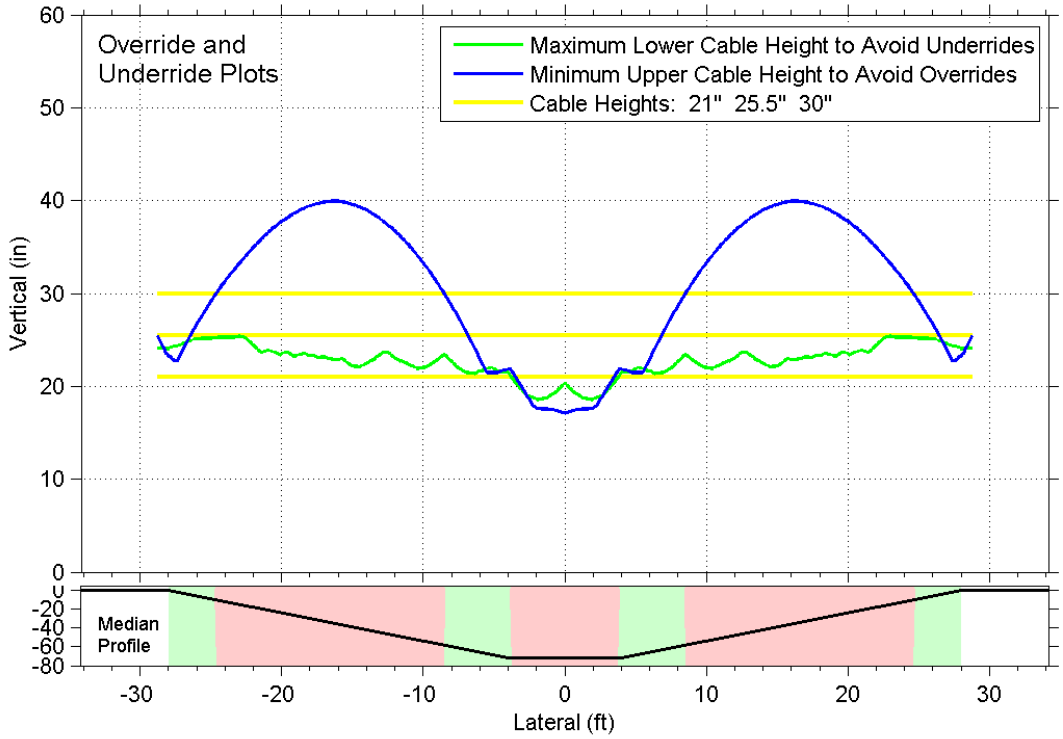
Flat-bottom Median - 4H:1V Slope - 8ft FB Width - 4ft Depth

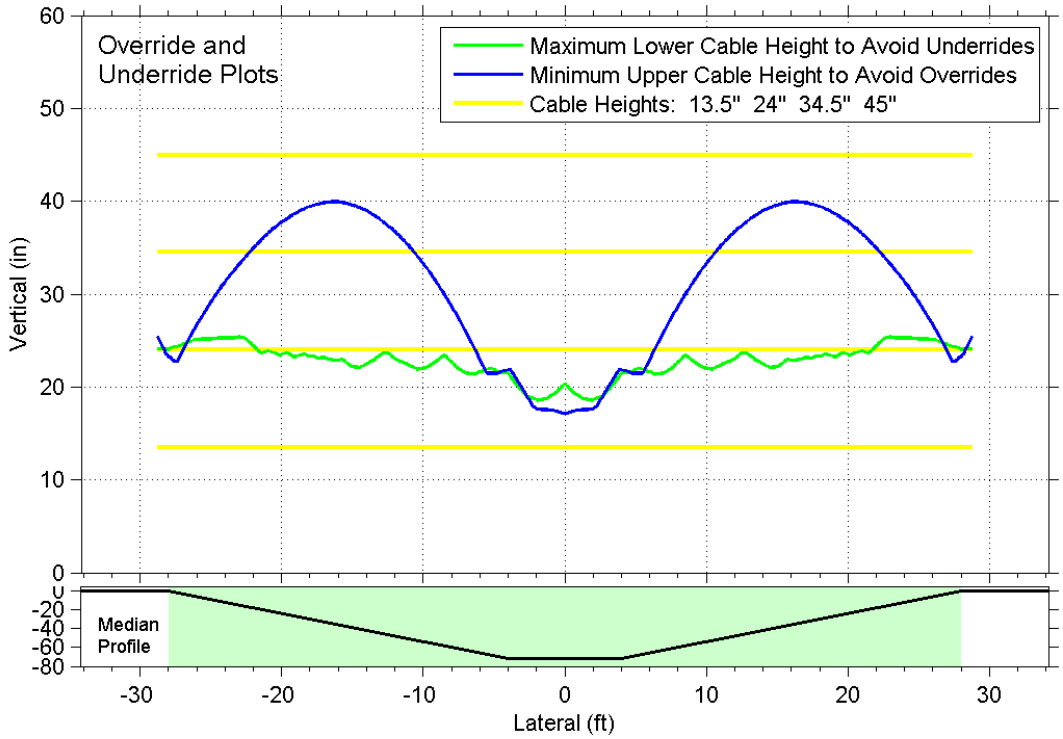




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

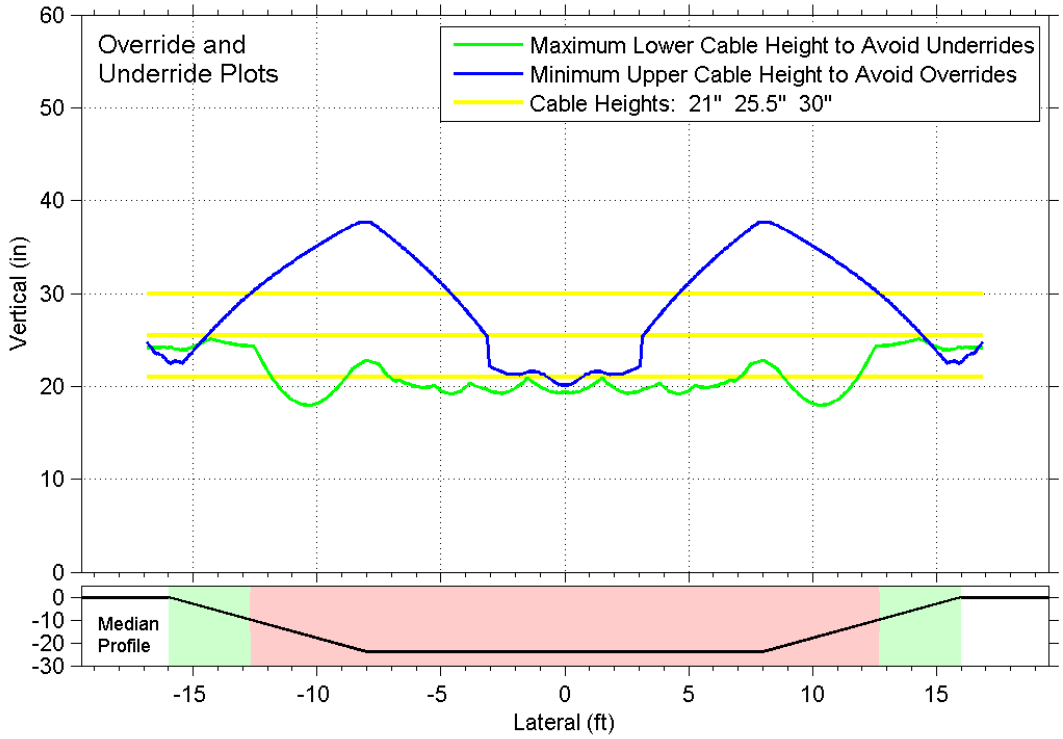
Flat-bottom Median - 4H:1V Slope - 8ft FB Width - 6ft Depth

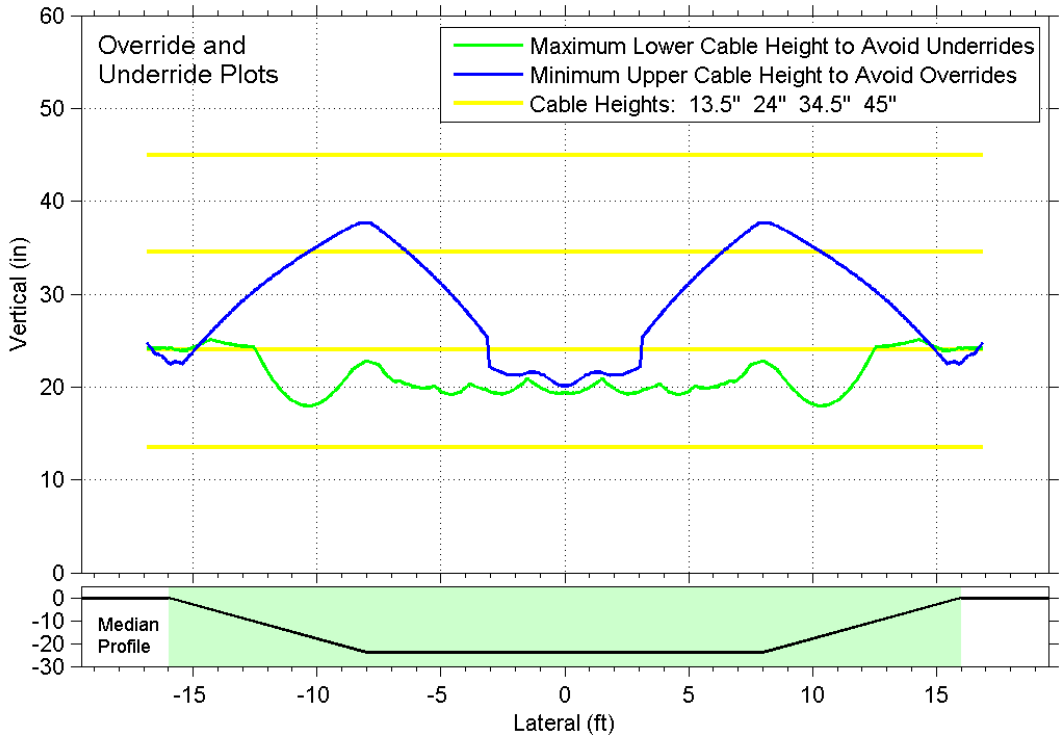




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

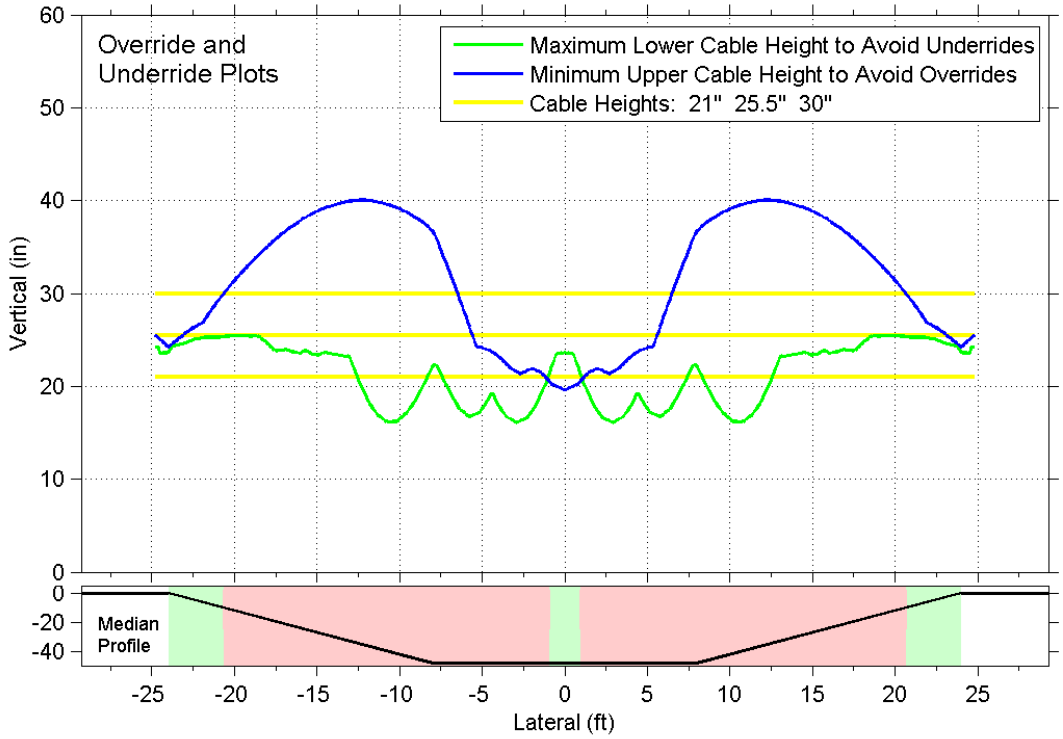
Flat-bottom Median - 4H:1V Slope - 16ft FB Width - 2ft Depth

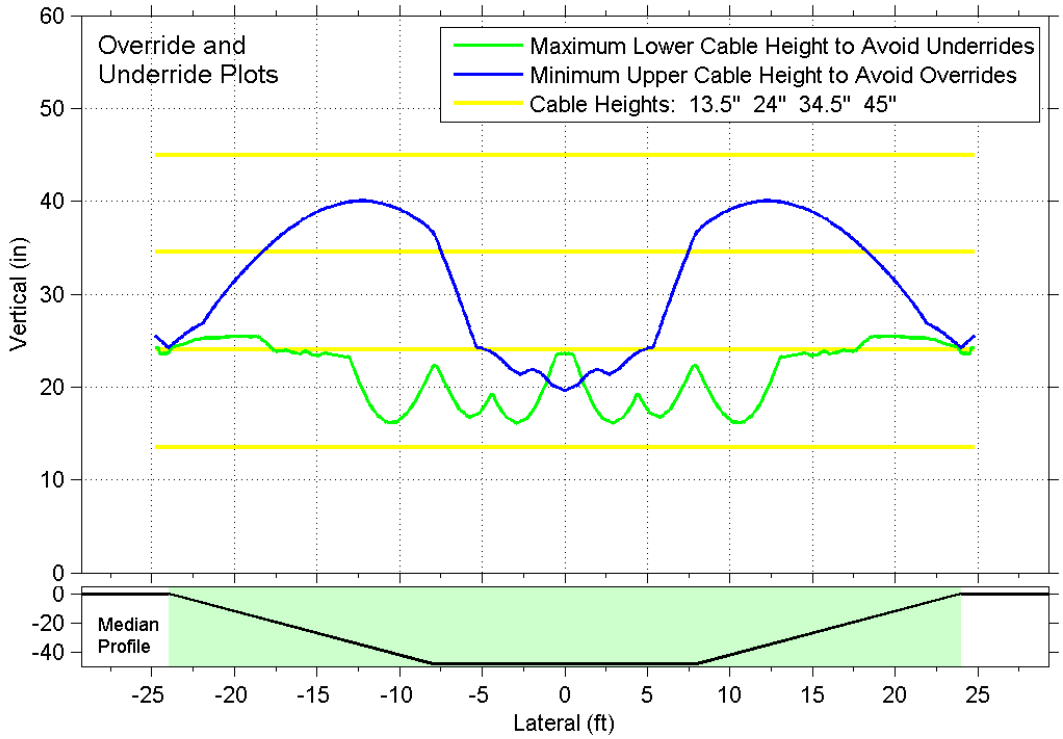




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

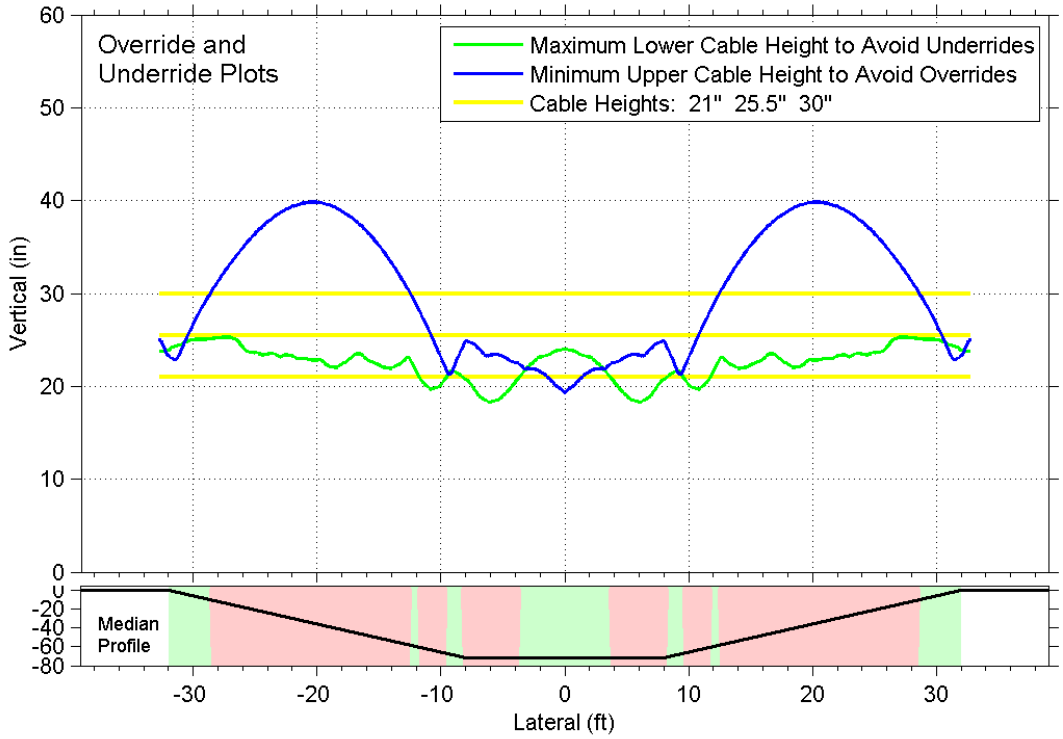
Flat-bottom Median - 4H:1V Slope - 16ft FB Width - 4ft Depth

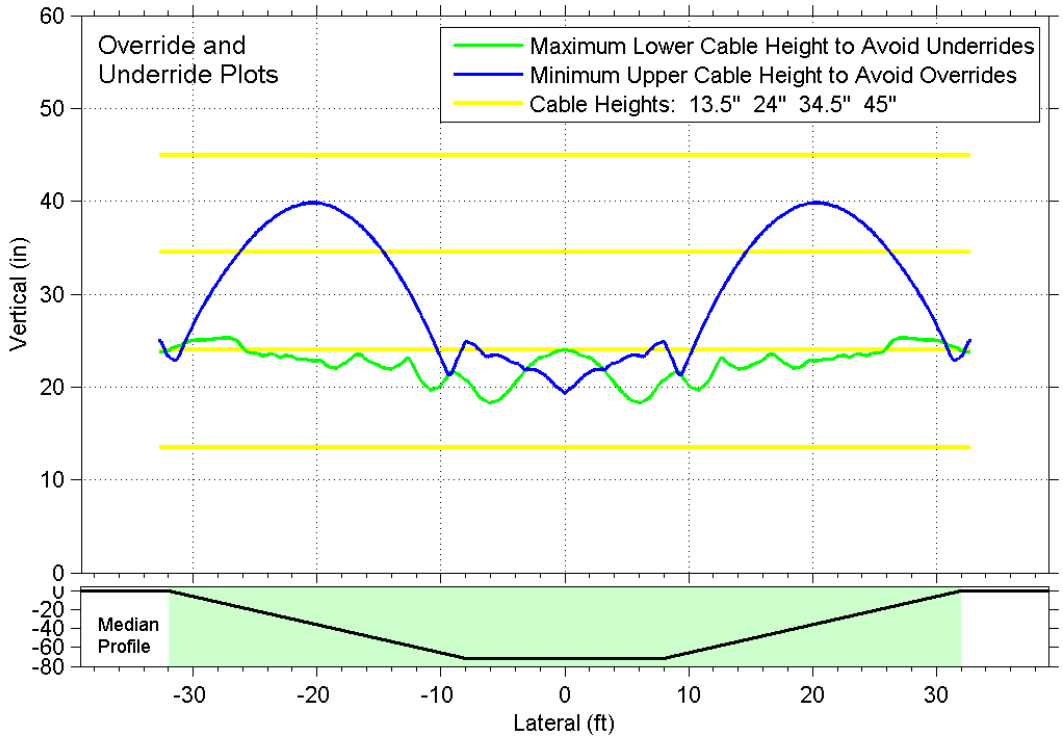




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

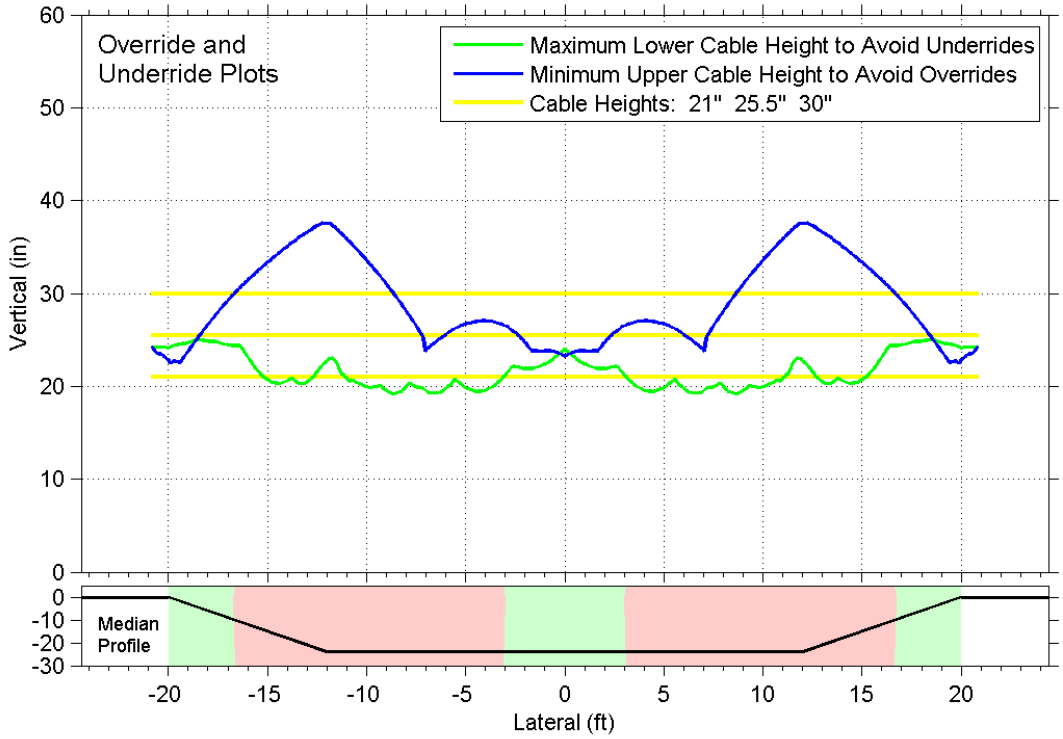
Flat-bottom Median - 4H:1V Slope - 16ft FB Width - 6ft Depth

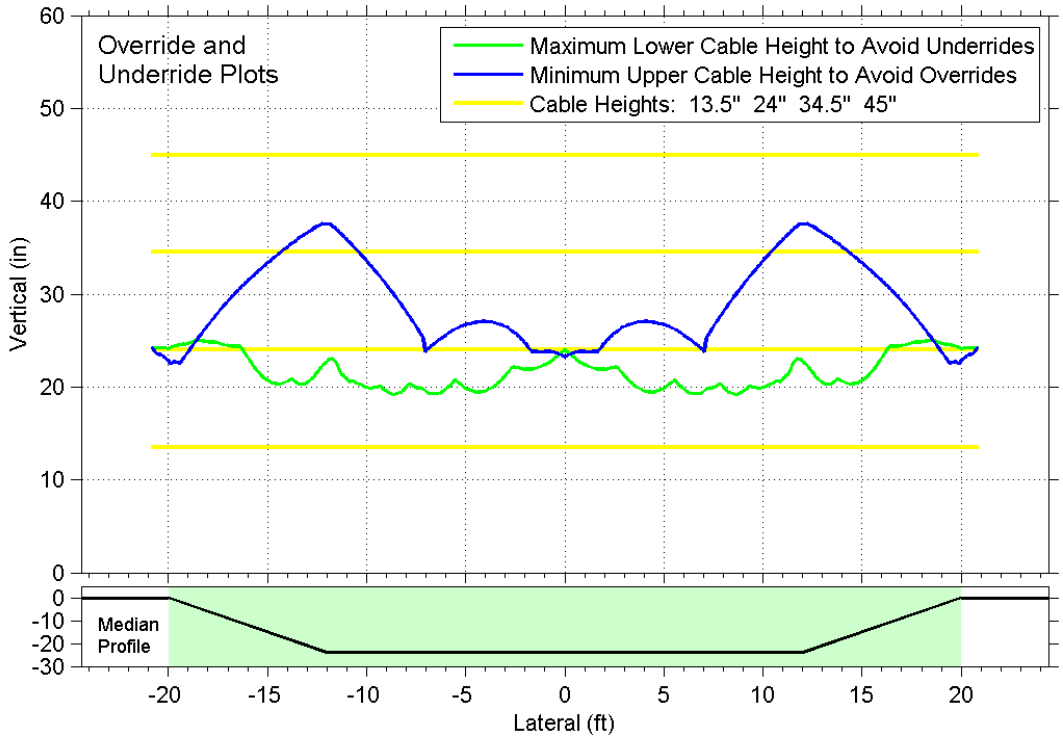




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

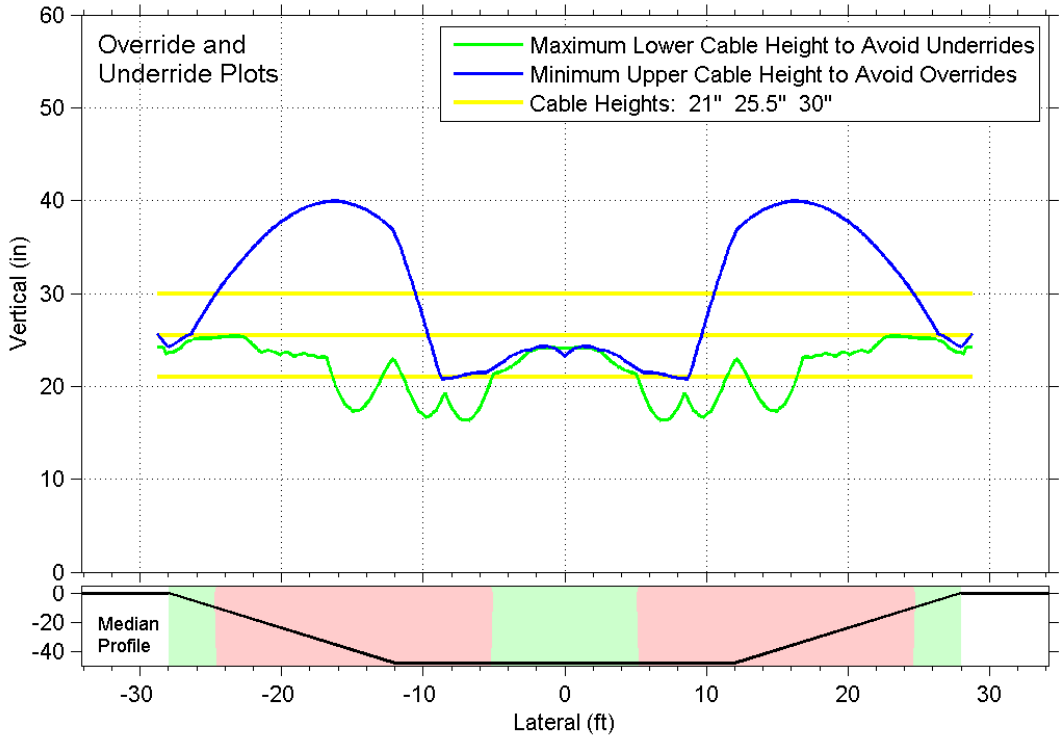
Flat-bottom Median - 4H:1V Slope - 24ft FB Width - 2ft Depth

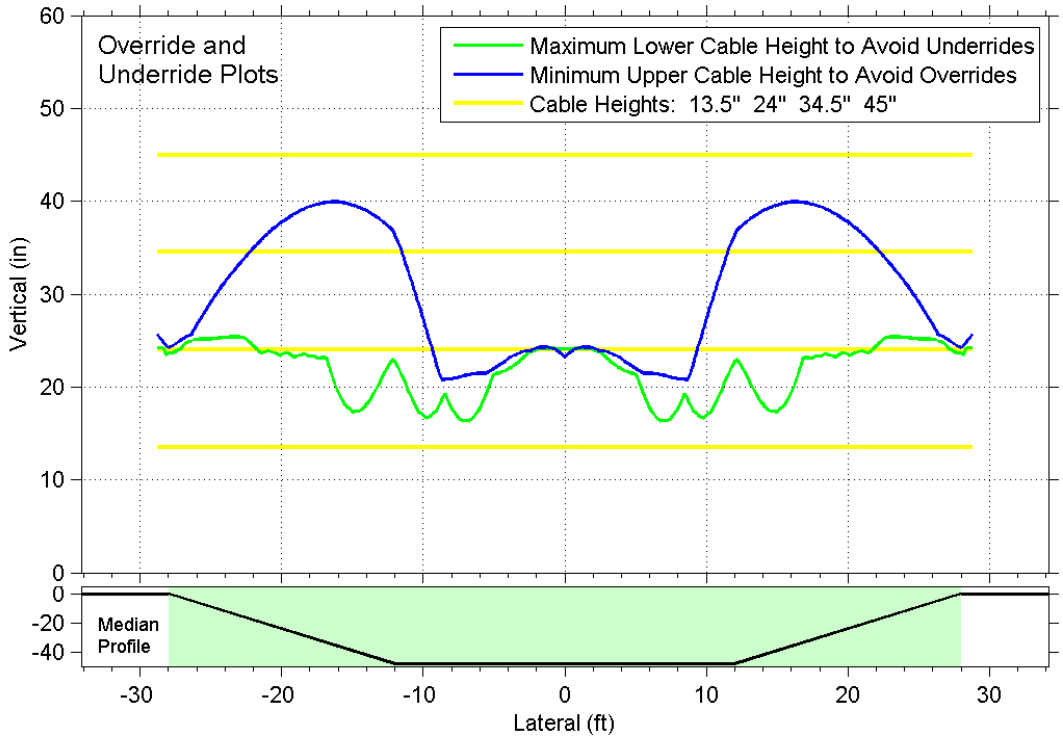




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

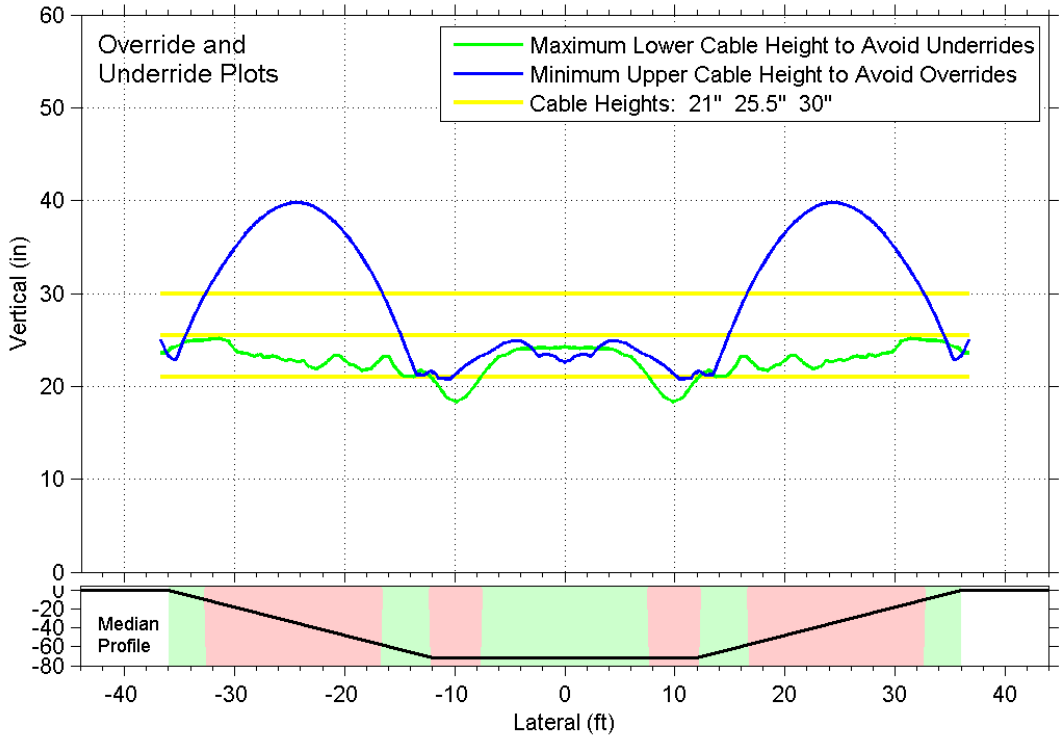
Flat-bottom Median - 4H:1V Slope - 24ft FB Width - 4ft Depth

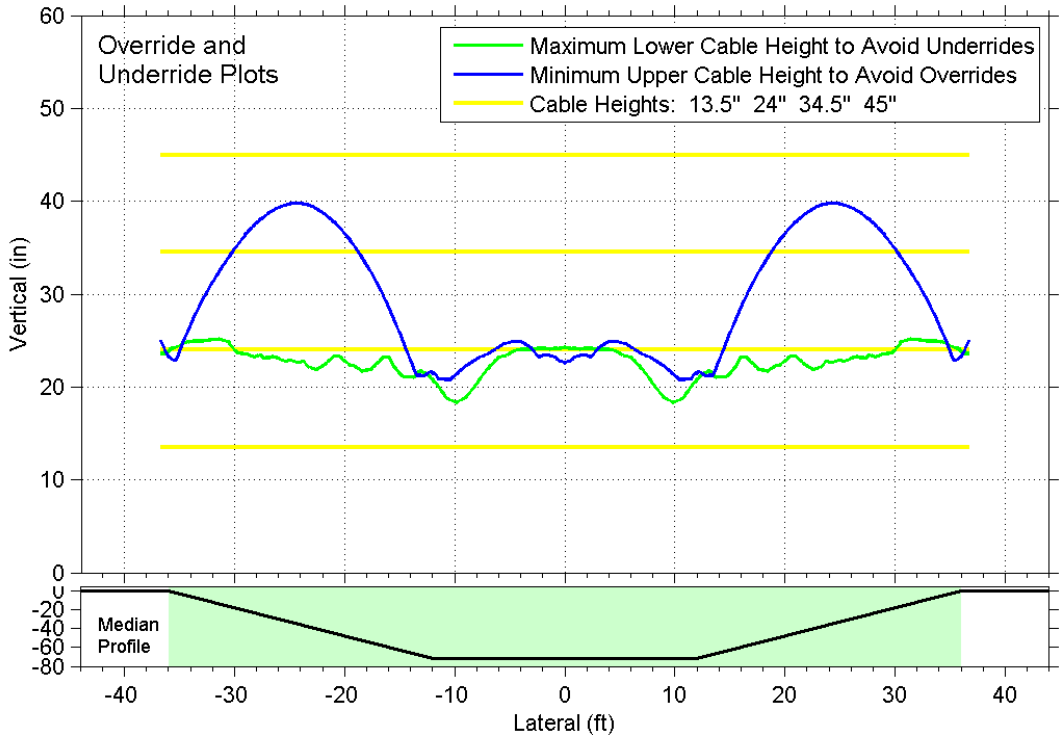




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

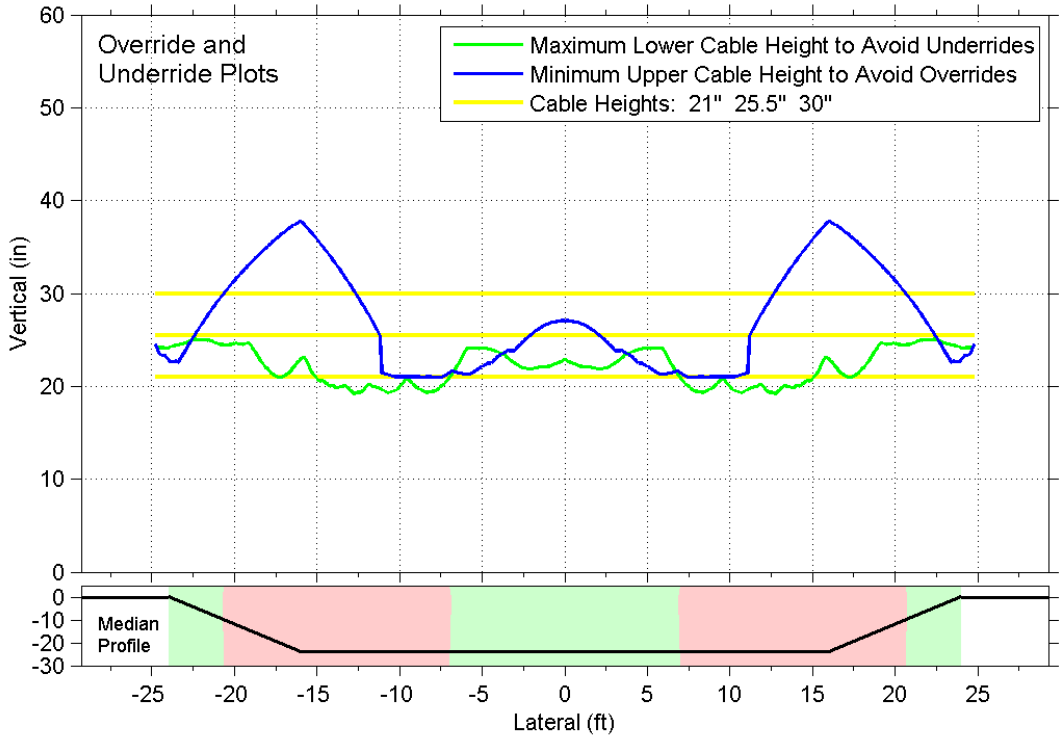
Flat-bottom Median - 4H:1V Slope - 24ft FB Width - 6ft Depth

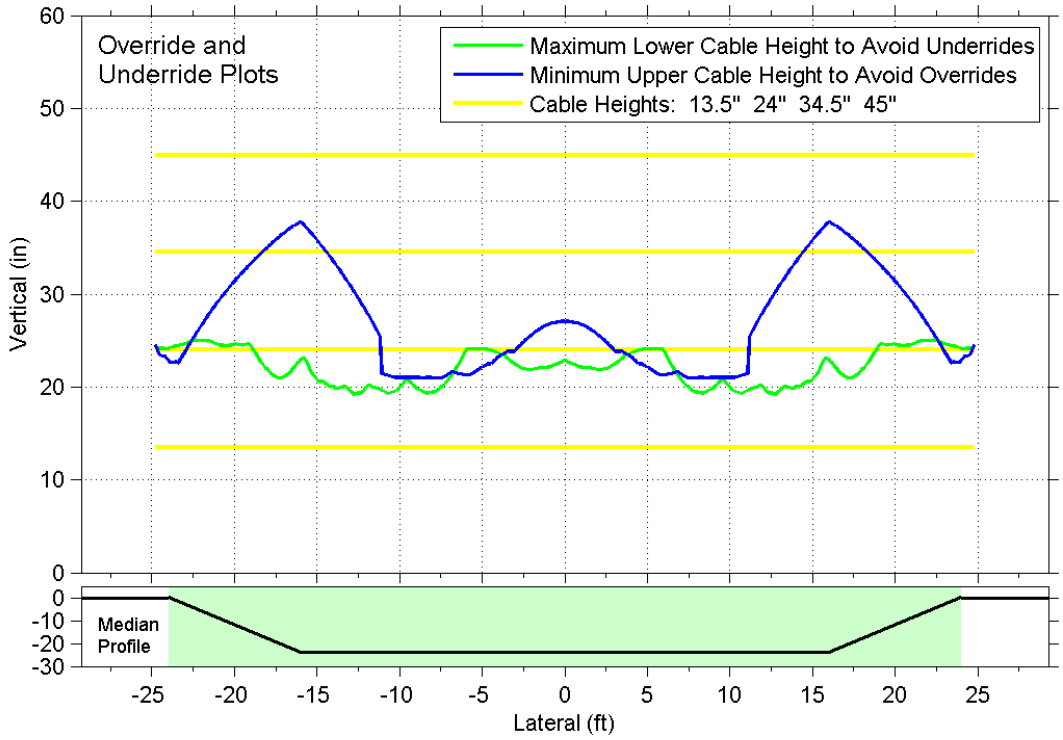




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

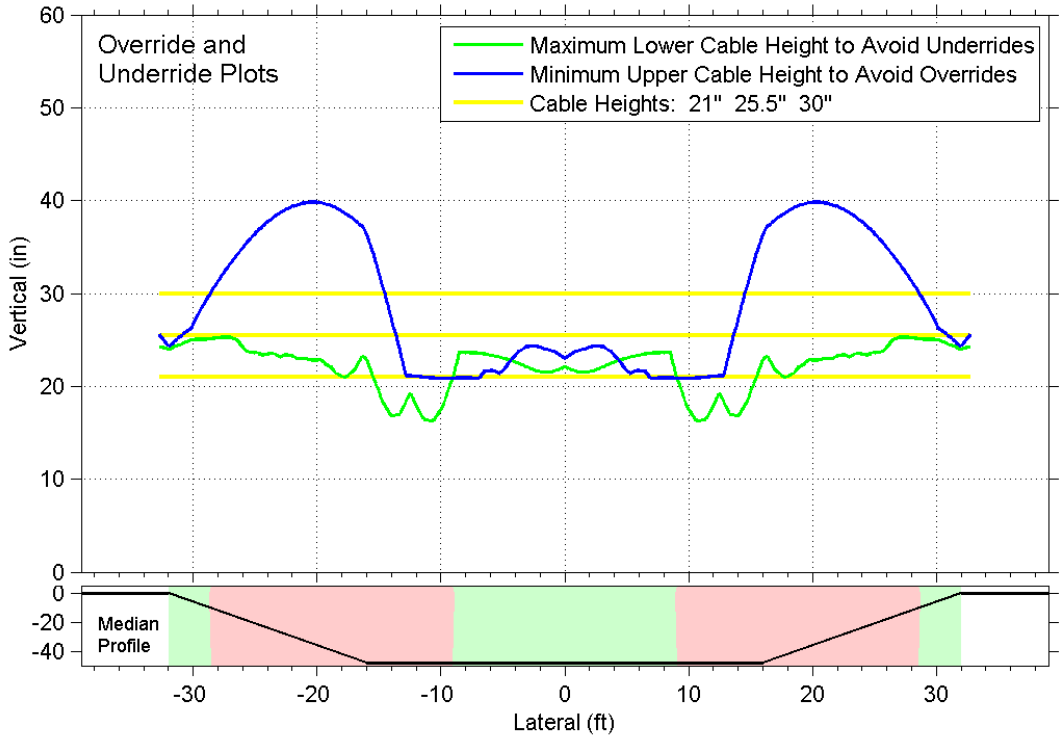
Flat-bottom Median - 4H:1V Slope - 32ft FB Width - 2ft Depth

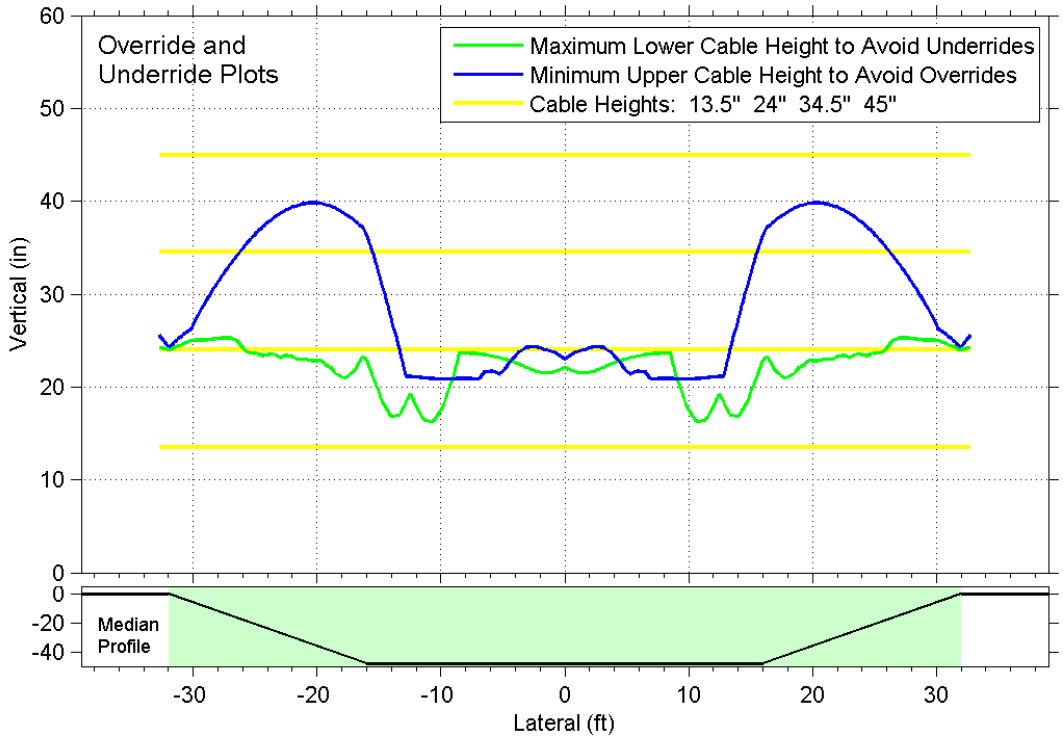




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

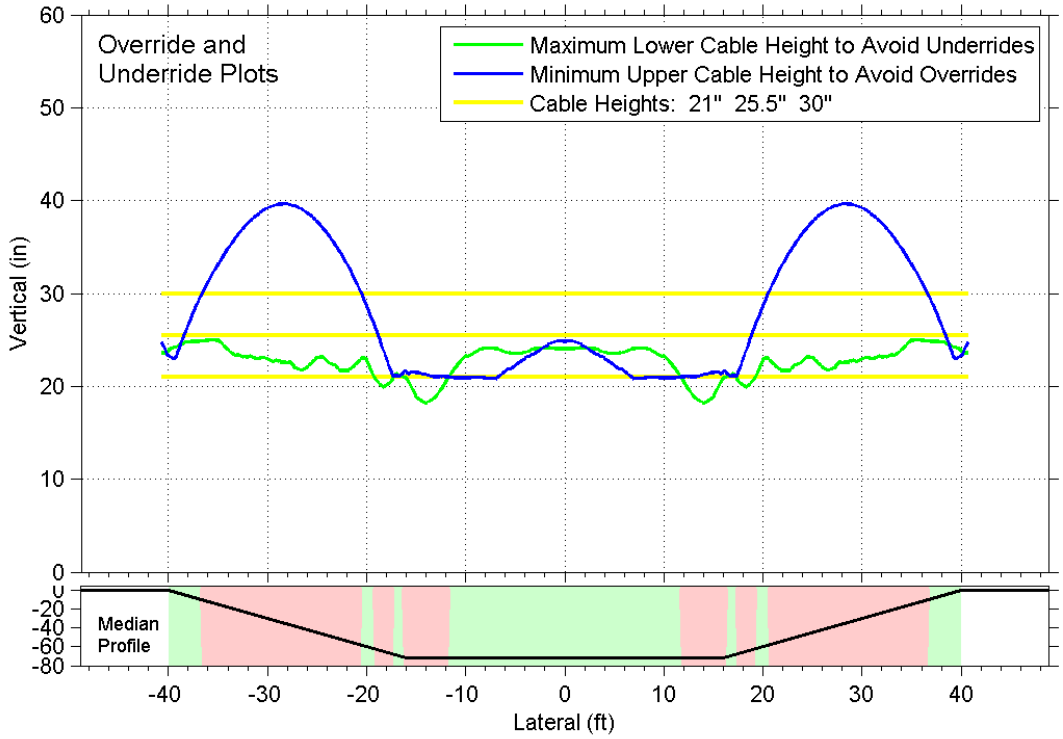
Flat-bottom Median - 4H:1V Slope - 32ft FB Width - 4ft Depth

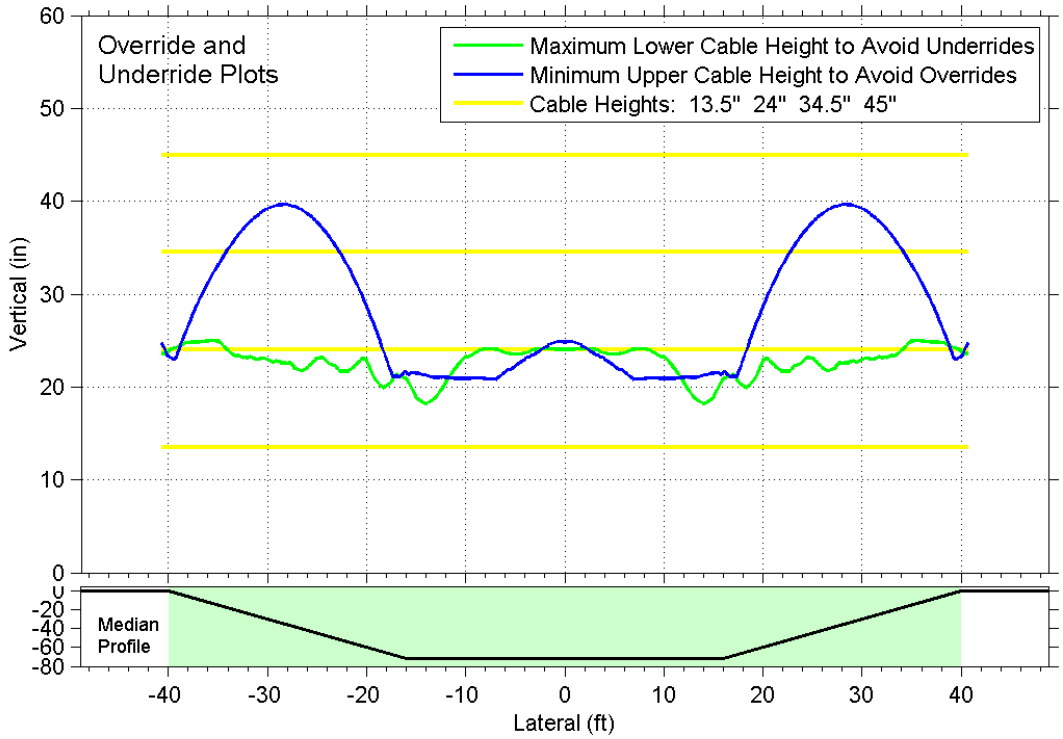




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

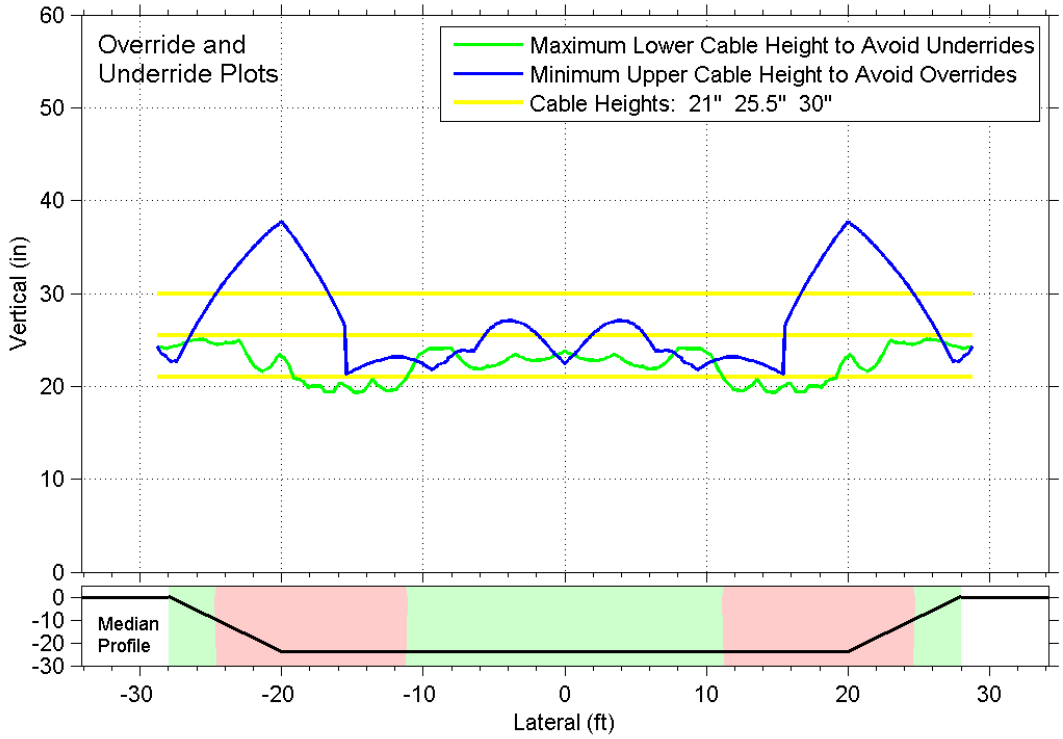
Flat-bottom Median - 4H:1V Slope - 32ft FB Width - 6ft Depth

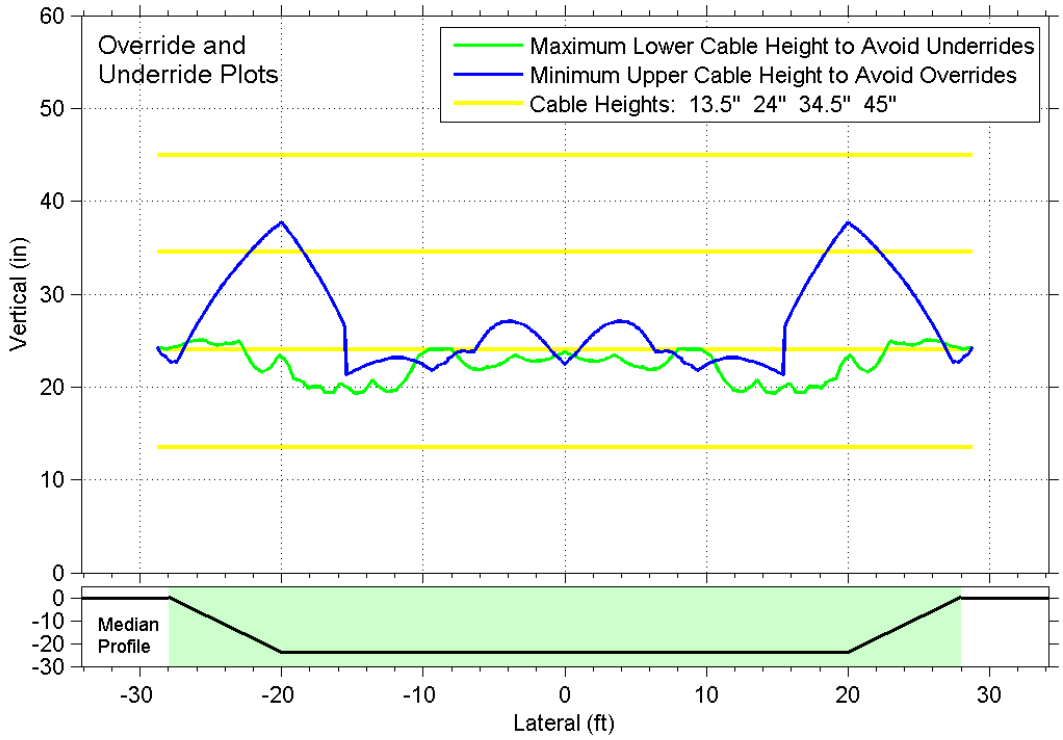




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

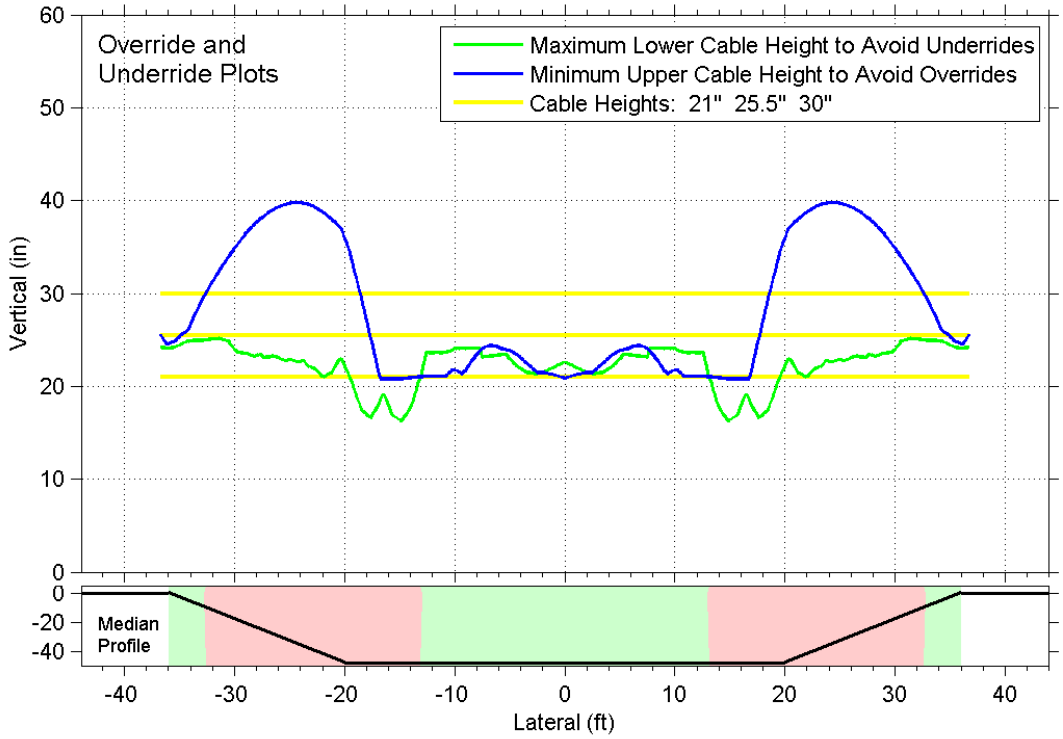
Flat-bottom Median - 4H:1V Slope - 40ft FB Width - 2ft Depth

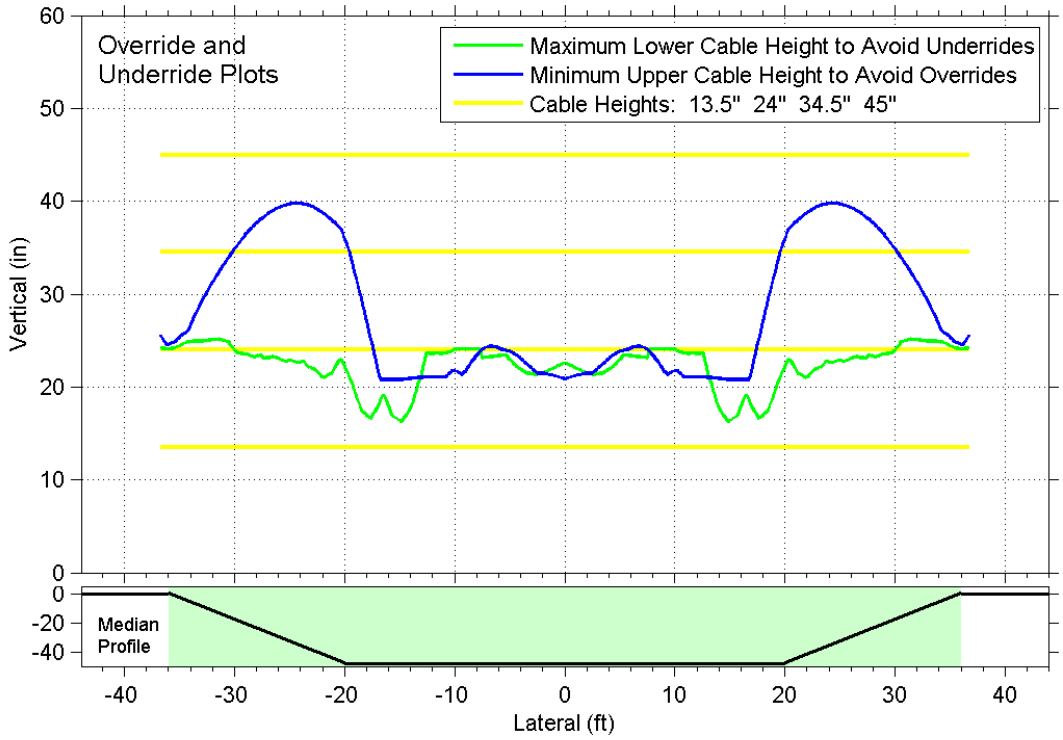




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

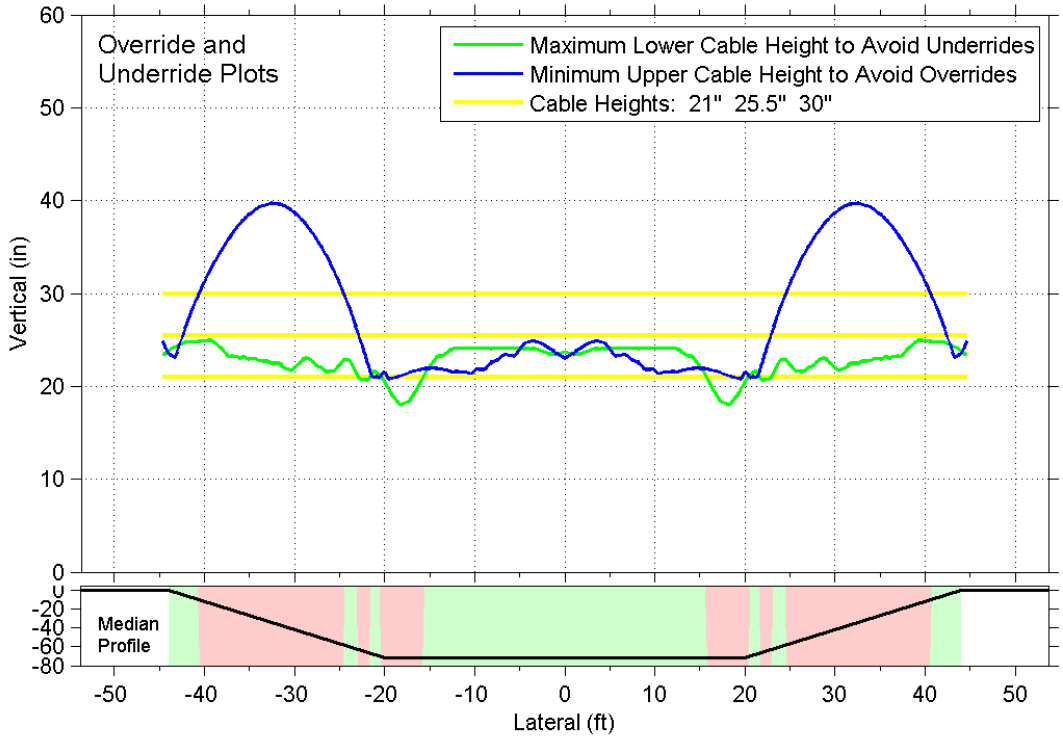
Flat-bottom Median - 4H:1V Slope - 40ft FB Width - 4ft Depth

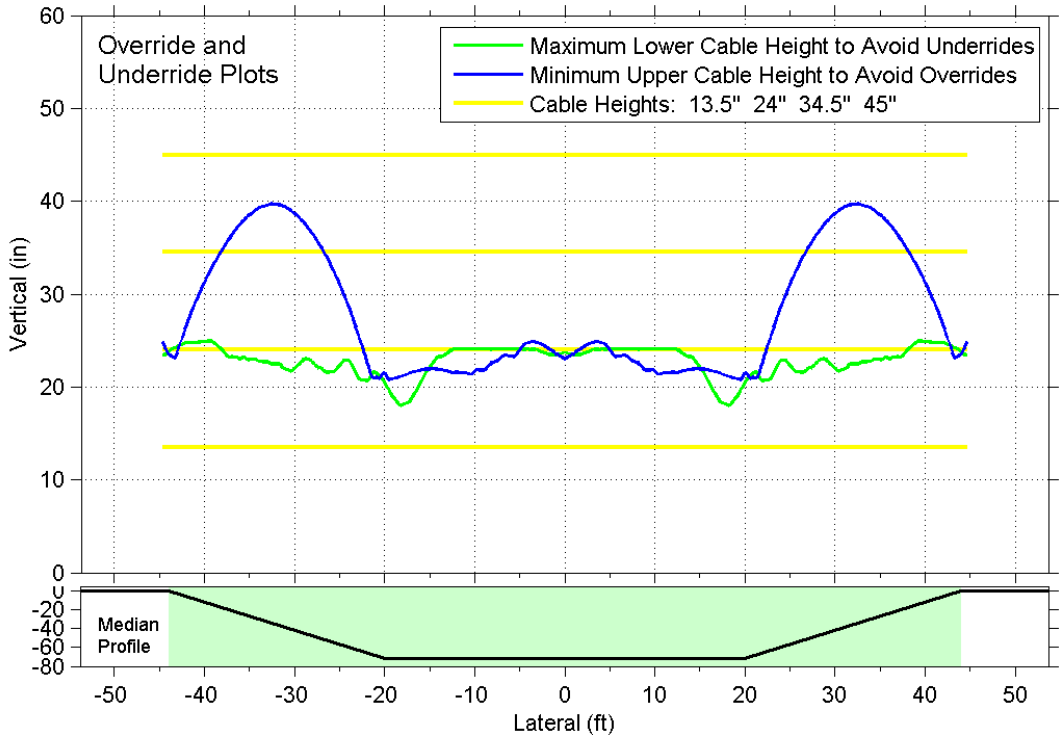




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

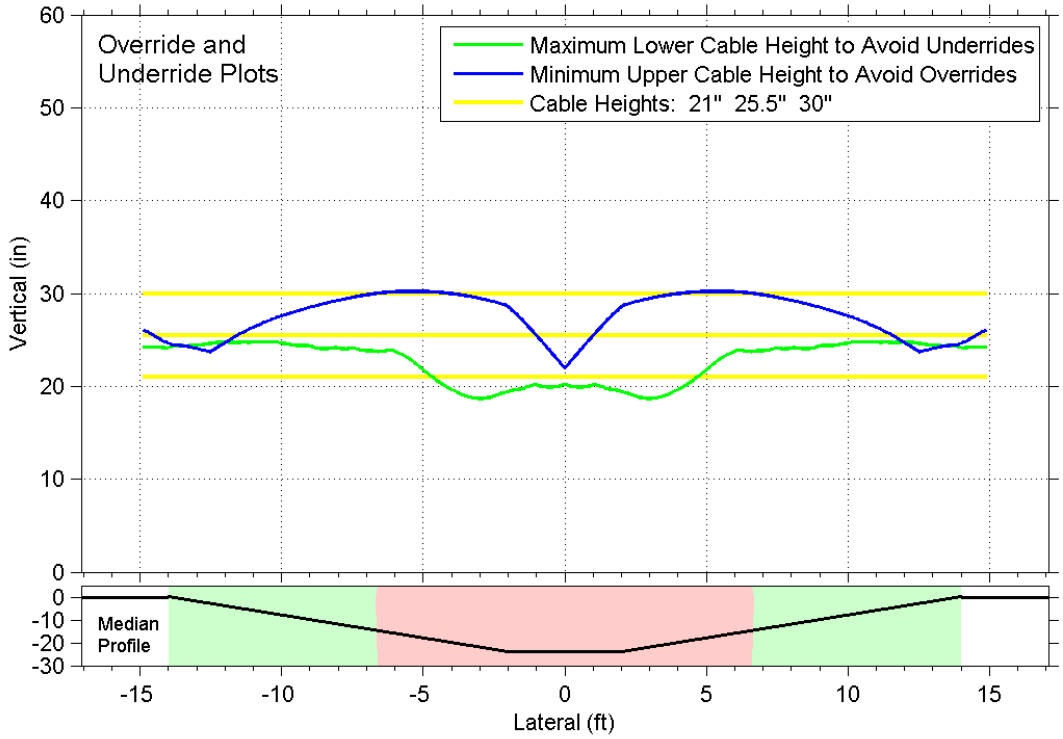
Flat-bottom Median - 4H:1V Slope - 40ft FB Width - 6ft Depth

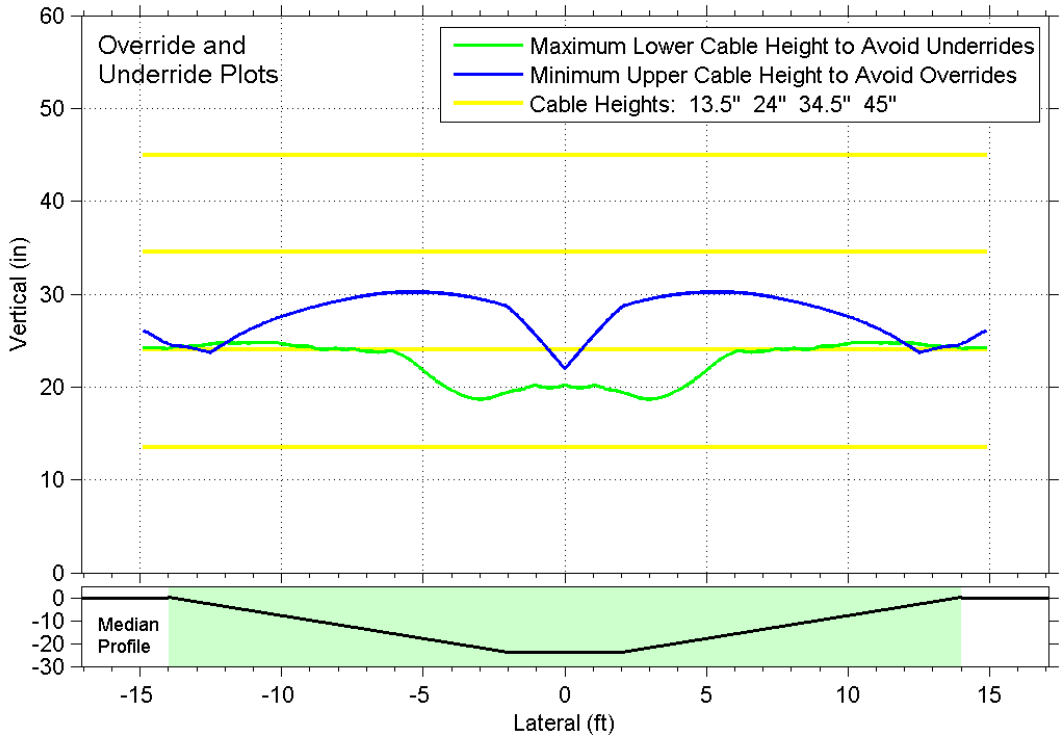




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

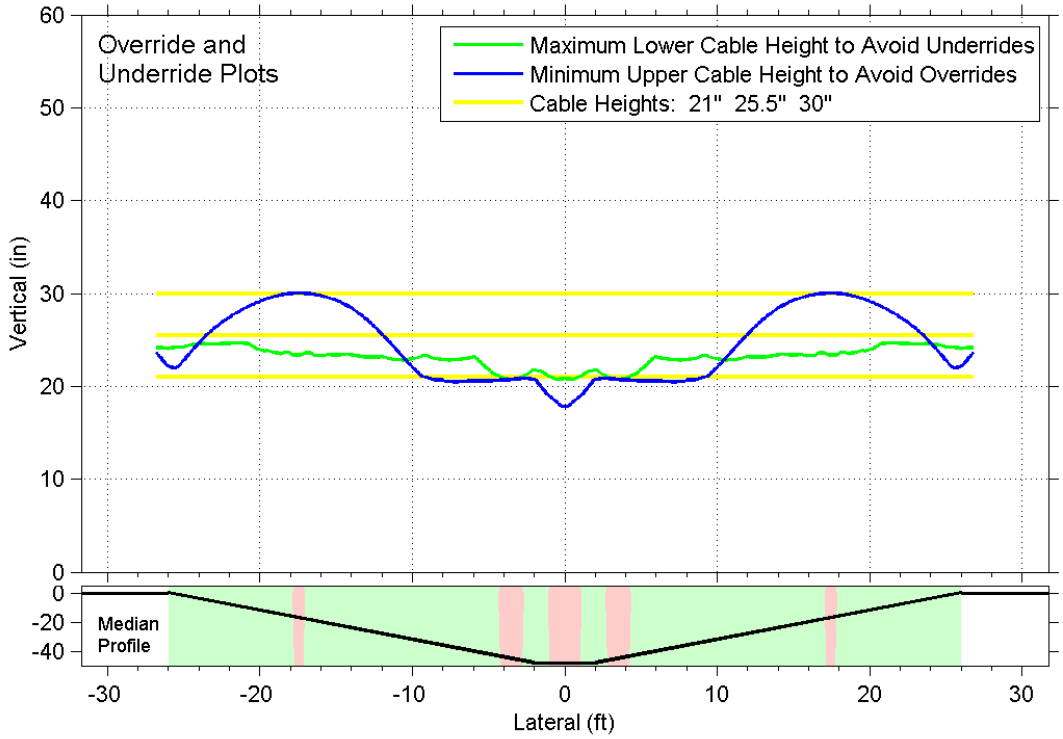
Flat-bottom Median - 6H:1V Slope - 4ft FB Width - 2ft Depth

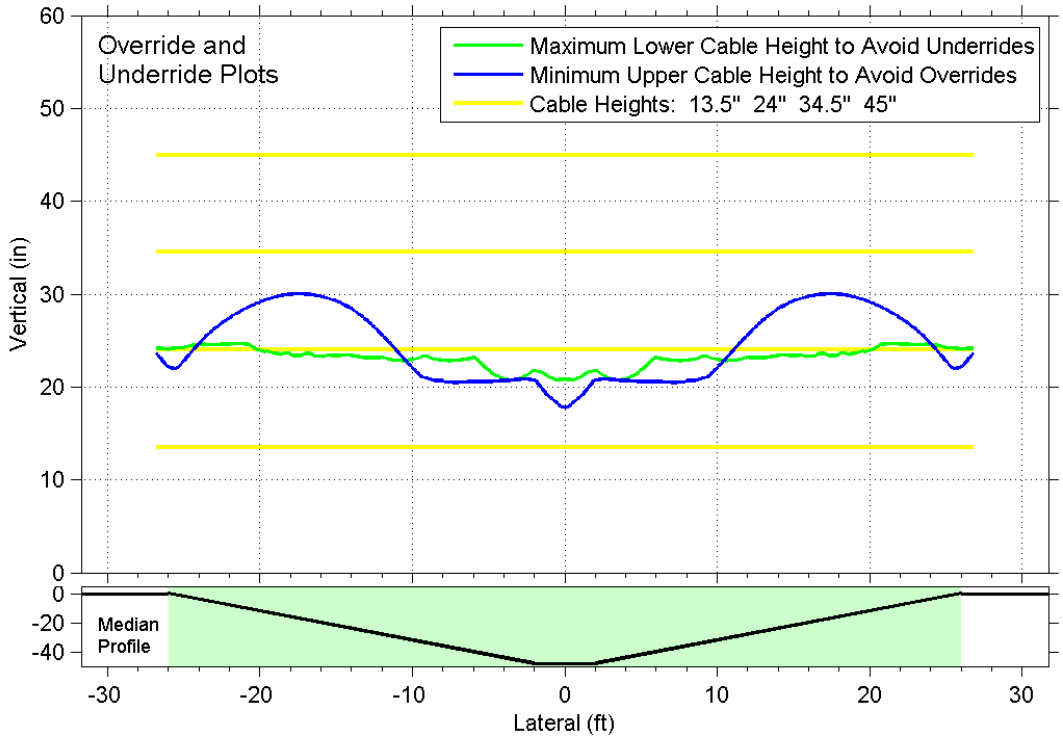




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

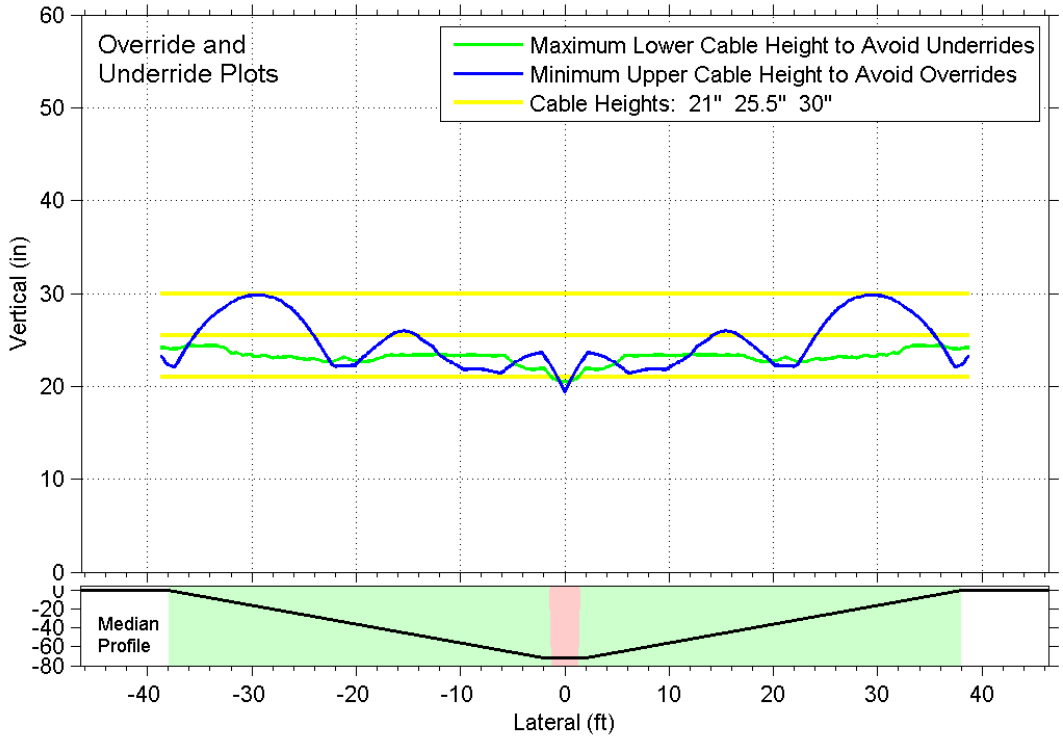
Flat-bottom Median - 6H:1V Slope - 4ft FB Width - 4ft Depth

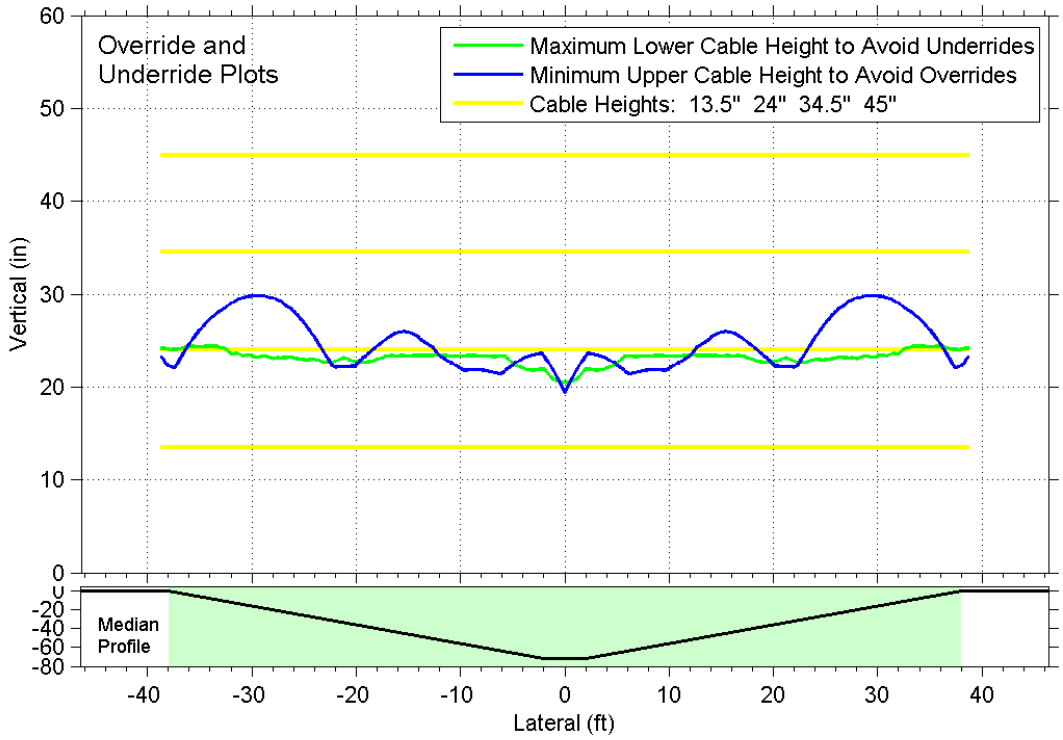




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

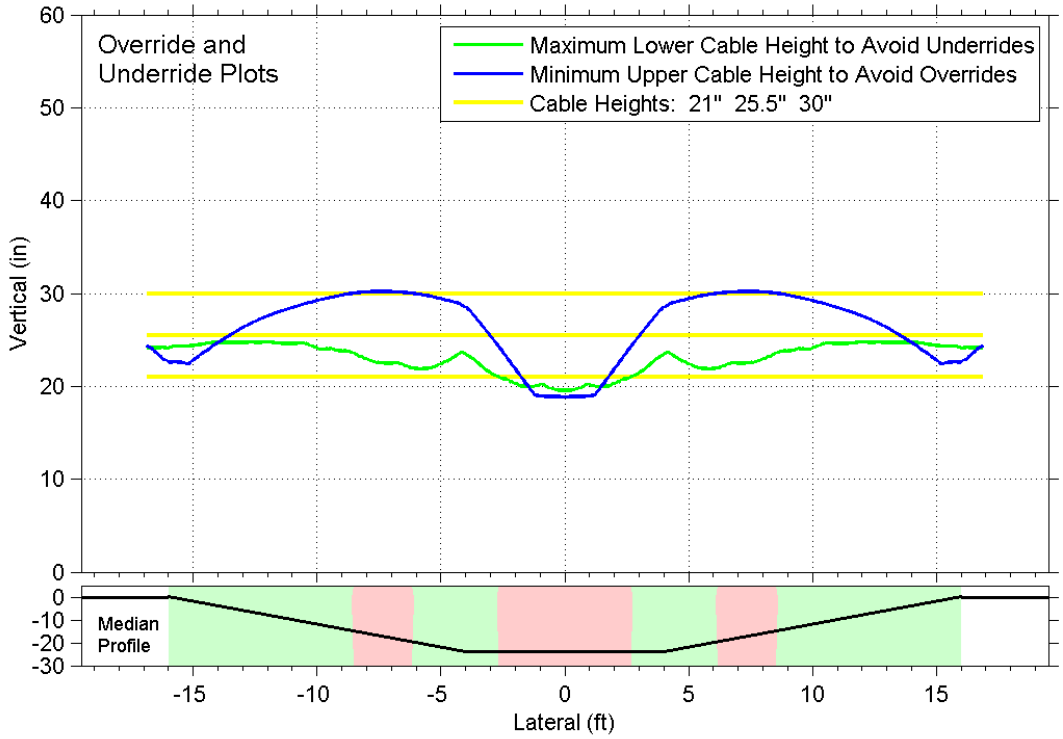
Flat-bottom Median - 6H:1V Slope - 4ft FB Width - 6ft Depth

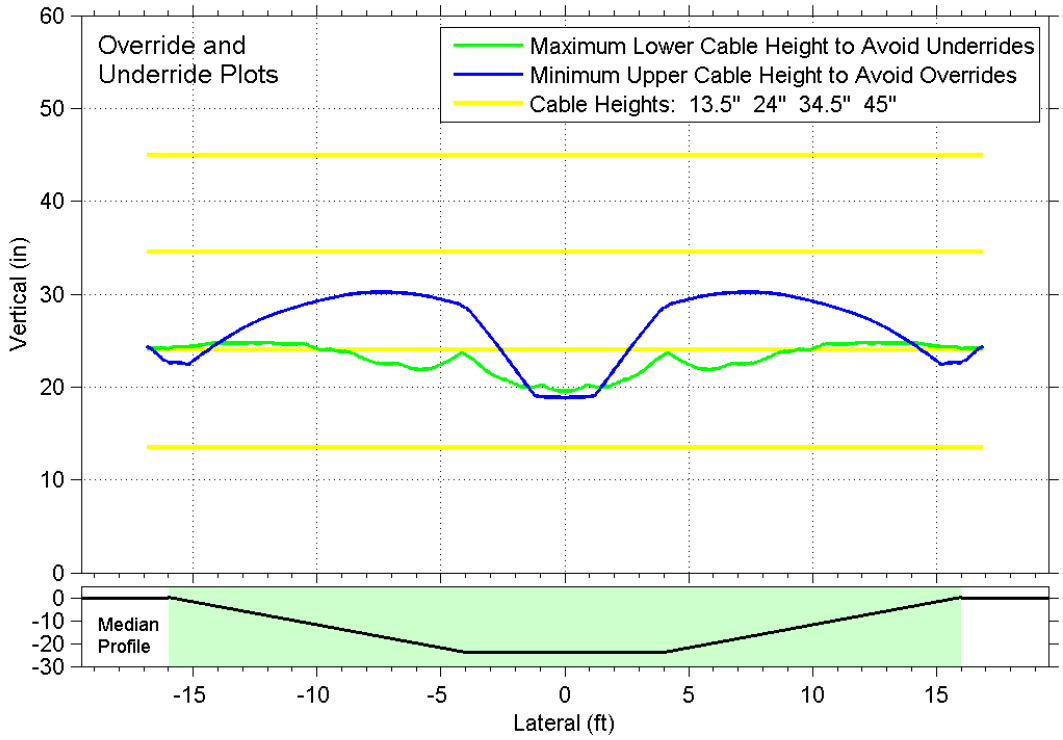




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

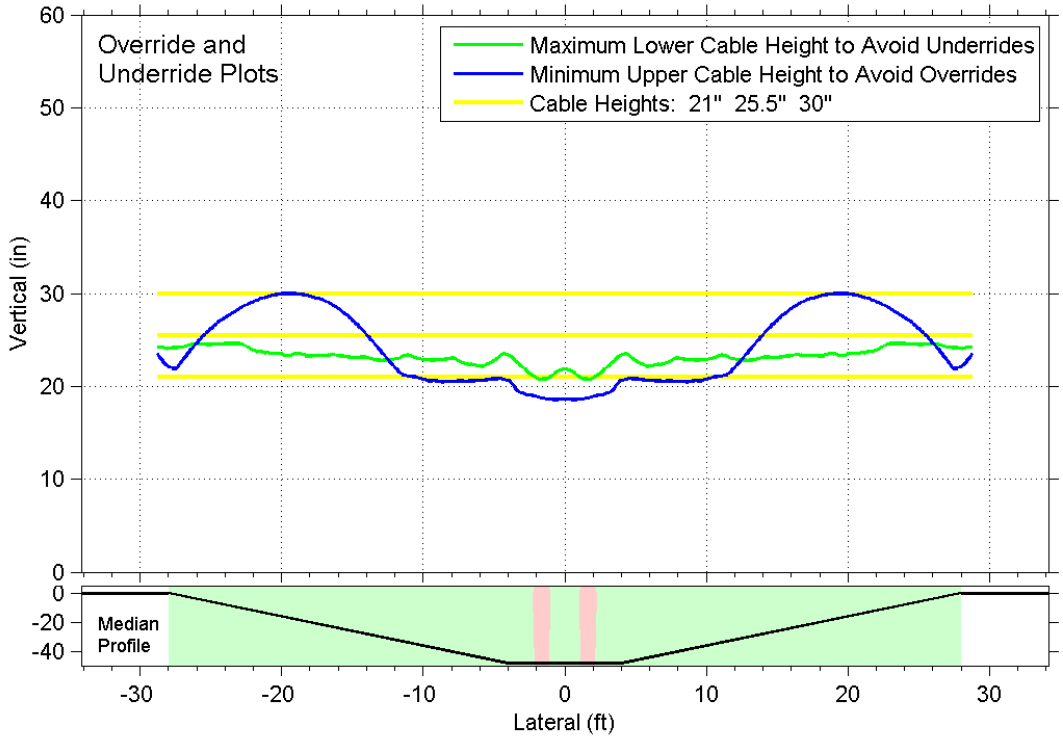
Flat-bottom Median - 6H:1V Slope - 8ft FB Width - 2ft Depth

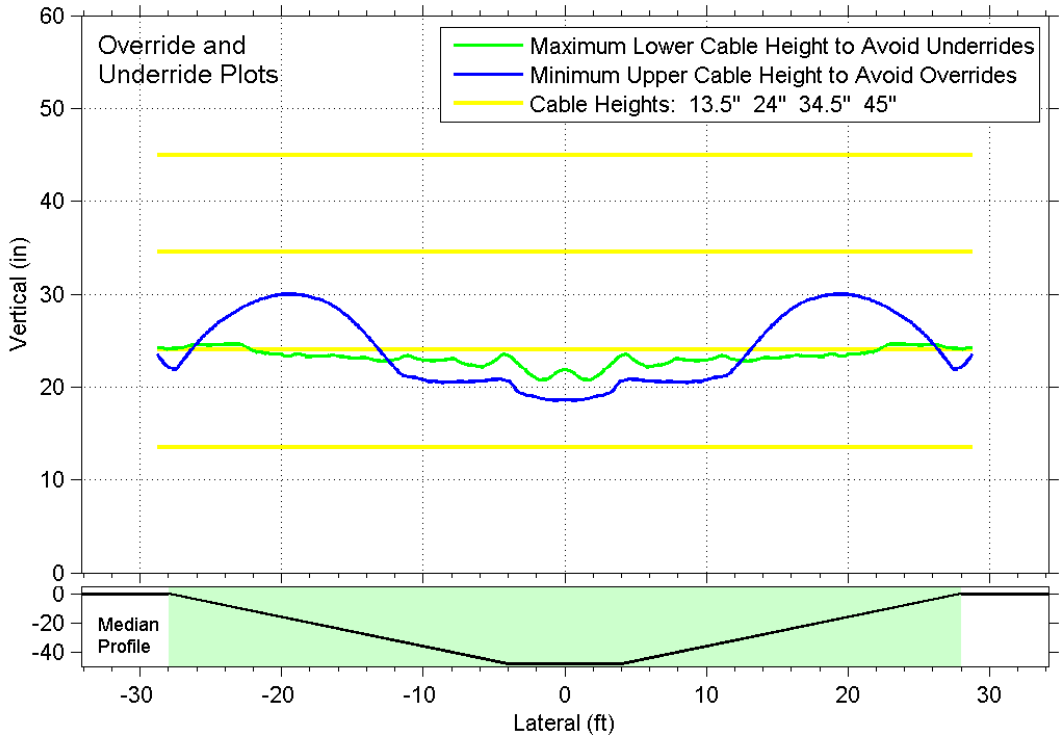




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

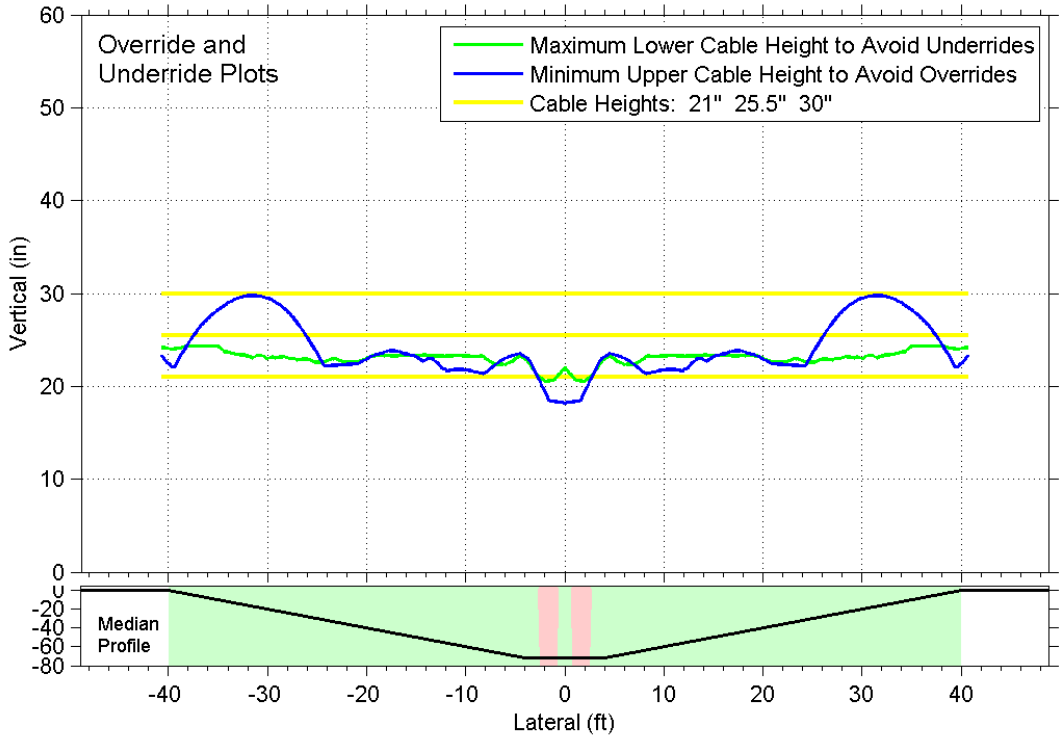
Flat-bottom Median - 6H:1V Slope - 8ft FB Width - 4ft Depth

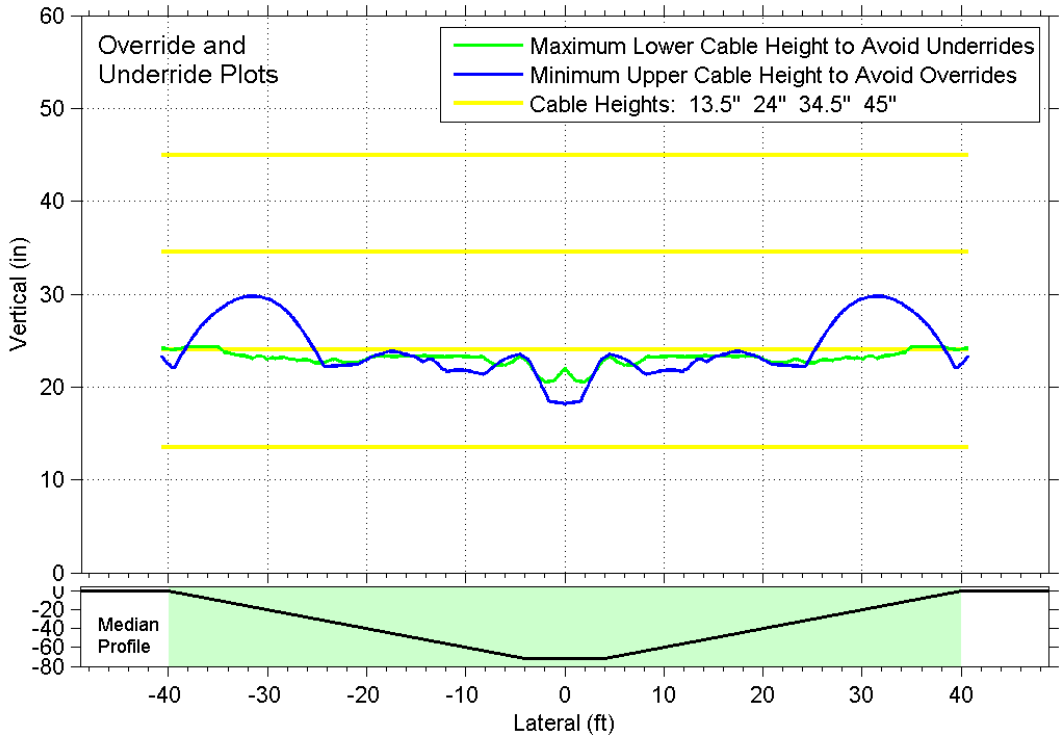




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

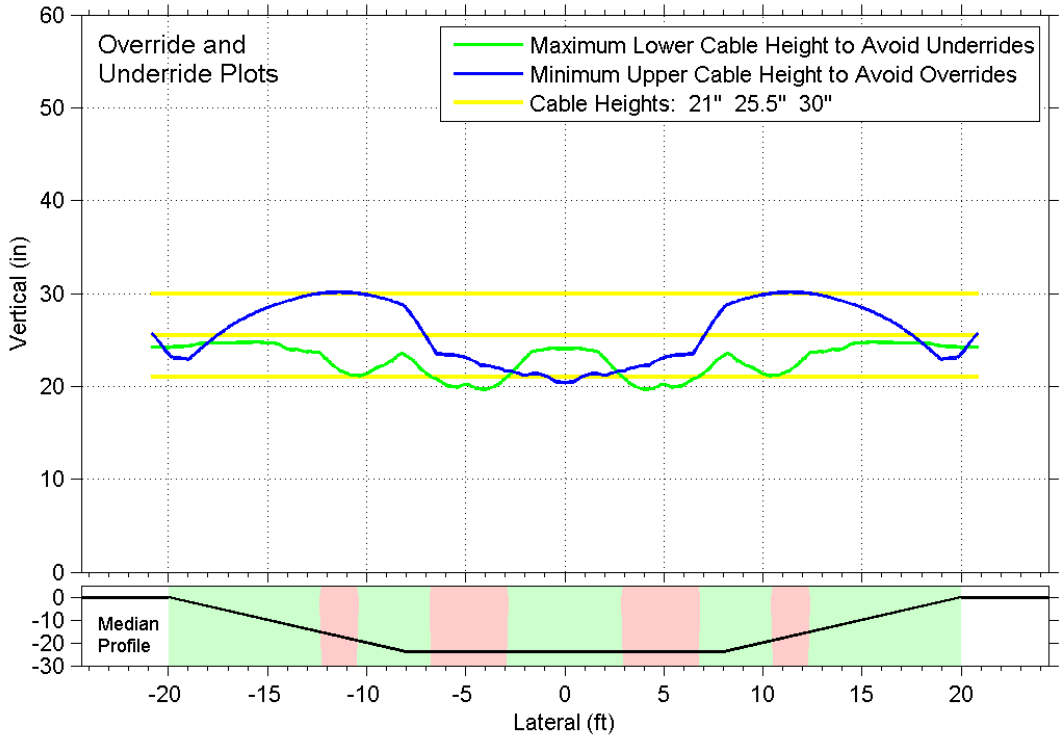
Flat-bottom Median - 6H:1V Slope - 8ft FB Width - 6ft Depth

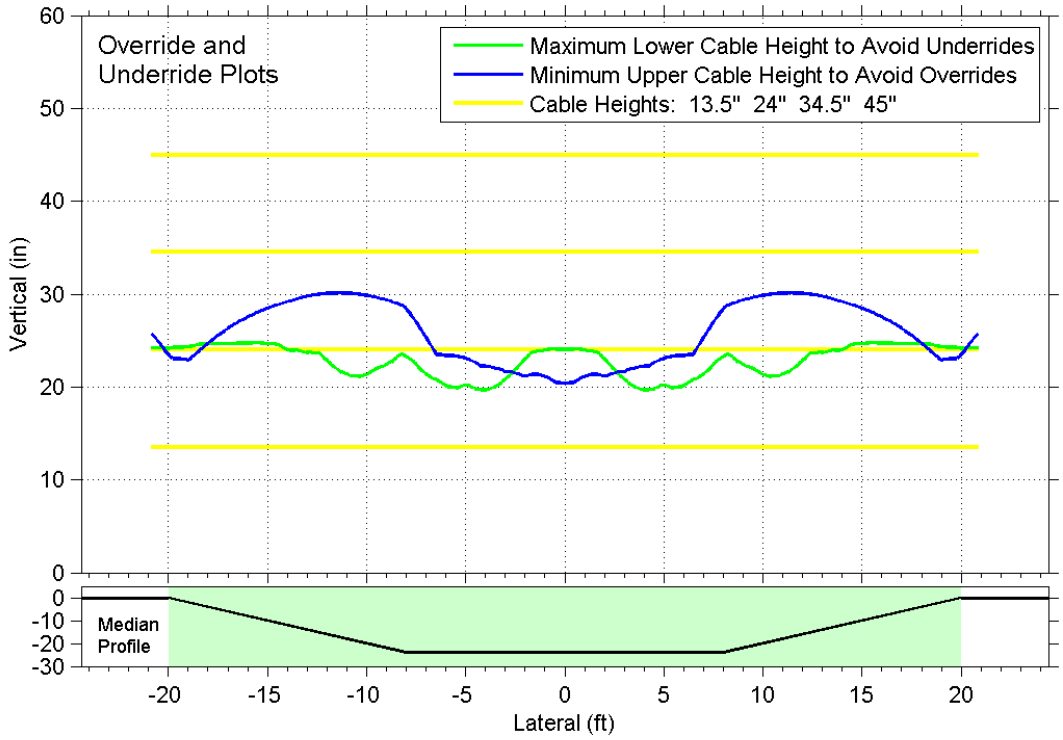




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

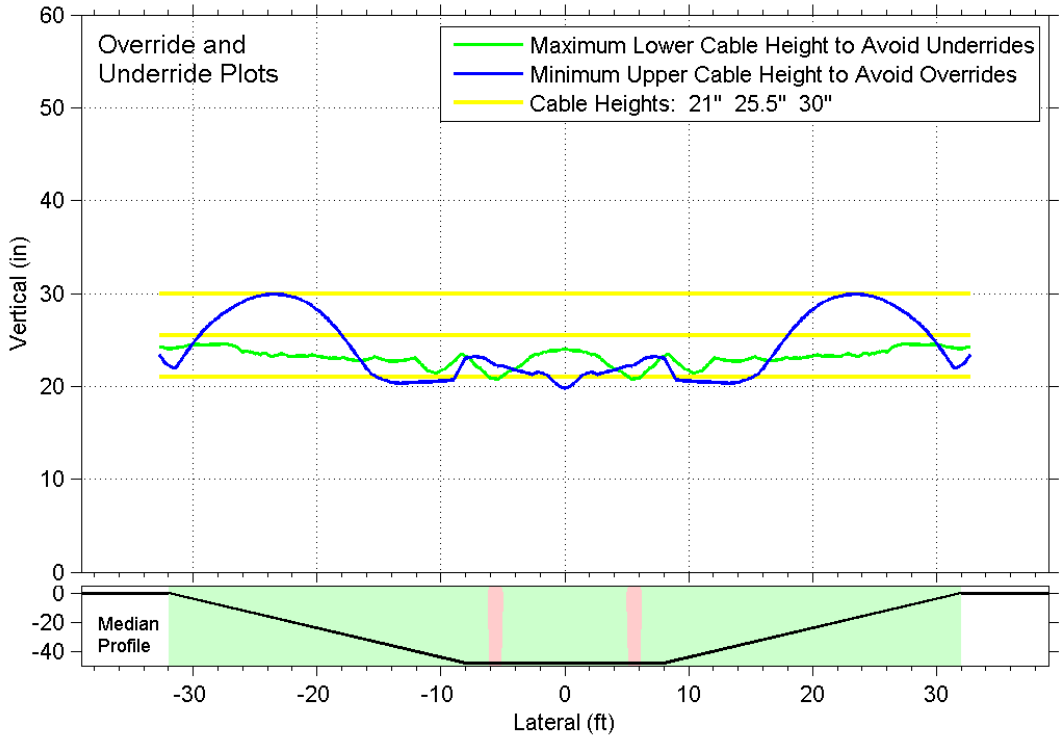
Flat-bottom Median - 6H:1V Slope - 16ft FB Width - 2ft Depth

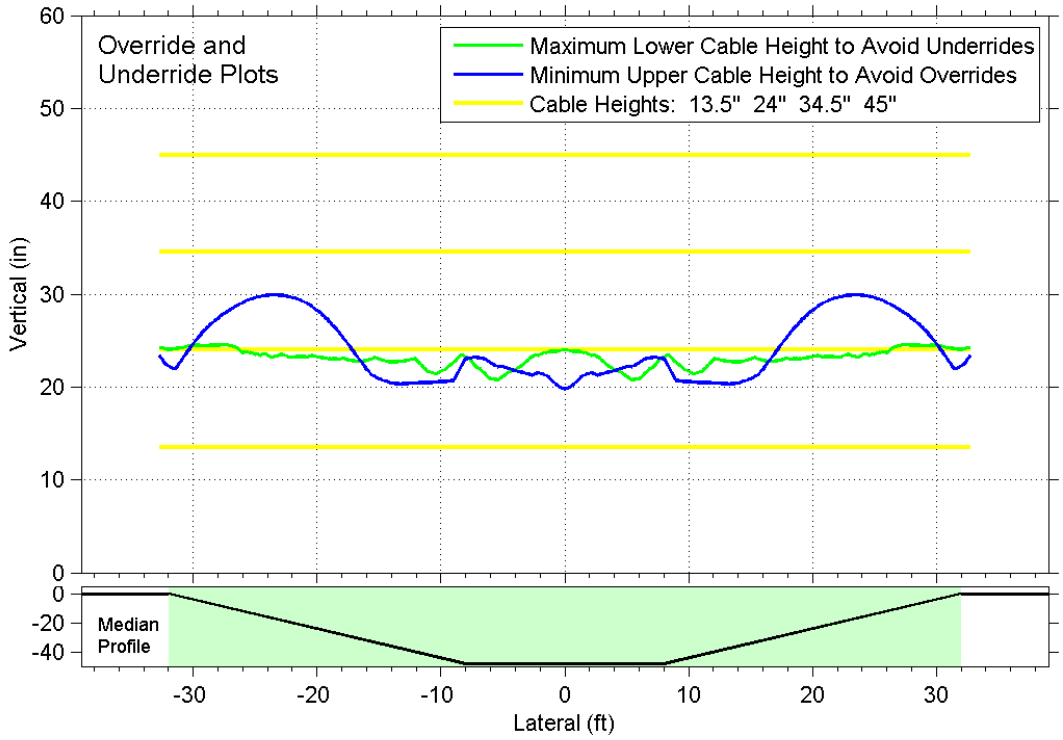




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

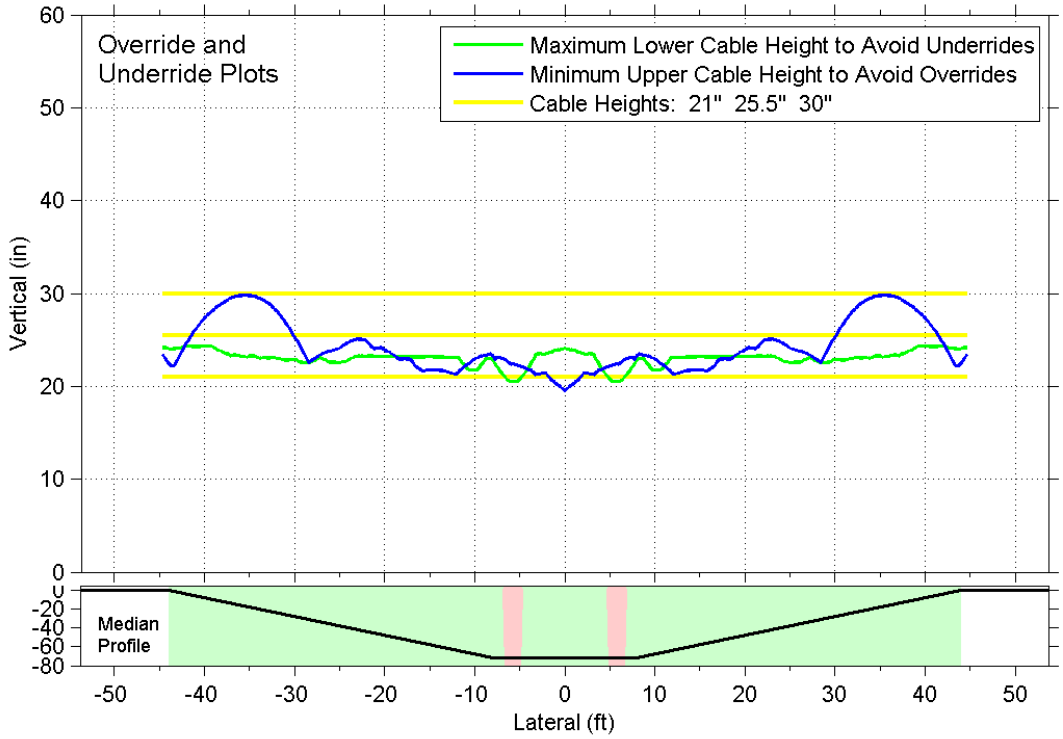
Flat-bottom Median - 6H:1V Slope - 16ft FB Width - 4ft Depth

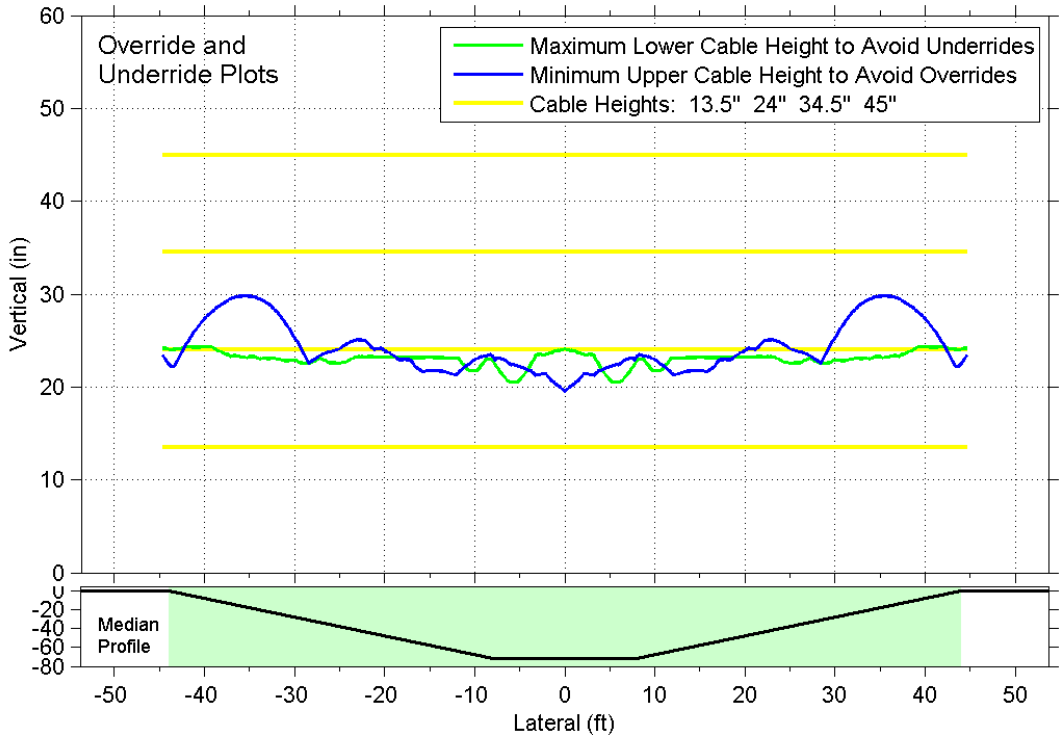




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

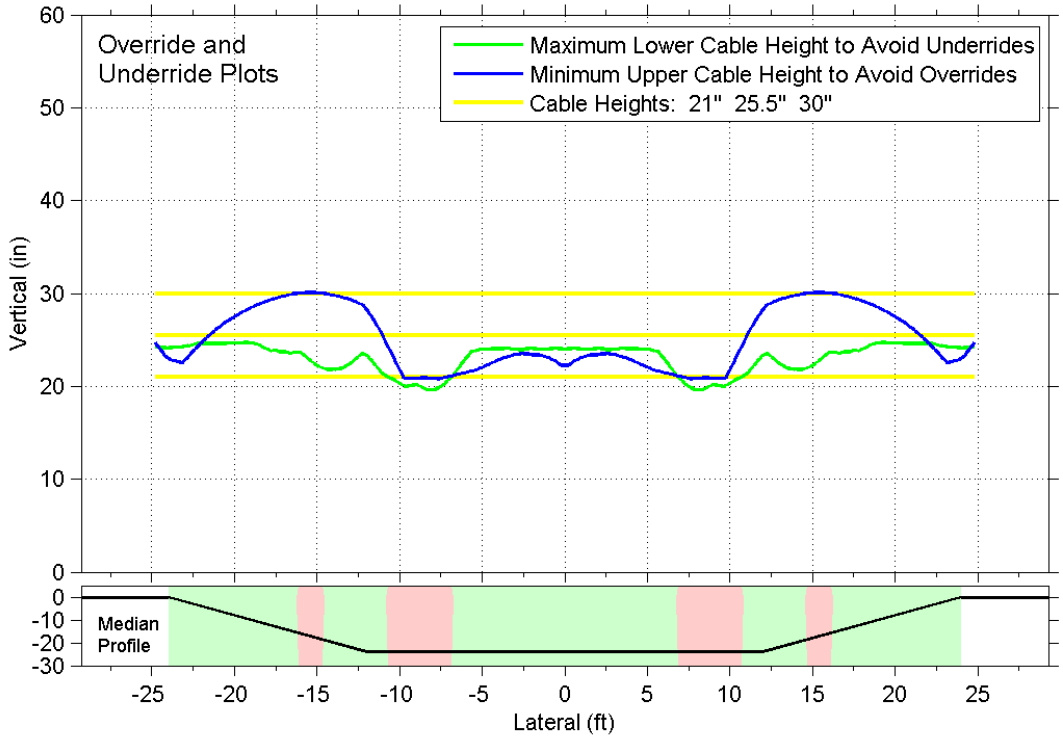
Flat-bottom Median - 6H:1V Slope - 16ft FB Width - 6ft Depth

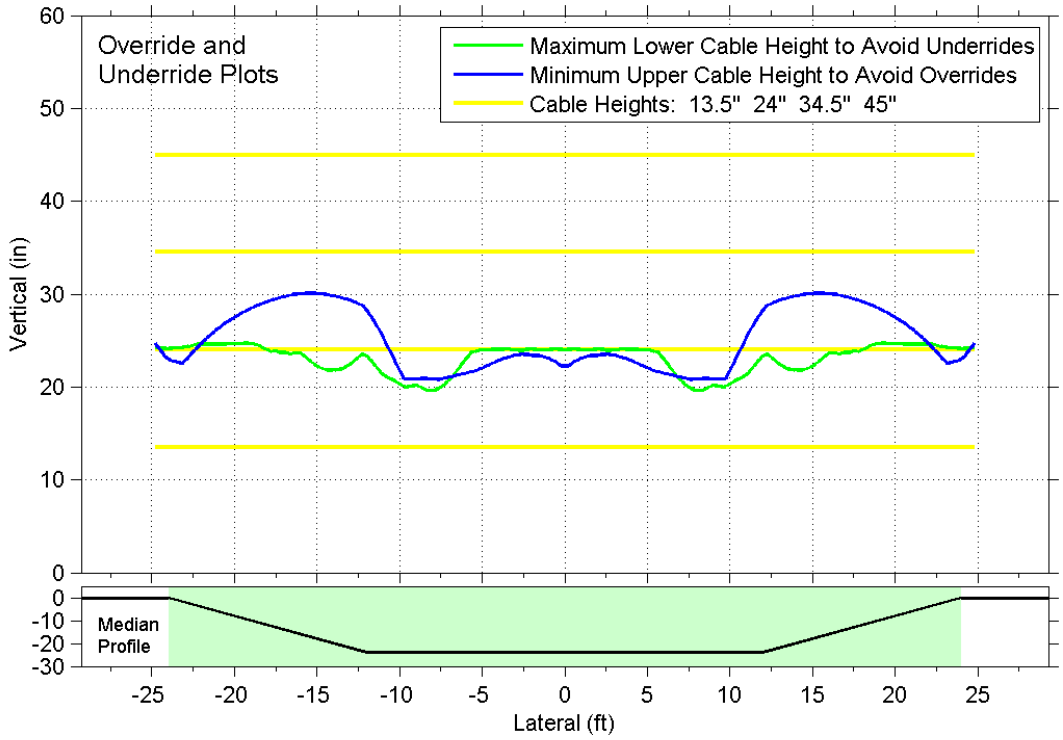




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

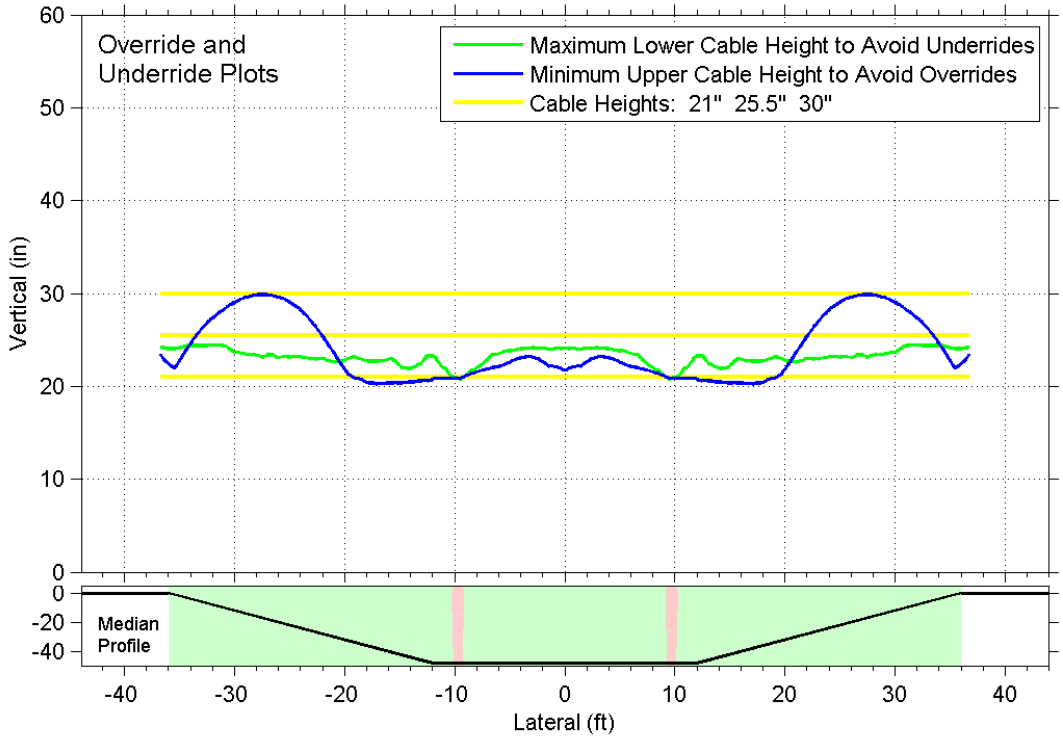
Flat-bottom Median - 6H:1V Slope - 24ft FB Width - 2ft Depth

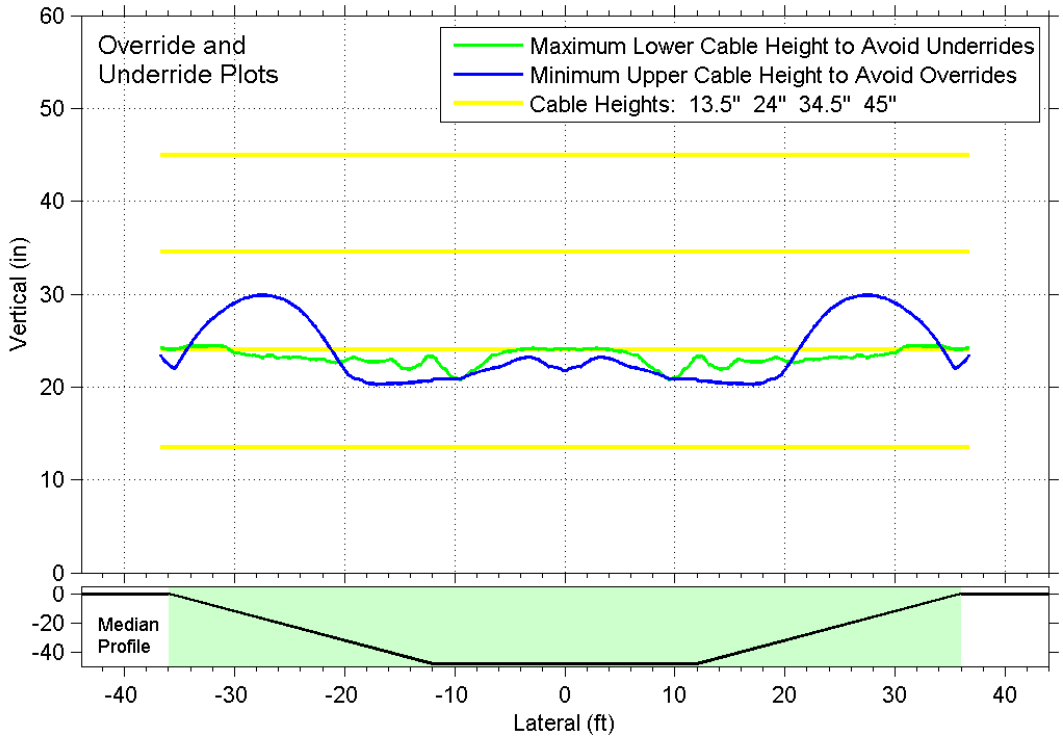




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

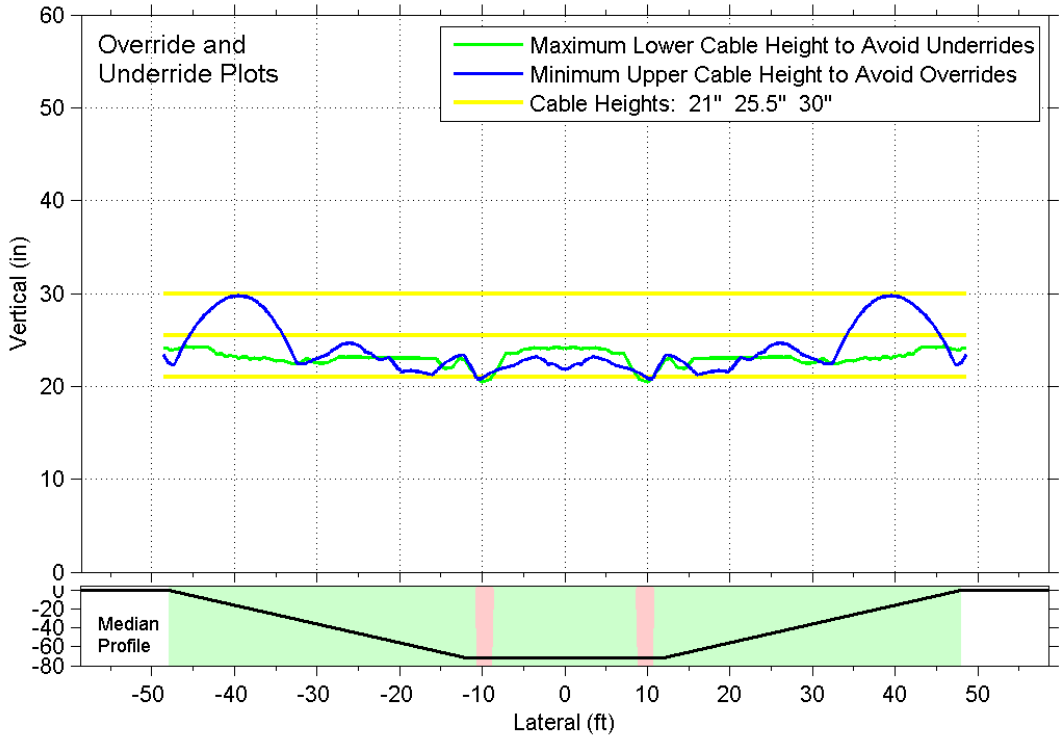
Flat-bottom Median - 6H:1V Slope - 24ft FB Width - 4ft Depth

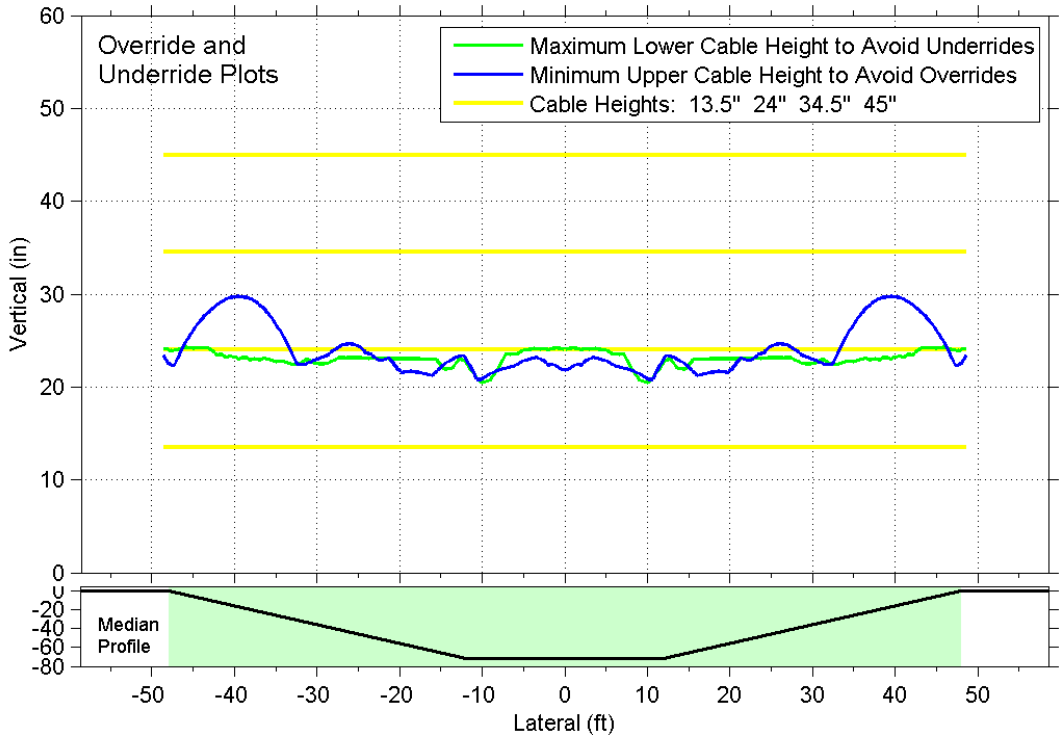




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

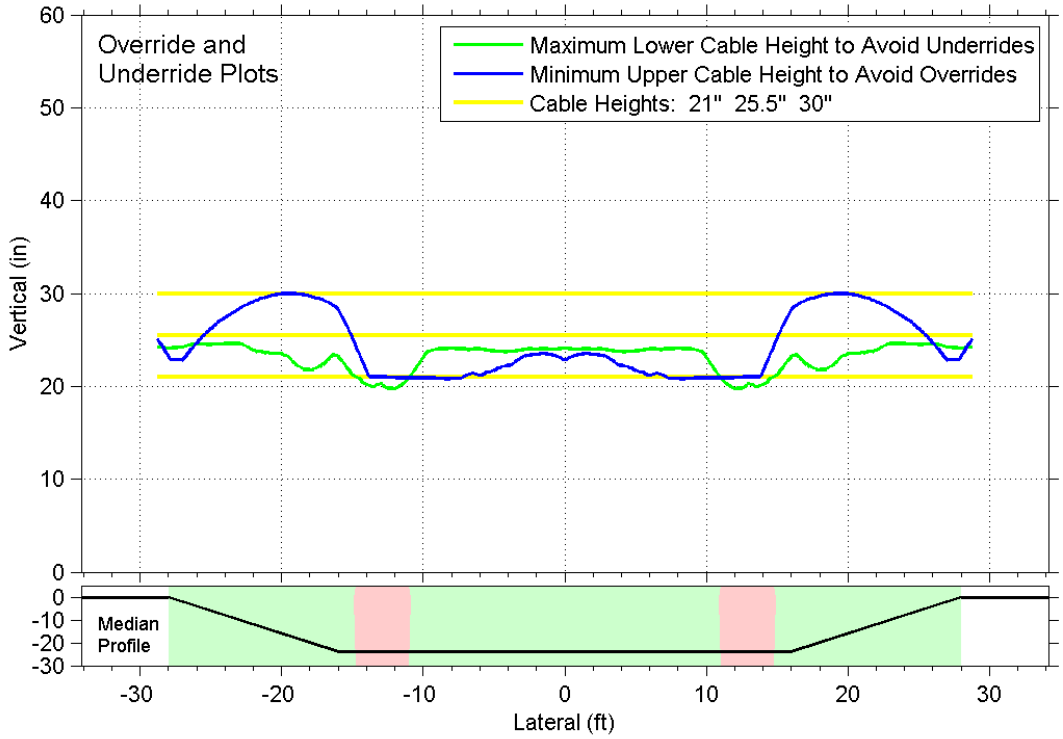
Flat-bottom Median - 6H:1V Slope - 24ft FB Width - 6ft Depth

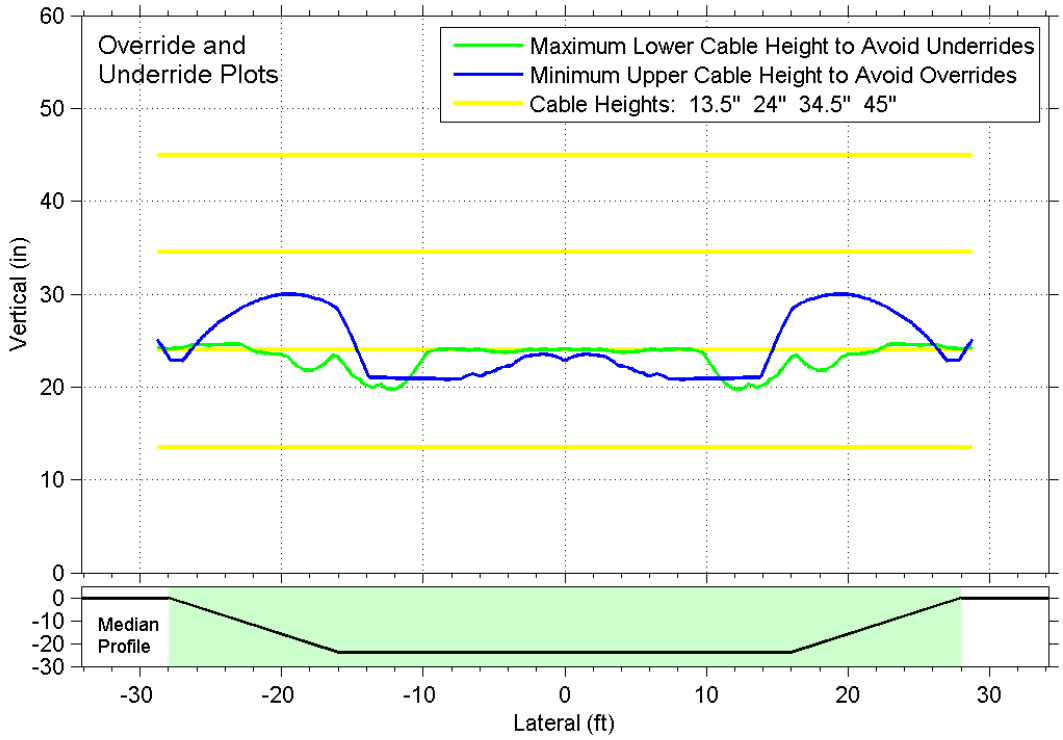




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

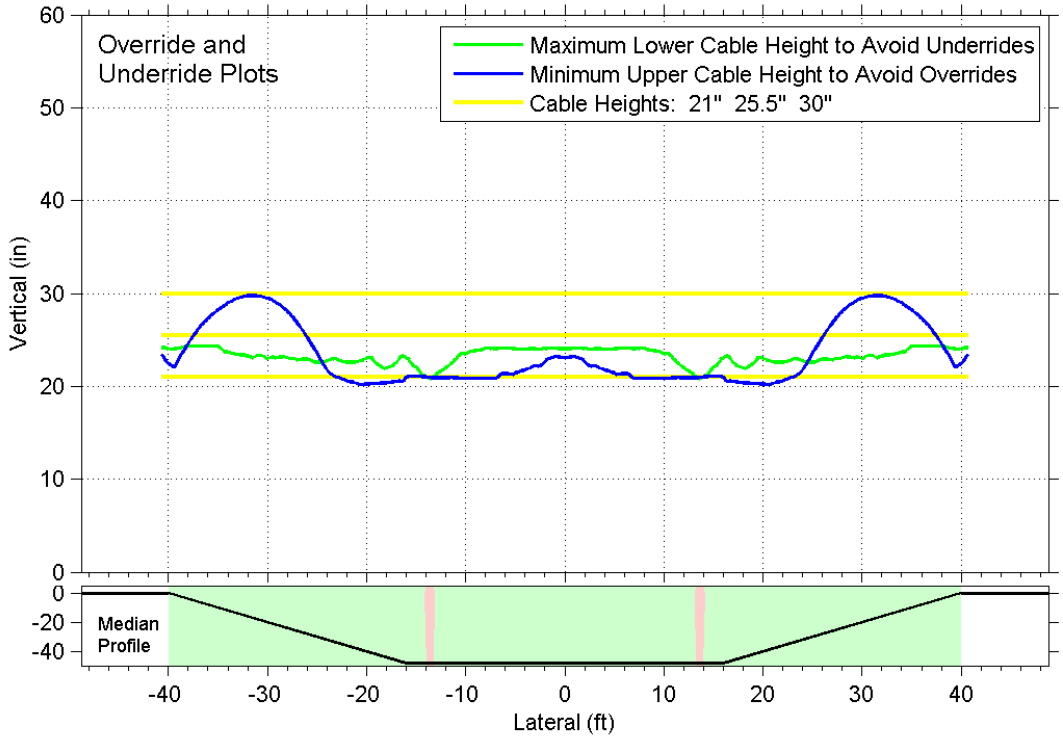
Flat-bottom Median - 6H:1V Slope - 32ft FB Width - 2ft Depth

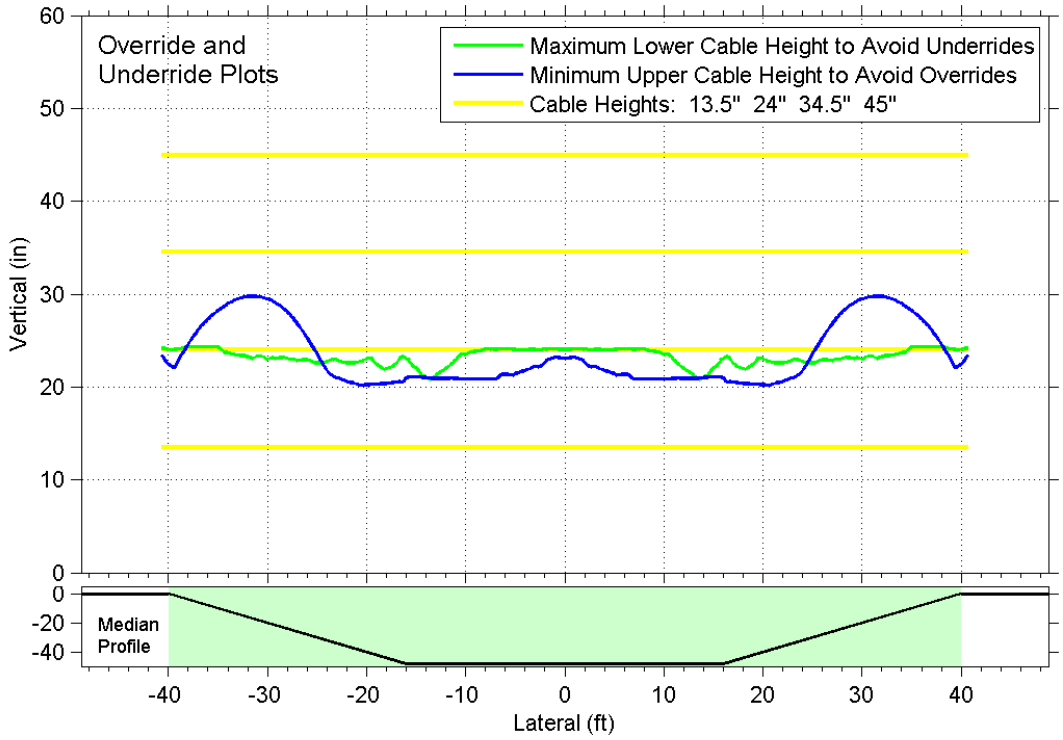




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

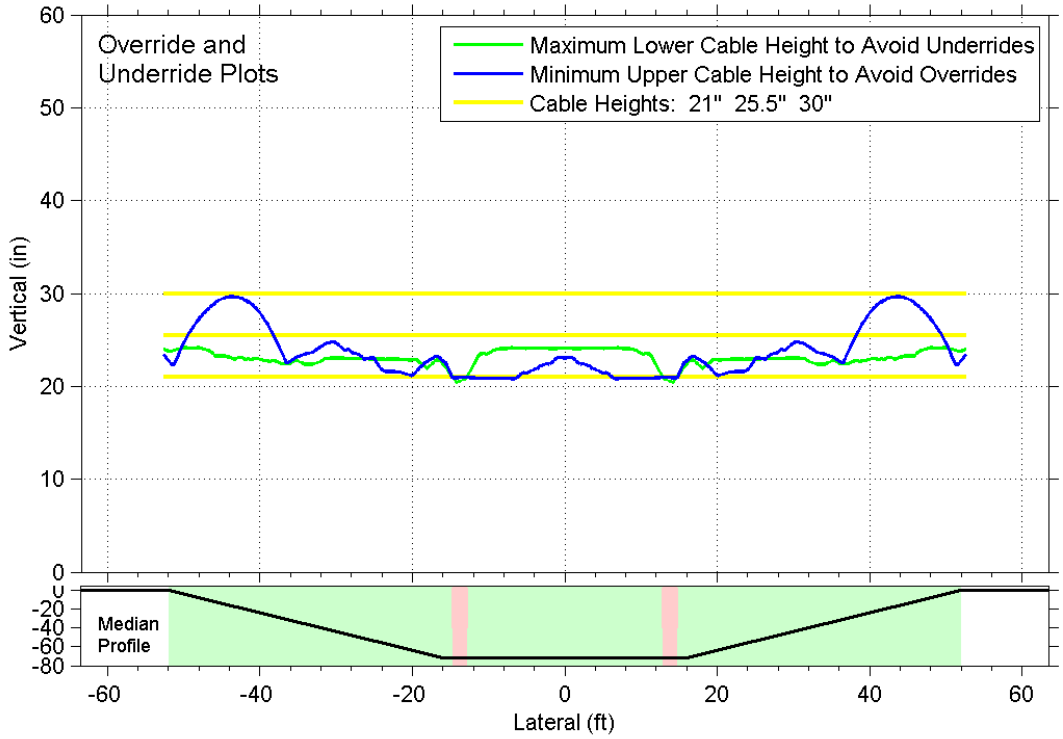
Flat-bottom Median - 6H:1V Slope - 32ft FB Width - 4ft Depth

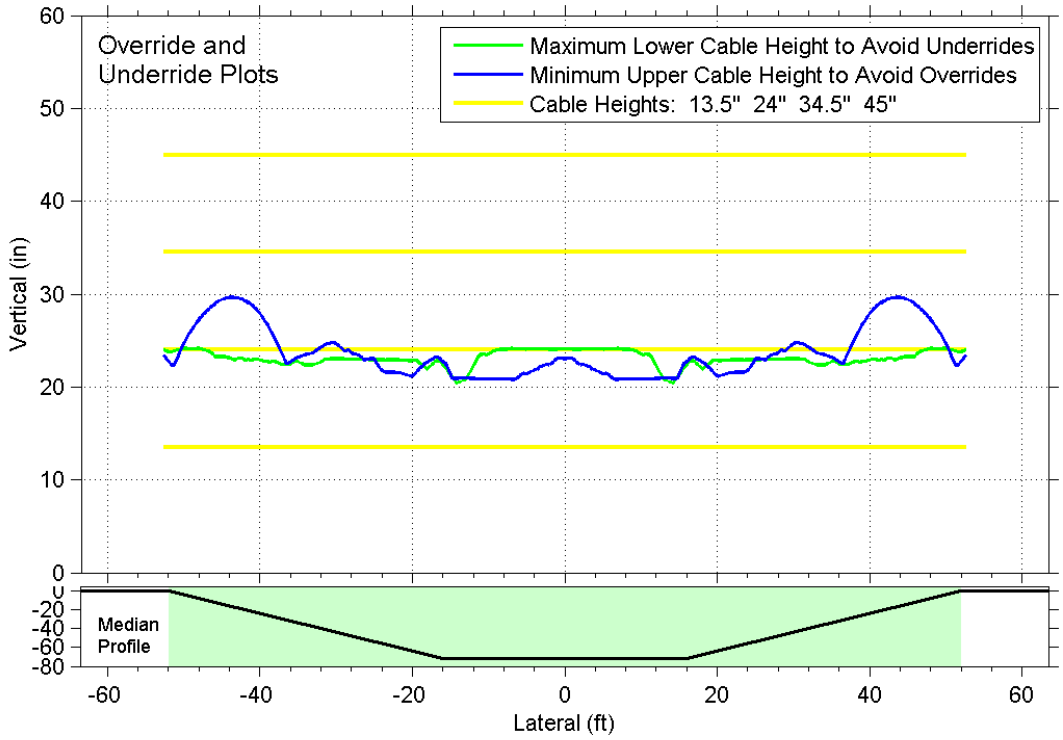




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

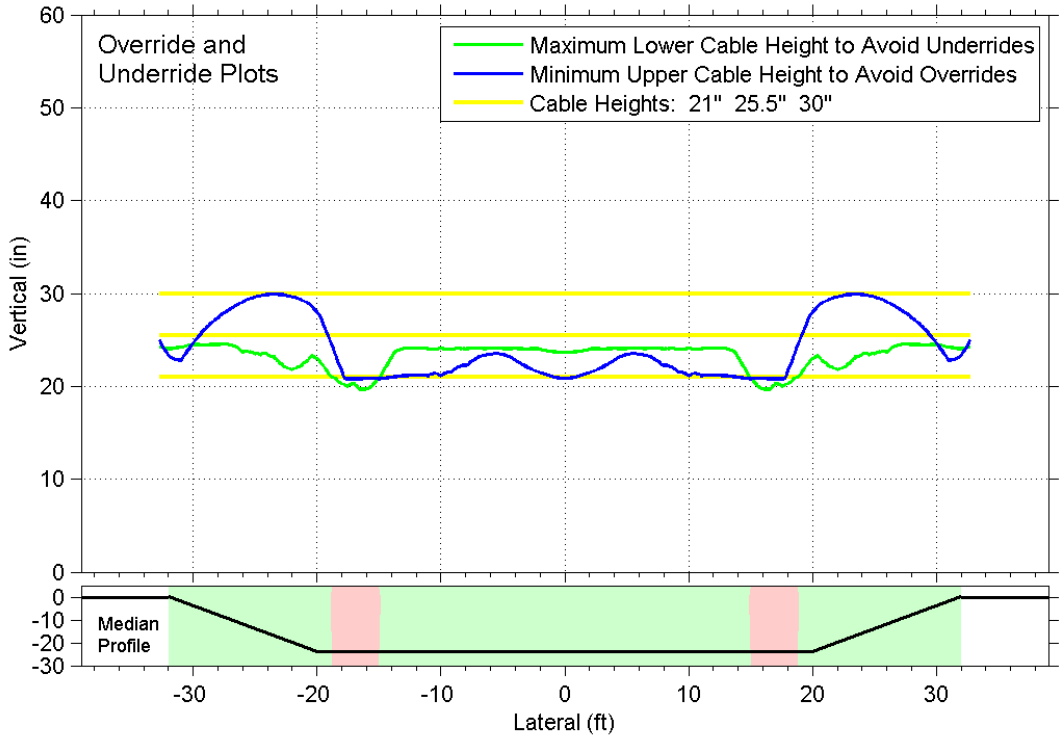
Flat-bottom Median - 6H:1V Slope - 32ft FB Width - 6ft Depth

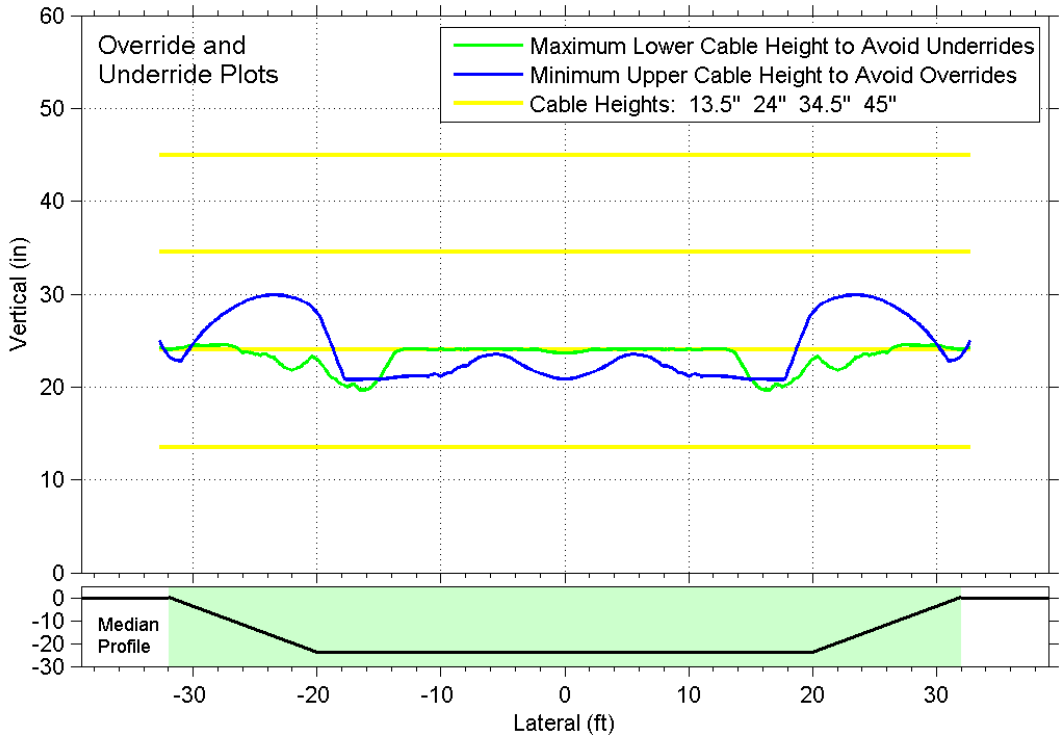




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

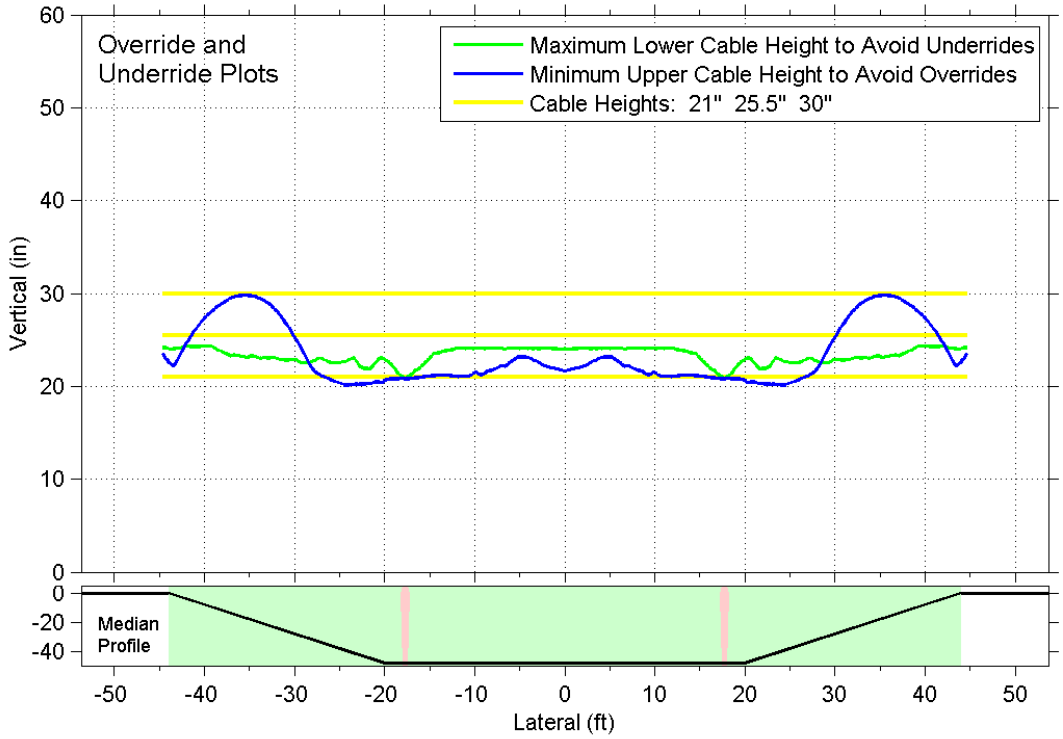
Flat-bottom Median - 6H:1V Slope - 40ft FB Width - 2ft Depth

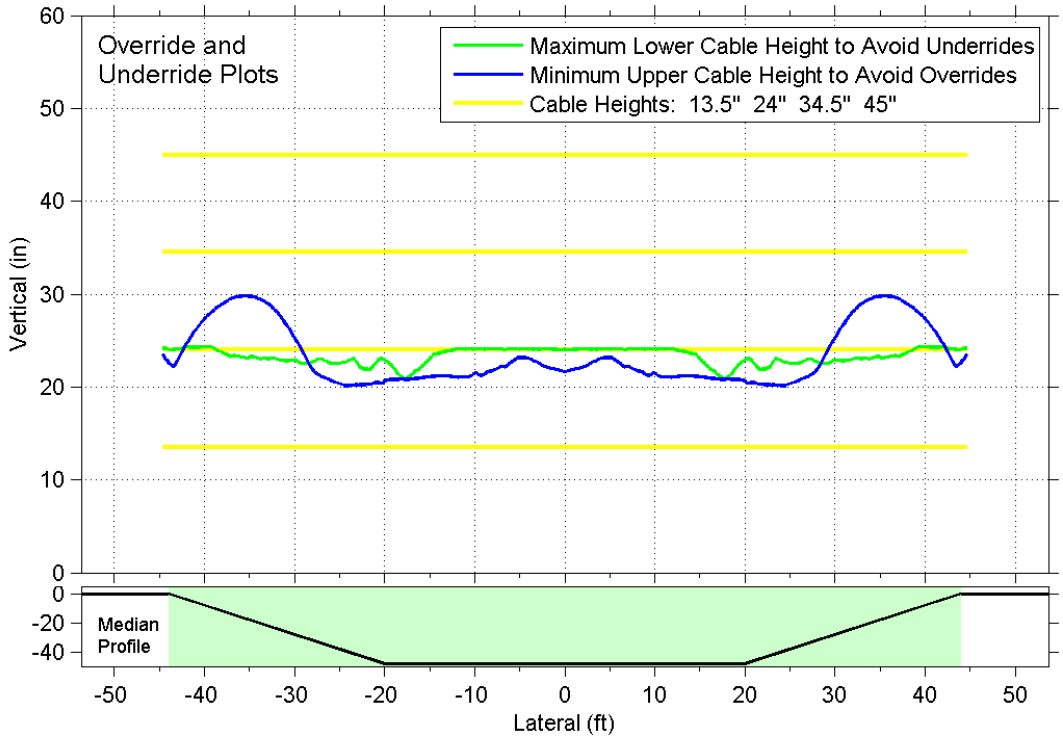




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

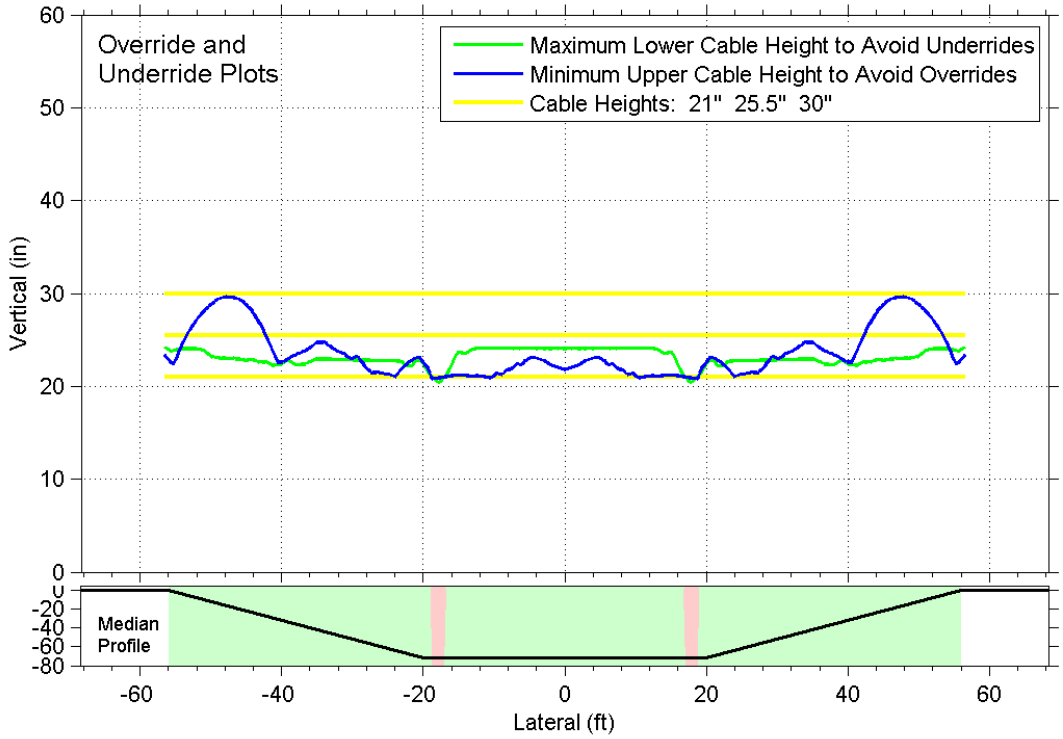
Flat-bottom Median - 6H:1V Slope - 40ft FB Width - 4ft Depth

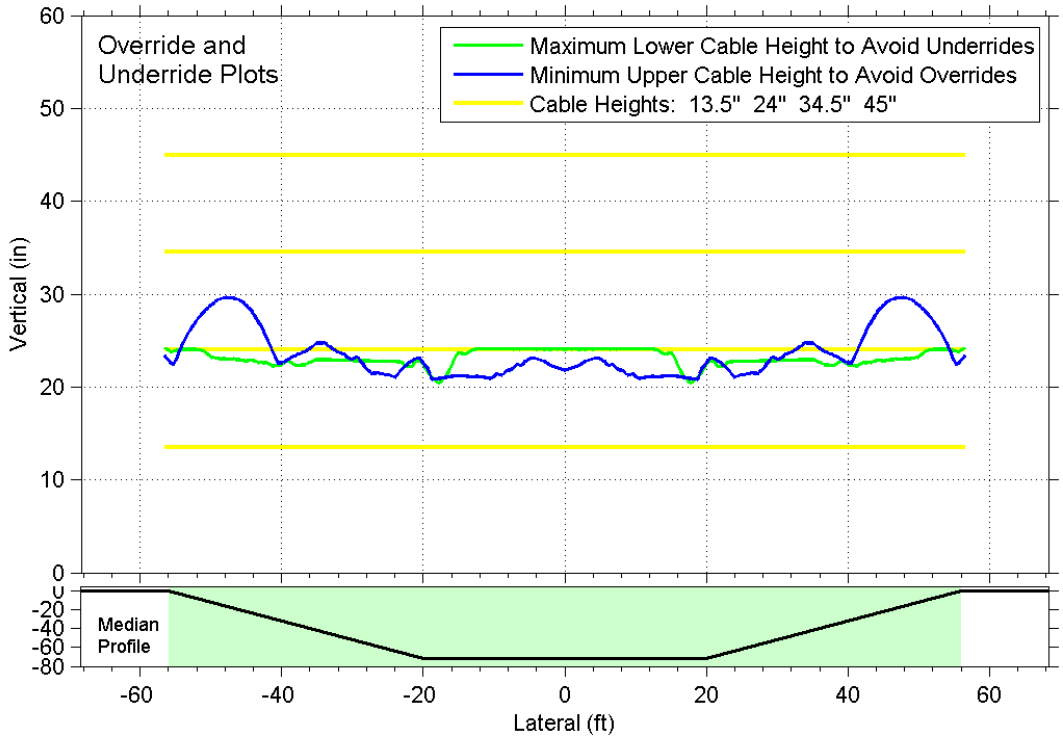




Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

Flat-bottom Median - 6H:1V Slope - 40ft FB Width - 6ft Depth





Lateral placement where the barrier is likely to capture vehicles
Lateral placement where the barrier may miss some cases

APPENDIX D: SUMMARY OF CABLE BARRIER FULL-SCALE CRASH TESTS (FHWA DATABASE)

Accept. Letter	Barrier Manufact.	# of Cables	Cable Heights (mm)	Install. length (m)	Post Shape	Post Spacing (m)	Impact Vehicle	Vehicle Mass (kg)	Speed (km/h)	Angle (deg)	Terrain (slope/width)	Tension (kN)	Defl. (m)
B82	Brifen	4	510, 675, 675, 720	109.0	S-Shaped	3.20	Passenger Car	898	101.0	20.0	Flat	14 - 36	1.04
B82	Brifen	4	510, 675, 675, 720	109.0	S-Shaped	3.20	Pick-up	1999	99.4	26.0	Flat	14 - 36	2.40
B82b	Brifen	4	480, 630, 780, 930	275.0	S-Shaped	3.20	Ford Fiesta 3-door hatch	894	100.8	21.3	Flat		1.35
B82b	Brifen	4	480, 630, 780, 930	275.0	S-Shaped	3.20	International Harvester	8050	79.7	15.8	Flat		2.21
B82b1	Brifen	4	480, 630, 780, 930	111.0	S-Shaped	3.20	1998 Crown Victoria		95.6	26.5	1V:4H, 9.8 m	20.0	2.20
B82b1	Brifen	4	480, 630, 780, 930	111.0	S-Shaped	3.20	1998 Suzuki Swift		101.3	21.1	1V:4H, 9.8 m	18.7	1.20
B82b1	Brifen	4	480, 630, 780, 930	111.0	S-Shaped	3.20	1998 Chevrolet C2500		101.4	24.1	1V:4H, 9.8 m	24.7	2.70
B82c	Brifen	3	460, 600, 720	278.0	S-Shaped	3.20	1998 Suzuki Swift		100.3	20.2	Flat	24.0	0.84
B82c	Brifen	3	460, 600, 720	278.0	S-Shaped	3.20	2000 Chevrolet C2500		98.0	25.3	Flat	24.0	2.60
B82c	Brifen	3	460, 600, 720	278.0	S-Shaped	2.40	1998 Chevrolet C2500		99.3	25.1	Flat	24.0	2.70
B82c1	Brifen	3	460, 600, 720	111.0	S-Shaped	3.20	Chevrolet C2500	2139	97.2	24.5	Flat	22.2	2.10
B137	Gibraltar	3	508, 635, 711	61.0	C-Shaped	4.57	2001 GMC Sierra 2-Door	2064	102.4	25.0	Flat	21.4	2.62
B137	Gibraltar	3	508, 635, 711	62.0	C-Shaped	4.57	1999 Chevrolet Metro	827	100.2	20.0	Flat	21.4	0.76
B137a	Gibraltar	3	508, 762, 991	106.7	C-Shaped	1.91	1999 International Truck	8000	80.0	15.0	Flat	21.4	2.13
B137b	Gibraltar	3	508, 762, 991	93.0	C-Shaped	9.14	2000 Chevrolet C2500	2034	101.5	25.0	Flat	25.4	2.80
B137b	Gibraltar	3	508, 762, 991	93.0	C-Shaped	3.05	2000 Chevrolet C2500	2020	99.9	25.0	Flat	25.4	2.00
B137c	Gibraltar	3	508, 762, 991	91.4	C-Shaped	9.14	1996 Geo Metro	812	97.5	25.0	1V:4H, 7.3 m	25.4	1.50
B137c	Gibraltar	3	508, 762, 991	91.4	C-Shaped	9.14	2001 Chevrolet C2500	2038	98.7	25.0	1V:4H, 7.3 m	25.4	NA
B137c	Gibraltar	3	508, 762, 991	92.9	C-Shaped	6.10	2003 Dodge Ram 1500	2222	97.1	26.0	1V:4H, 7.3 m	25.4	2.81
B137c	Gibraltar	3	508, 762, 991	91.4	C-Shaped	9.14	1997 Geo Metro	845	101.6	20.0	1V:4H, 7.3 m	25.4	1.43
B96	NuCor	3	520, 650, 775	101.4	U-Shaped	1.90	1997 Chevrolet C2500	2040	100.7	25.3	Flat	25.0	1.99
B96a	NuCor	3	520, 650, 775	101.4	U-Shaped	1.90	1999 Chevrolet C2500	2074	99.3	25.7	Flat	25.0	1.80
B96a	NuCor	3	520, 650, 775	101.4	U-Shaped	1.90	2000 Chevrolet C2500	2123	98.1	26.4	Flat	25.0	2.31
B96b	NuCor	3	535, 640, 740	101.5	U-Shaped	2.00	1998 Chevrolet C2500	2106	100.4	25.2	Flat	25.0	1.70
B167	NuCor	4	380, 640, 890, 890	103.7	U-Shaped	6.10	1998 Mitsubishi Fuso	8050	84.5	15.0	Flat	25.0	2.29
B167	NuCor	4	380, 640, 890, 890	103.7	U-Shaped	6.10	1997 Toyota Starlet	904	100.5	20.1	Flat	25.0	1.40

Accept. Letter	Barrier Manufact.	# of Cables	Cable Heights (mm)	Install. length (m)	Post Shape	Post Spacing (m)	Impact Vehicle	Vehicle Mass (kg)	Speed (km/h)	Angle (deg)	Terrain (slope/width)	Tension (kN)	Defl. (m)
B88	Safence	4	480, 630, 780, 930	116.0	Elliptical	2.50	1980 Ford Fiesta	907	102.0	20.0	Flat	14.7	1.10
B88	Safence	4	480, 630, 780, 930	116.0	Elliptical	2.50	1994 Chevrolet Pick-up	2036	104.0	25.0	Flat	14.7	1.80
B88a	Safence	4	500, 580, 660, 740	71.0	I-Shaped	2.50	1979 SAAB 900	1479	110.0	19.0	Flat	20.0	1.30
B88a	Safence	4	500, 580, 660, 740	71.0	I-Shaped	2.50	1977 Ford Fiesta	882	105.0	19.0	Flat	20.0	0.80
B88a	Safence	3	500, 595, 690	71.0	I-Shaped	2.50	1977 Ford Fiesta	879	107.0	19.0	Flat	20.0	0.70
B88a	Safence	3	500, 595, 690	71.0	I-Shaped	2.50	1975 SAAB 99L	1499	111.0	19.0	Flat	20.0	1.30
B88a	Safence	4	460, 540, 610, 690	125.0	U-Shaped	2.50	1988 Volvo FL6111	10040	70.0	14.0	Flat	14.6	1.50
B88a	Safence	4	460, 540, 610, 690	125.0	U-Shaped	2.50	1988 Volvo FL6111	10040	70.0	15.0	Flat	14.6	1.50
B88a	Safence	3	480, 575, 670	118.0	C-Shaped	3.00	1978 Ford Fiesta	899	107.0	20.0	Flat	10.0	1.40
B88a	Safence	3	480, 575, 670	118.0	C-Shaped	3.00	1976 Volvo 242	1438	111.0	20.0	Flat	29.0	1.60
B88a	Safence	3	480, 575, 670	108.0	I-Shaped	3.00	1980 SAAB 900 GL	1429	111.0	20.0	Flat		1.70
B88d	Safence	3	480, 640, 720	118.7	C-Shaped	4.00	1996 Volvo FL 608 4X2	8020	78.7	15.1	Flat	17.0	2.10
B88d	Safence	3	480, 640, 720	118.7	C-Shaped	10.00	1996 Volvo FL 608 4X2	8020	78.7	15.1	Flat	17.0	3.70
B88e	Safence	4	480, 560, 640, 720	72.0	I-Shaped	2.50	2000 Nissan Micra 1.0 3D	912	98.9	20.0	Flat	14.0	0.85
B88e	Safence	4	480, 560, 640, 720	72.0	I-Shaped	2.50	2001 Nissan Micra 1.0 3D	898	101.6	15.0	Flat	14.0	
B88e	Safence	4	480, 560, 640, 720	72.0	I-Shaped	2.50	2001 Nissan Micra 1.0 3D	900	102.0	0.0	Flat	14.0	
B88e	Safence	4	480, 560, 640, 720	72.0	I-Shaped	2.50	1995 Chevrolet C2500	2024	101.9	20.0	Flat	14.0	1.67
B88f	Safence	3	500, 785, 975	185.0	C-Shaped	4.90	Ford Transit 350E	2222	101.5	25.0	1V:4H, 8.0 m	11.8	5.00
B88f	Safence	3	500, 785, 975	185.0	C-Shaped	4.90	Kia Rio	1124	103.0	25.0	1V:4H, 8.0 m	11.8	
B119	Trinity	3	530, 640, 750	101.9	C-Shaped	3.00	1998 Chevrolet 2500	2045	100.6	24.2	Flat	24.0	2.40
B119a	Trinity	3	530, 640, 750	101.9	C-Shaped	5.00	1998 Chevrolet C2500	2060	99.4	25.7	Flat	24.0	2.80
B119b	Trinity	3	530, 640, 750	101.9	C-Shaped	2.00	1998 Chevrolet C2500	2075	100.6	25.6	Flat	24.0	2.08
B141	Trinity	3	530, 640, 750	101.9	I-Shaped	6.10	1999 Chevrolet C2500	2108	96.5	24.7	Flat	24.0	2.36
B141	Trinity	3	530, 640, 750	101.9	I-Shaped	6.10	1991 Ford F-700	8196	82.5	14.1	Flat	24.0	2.21
B141a	Trinity	3	530, 640, 750	101.9	I-Shaped	6.10	2000 Chevrolet C2500	2134	100.0	24.7	Flat	25.0	1.89
B141b	Trinity	3	540, 645, 750	100.6	I-Shaped	9.90	2000 Chevrolet C2500	2102	102.6	24.9	Flat	25.0	3.41
B141c	Trinity	3	445, 745, 1060	100.6	I-Shaped	6.1	2270P		100.0	25.0	1V:4H, 9.1 m	24.9	2.85
B141c	Trinity	3	445, 745, 1060	100.6	I-Shaped	6.1	820C		100.0	20.0	1V:4H, 9.1 m	24.9	
B141c	Trinity	3	445, 745, 1060	100.6	I-Shaped	6.1	820C		100.0	20.0	1V:4H, 9.1 m	24.9	
B141c	Trinity	3	445, 745, 1060	100.6	I-Shaped	2.0	2270P		100.0	25.0	1V:4H, 9.1 m	24.9	2.19