APPENDIX B
Channel Stabilization Measures

OVERVIEW OF VARIOUS CHANNEL STABILIZATION MEASURES

INTRODUCTION

Channel stabilization measures are structures used to control the vertical and horizontal alignment of a channel. For example, riprap is commonly used for bank protection to control lateral channel shifting. Grade control or drop structures are often used to control vertical incision (degradation) and are typically constructed of concrete or driven sheet pile. However, other less common channel stabilization methods and construction techniques are often useful, and in some cases more appropriate for a given situation. The following information provides an overview of channel stabilization measures and provides an introduction to some of the measures recommended for Cottonwood Creek.

BANK PROTECTION

Common alternatives for bank protection in urban areas can be classified as flexible revetment, rigid revetment, and spur fields. Flexible and rigid revetments have been widely used for channel linings in urban areas. Spur fields are less common in urban areas, but have been widely used in rural areas, particularly by the transportation and road engineering community.

Flexible Revetment Bank Protection

Common flexible revetments include dumped rock riprap and rock-and-wire mattress and gabions. Dumped rock riprap has been widely used for bank protection (**Figure 1**). Rock riprap protection is flexible and local damage is easily repaired. Successful design depends on adequate rock size and gradation, an appropriate filter between the underlying soil and riprap, and proper construction practices.

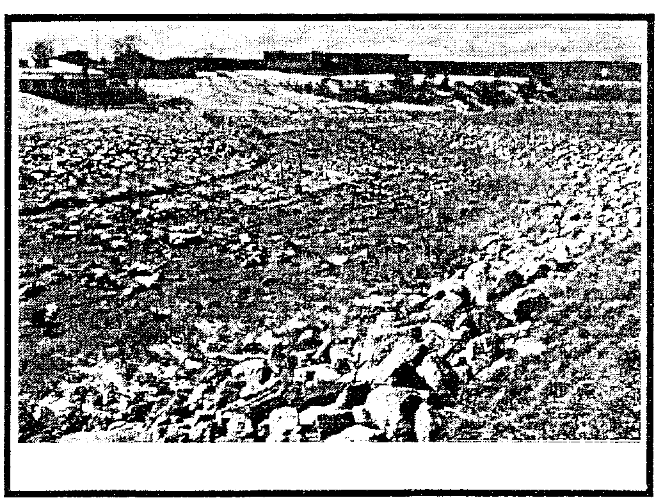


Figure 1. Dumped riprap bank protection, Cottonwood Creek, Colorado.

When only the channel banks are protected, adequate toe-down (burial into the channel bottom) must be provided to prevent failure by scour along the toe of slope. Rock riprap is often effectively used to provide toe protection along a bankline that is otherwise natural (e.g., a prudent line channel). Riprap placed along the toe of slope, with adequate toe-down, can prevent undercutting of the bank and potential bank mass failures.

The economic use of rock-and-wire products is favored by an arid climate, availability of stones of cobble size, and unavailability of rock for dumped rock riprap (FHWA 1991). Corrosion of wire mesh is slow in arid climates and ephemeral streams do not subject the wire to continuous abrasion. **Figure 2** shows a gabion wall constructed to protect the outside of a bend on the Black Arroyo, New Mexico. Where large rock is not available, the use of rock-and-wire products may be advantageous in spite of the eventual corrosion or abrasion of the wire. However, gabion walls are labor intensive to build and subject to vandalism (in urban areas the wire mesh has been cut or broken open and the rocks thrown into the channel).

Figure 2. Gabion wall on Black Arroyo, New Mexico.

Rigid Revetment Bank Protection

Common rigid revetment includes concrete paving and soil cement. Concrete paving minimizes channel size, but is typically the most expensive lining alternative. When used for bank lining only, adequate toe-down must be provided to prevent undermining. **Figure 3** illustrates a concrete trapezoidal channel under construction, terminating with a concrete drop structure at the downstream confluence (Unser Boulevard channel, New Mexico). The aesthetic appearance of concrete lining can be improved using tinted concrete; however, the smooth, flat appearance of a concrete lining generally does not blend well in a natural, or naturalistic, channel environment.

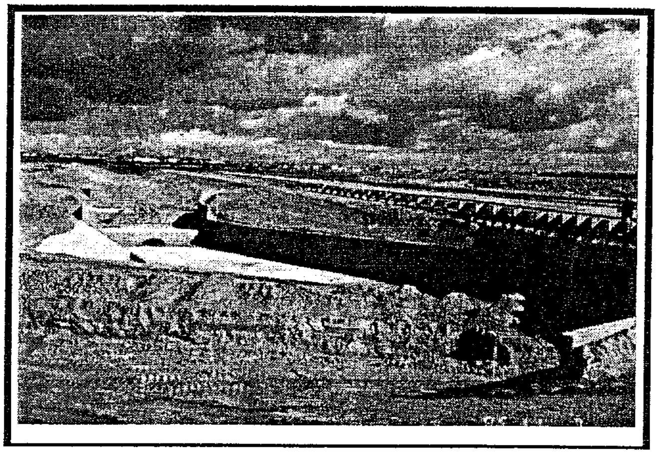


Figure 3. Concrete trapezoidal channel under construction.

Soil cement is a highly compacted mixture of soil (usually sand), Portland cement and water. The placement and compaction of soil cement is accomplished by conventional highway construction equipment and methods. The resulting product has an appearance, texture and color similar to that of the native bank materials (Hansen and Lynch 1995). A stair-step construction is typically used, with each lift about 8 ft wide and about 12 inches thick before compaction (6-8 inches thick after compaction). To provide a smoother edge, the soil cement can be trimmed at the end of each days placement; however, in many cases the added roughness of the stair-step edge is beneficially hydraulically, and the steps provide a means for people and animals to climb out of a channel, which can be a desirable emergency safety measure in urban areas.

Figure 4 illustrates stair-step soil cement bank protection on the outside of a bend on Calabacillas Arroyo, New Mexico, and **Figure 5** shows soil cement protection of both banks on Sand Creek, Colorado. Unlike other types of bank revetment, where milder slopes are desirable, soil cement in a stair-step construction can be used on steeper slopes (i.e., typically one-to-one), which reduces channel excavation costs. For many applications, soil cement is generally more aesthetically pleasing than other types of revetment and has roughness characteristics more comparable to those of the native bank materials.

Spur Field Bank Protection

Spurs are permeable or impermeable structures that project from the bank into the channel (FHWA 1991). Spurs may be used to alter flow direction, induce deposition or reduce flow velocity. Spurs may protect a stream bank at less cost than riprap revetment, and by deflecting current away from the bank and causing deposition, they may more effectively protect banks from erosion than revetment (Richardson and Simons 1984). Multiple spurs are typically designed to create a spur field along a bankline (**Figure 6**), with the overall design a function of permeability, orientation, spacing, height, shape, length, construction materials and stream environment (FHWA 1991). In contrast to bank revetment, which stabilizes the bankline but does not change the erosive flow conditions, a spur field can be used to control the problem by diverting flow back into the middle of channel and allowing a bank line to recover by sediment deposition and revegetation.

Figure 4. Soil cement bank protection, Calabacillas Arroyo.

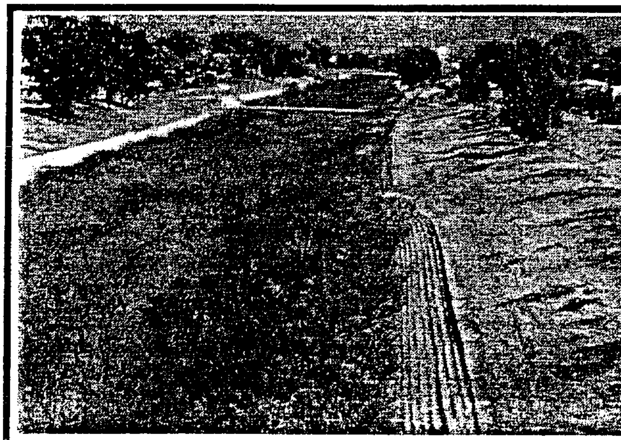


Figure 5. Soil cement bank protection, Sand Creek, Colorado

Figure 6. Spur view along the outside of a bend.

GRADE CONTROL PROTECTION

Grade control or vertical channel protection can range from simple rock riprap structures, to soil cement structures, to large concrete structures with baffled aprons and stilling basins. The terms grade control structure and drop structure are often used interchangeably; however, it can be useful to define a grade control structure as a structure that maintains the existing grade (with an invert typically at the existing channel/terrace bottom), and a drop structure as a structure used to lower the existing grade (by using an invert elevated above the natural channel/terrace bottom).

Success with riprap drop structures has been varied. In the Denver area, the use of riprap drop structures has been discouraged by the Denver Urban Drainage and Flood Control District, based on a comprehensive evaluation of the performance of existing riprap drop structures (McLaughlin Water Engineers 1986).

Soil cement drop structures have been effective in the southwest, with designs ranging from a straight drop to curvilinear and stepped drops. **Figure 7** illustrates a stepped soil cement drop structure on La Barranca Arroyo, New Mexico, and **Figure 8** shows a curvilinear soil cement drop structure on Calabacillas Arroyo, New Mexico.

Figure 7. Stepped soil-cement drop structure, La Barranca Arroyo, New Mexico.

Figure 8. Curvilinear soil cement drop structure, Cabacillas Arroyo, New Mexico.

Properly designed concrete drops are effective and can accommodate large drop heights with significant energy dissipation, but these type of structures are typically quite expensive. Often, a more economical and aesthetically pleasing design can be achieved by using multiple soil cement drops of lower height. **Figure 9** illustrates a small concrete grade control structure on Black's Arroyo, New Mexico. Concrete drop structures that are not much more than a retaining wall often fail, as illustrated by **Figure 10**. In contrast, this type of failure is rarely seen on stair-step soil cement drop structures due to the large mass of soil cement used in construction.

Figure 9. Concrete grade control structure, Black Arroyo, New Mexico.

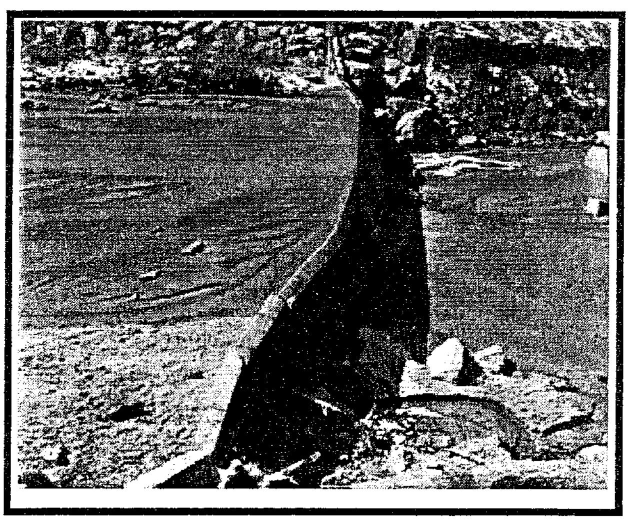
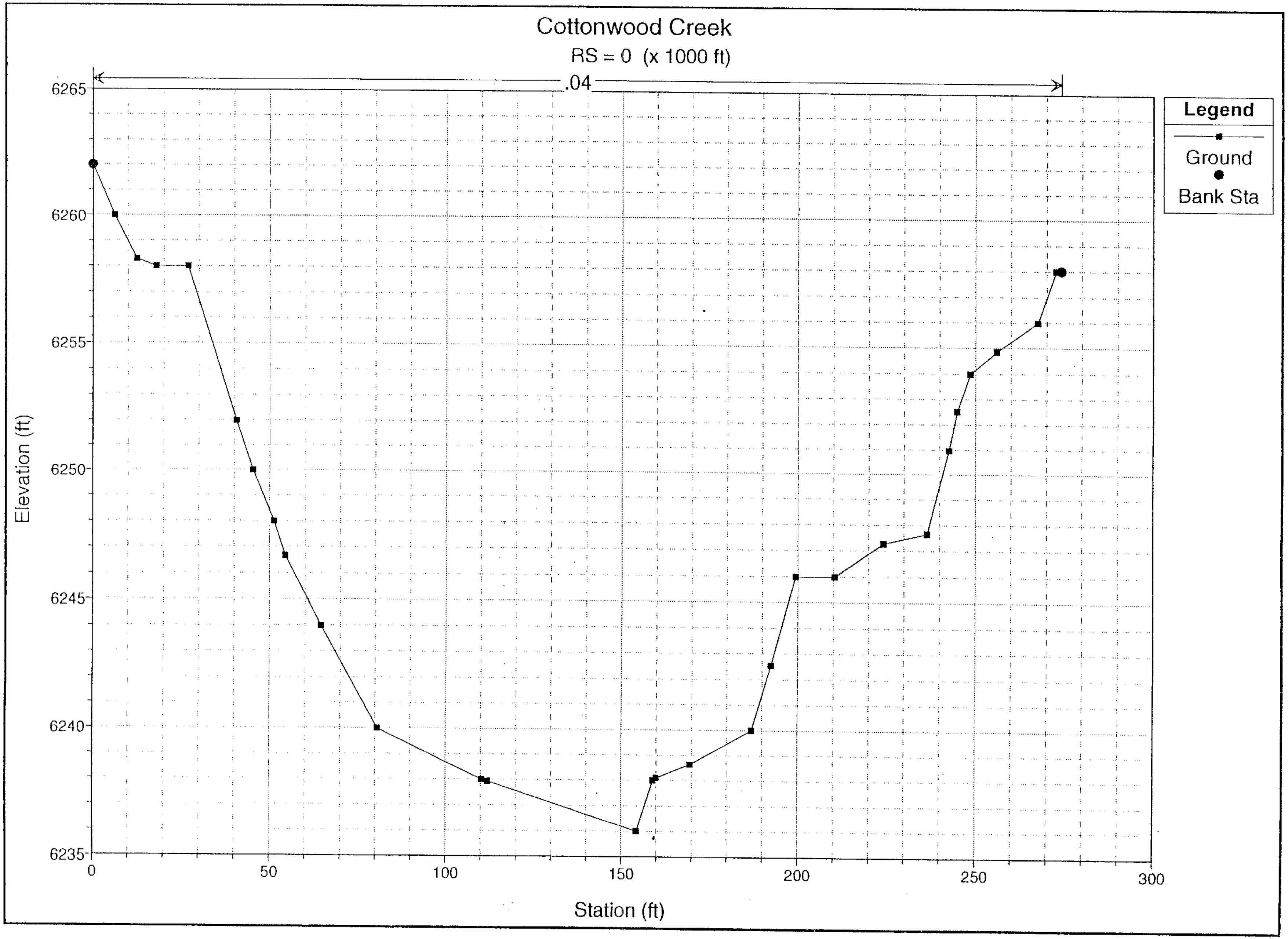


Figure 10. Failing grade control structure, Cottonwood Creek, Colorado.

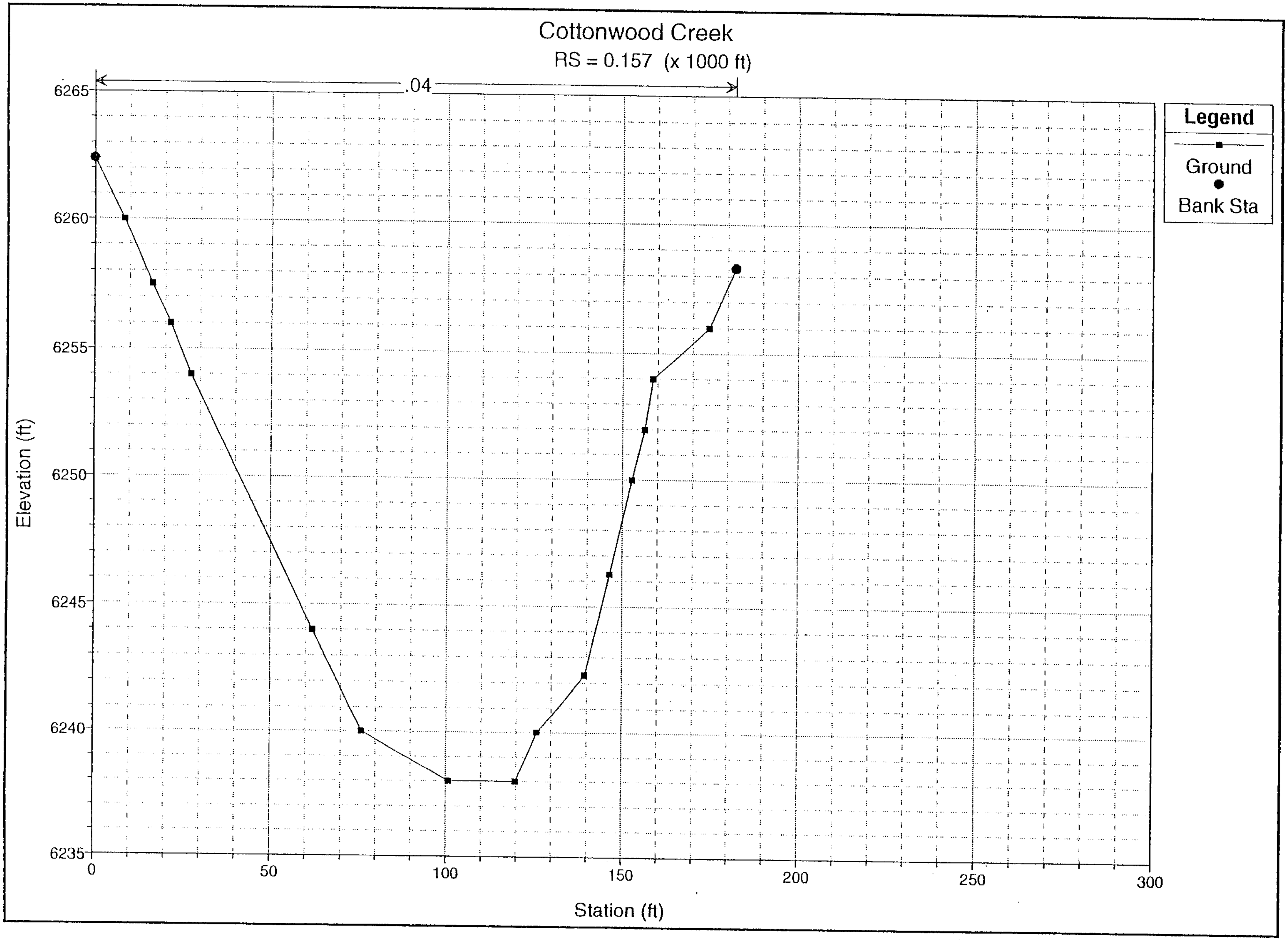
The durability of soil cement drop structures under perennial flow conditions is a concern, where the soil cement is exposed to slow but progressive erosion by year-round flow. Under these conditions it may be advisable to cap the soil cement structure with roller-compacted concrete (RCC). RCC uses a processed/graded aggregate and has a higher compressive strength than soil cement, but is constructed using similar techniques. RCC has been used for dam embankment overtopping protection and has functioned well under long term flow conditions (McLean and Hansen 1993).

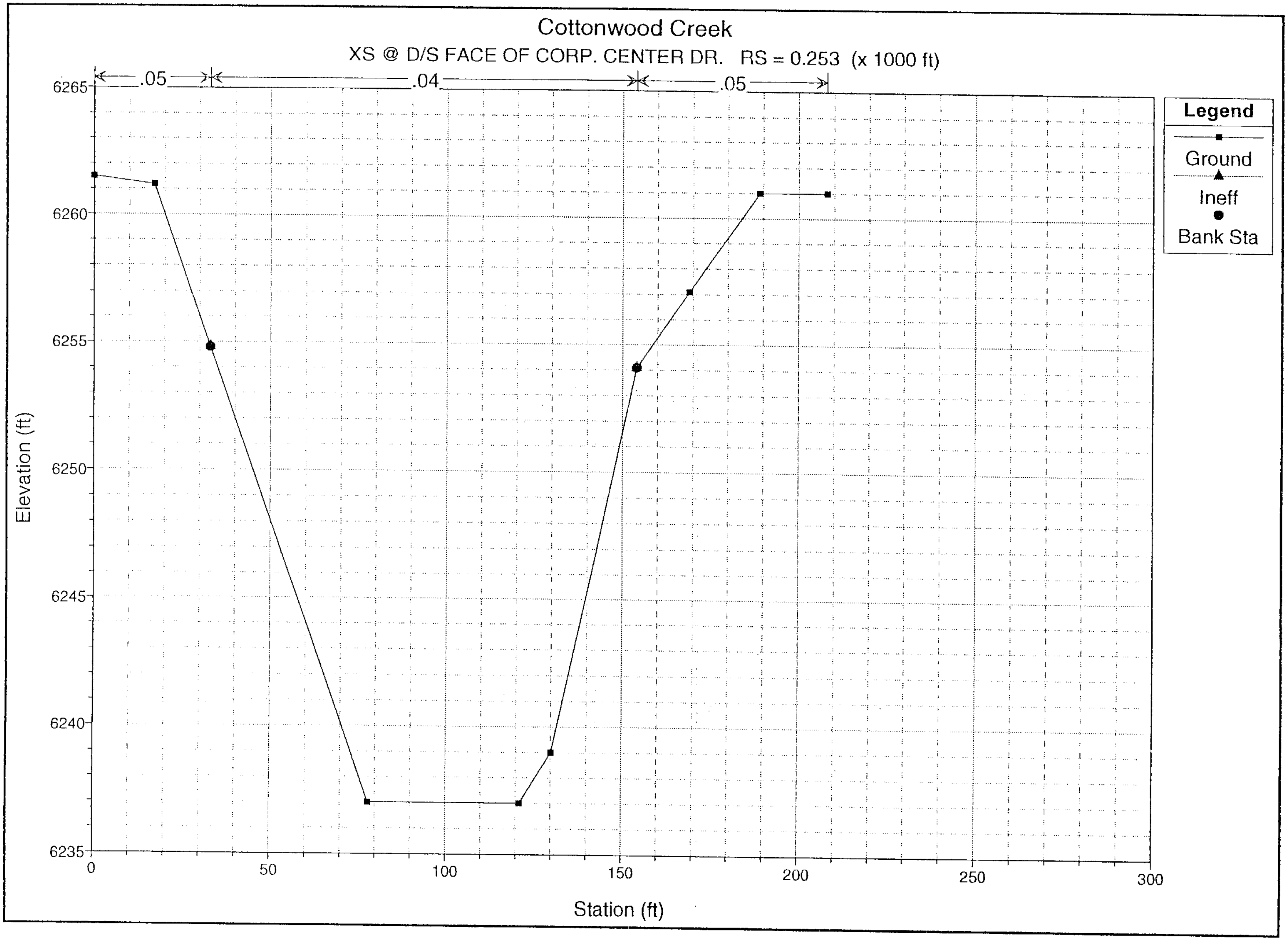
APPENDIX C
Hydraulics

Channel Cross Sections

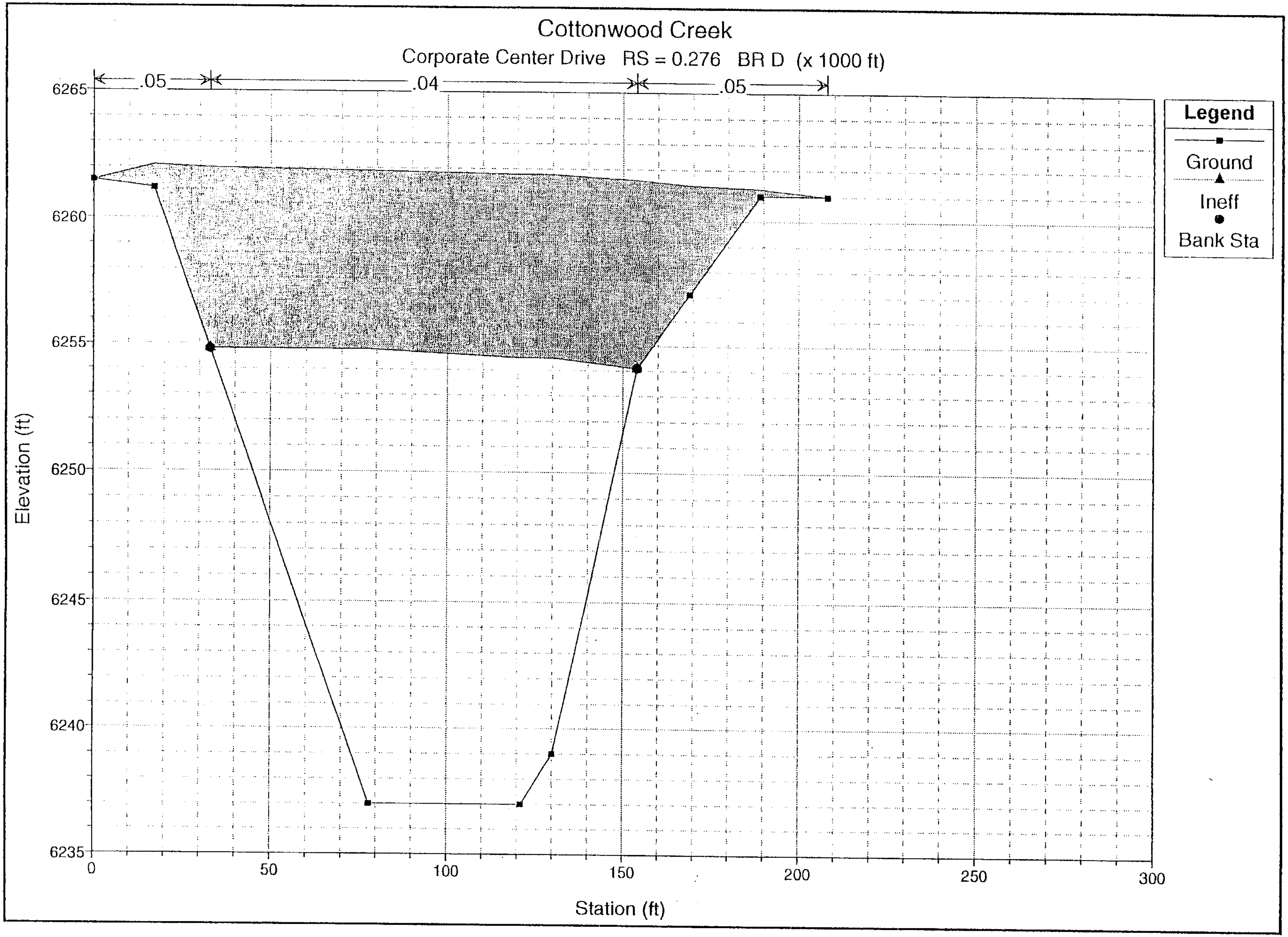


Cottonwood Creek
RS = 0 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)

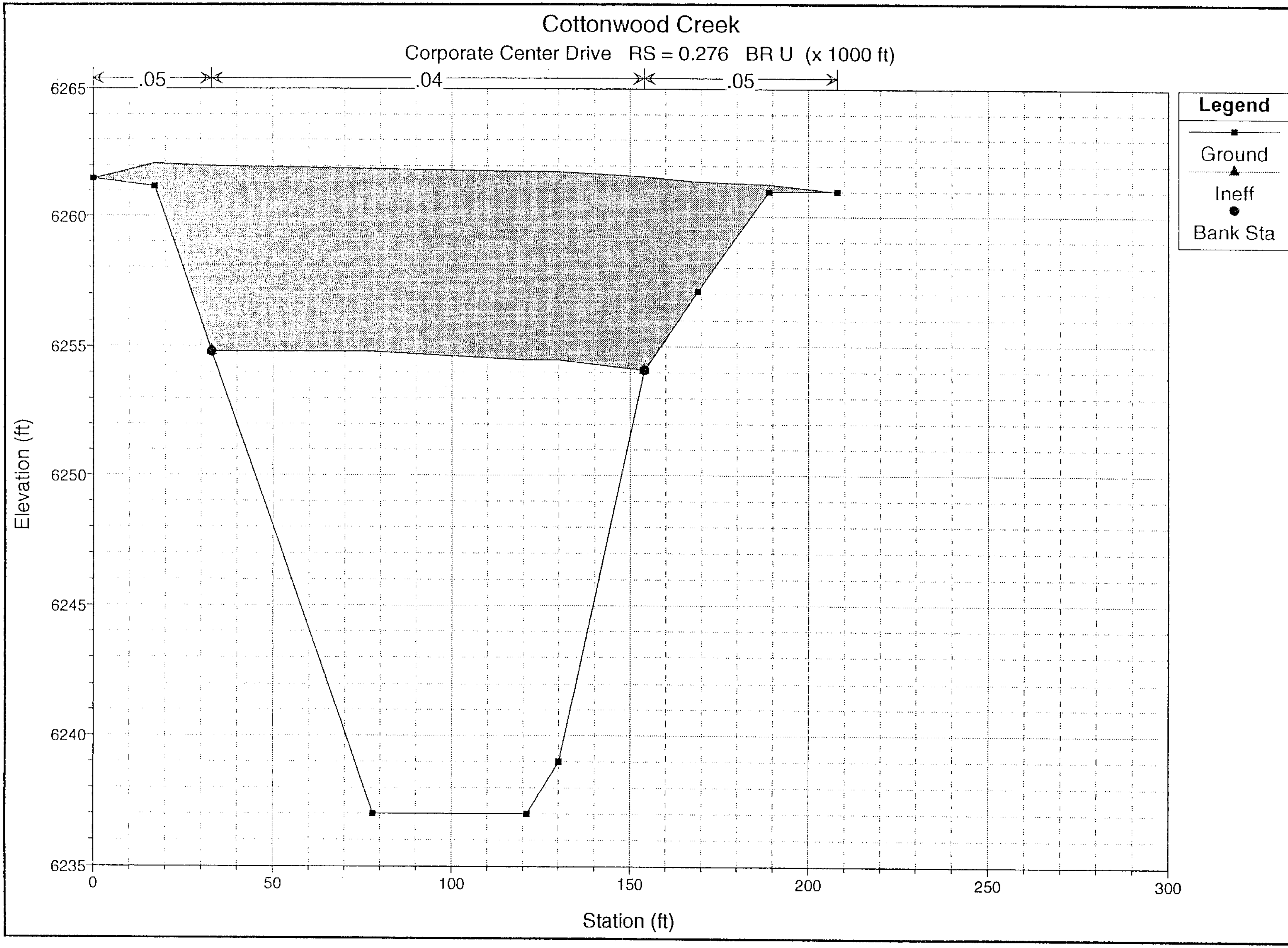

Cottonwood Creek
RS = 0.157 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)



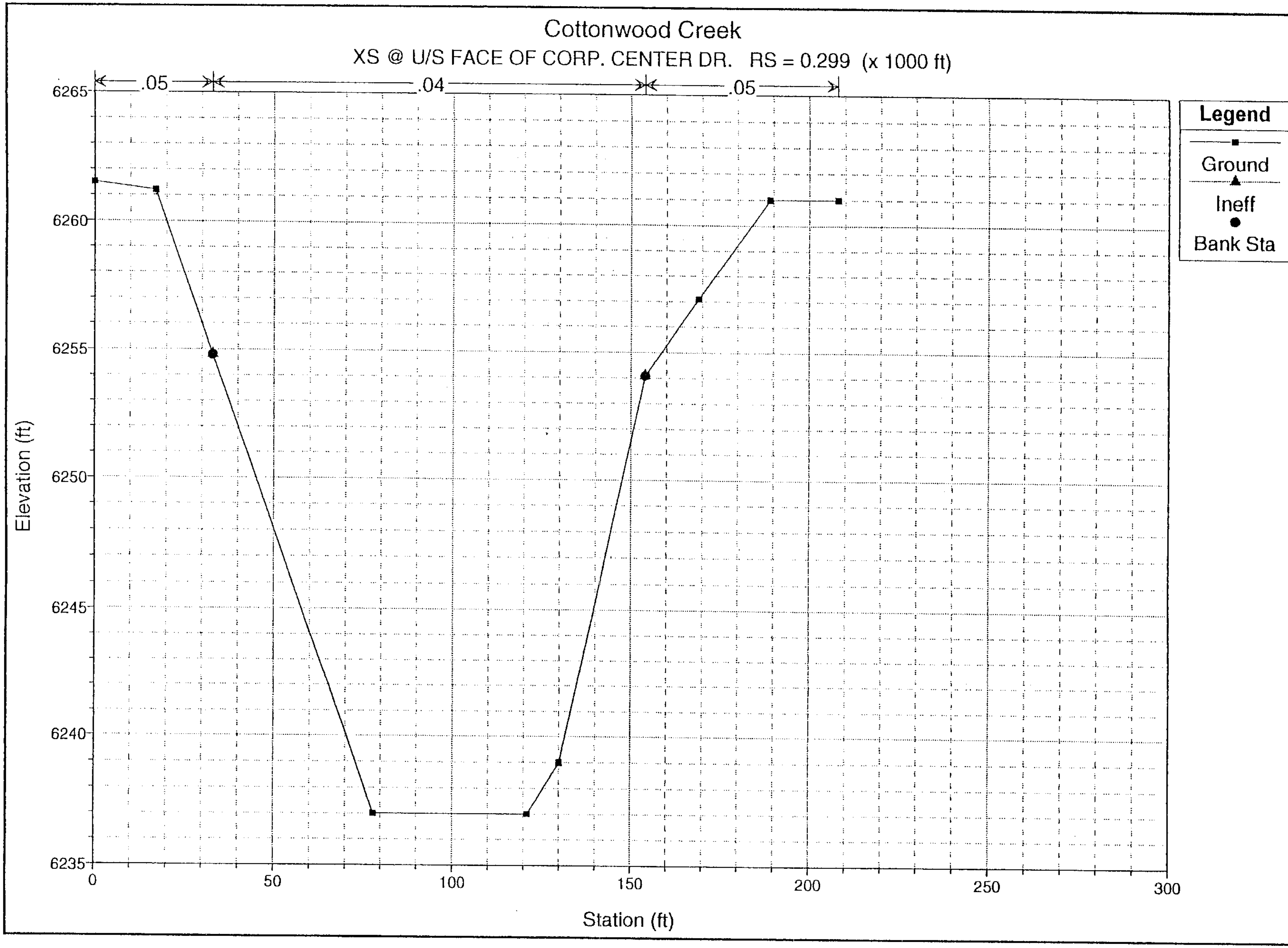
Cottonwood Creek
XS @ D/S FACE OF CORP. CENTER DR. RS = 0.253 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)



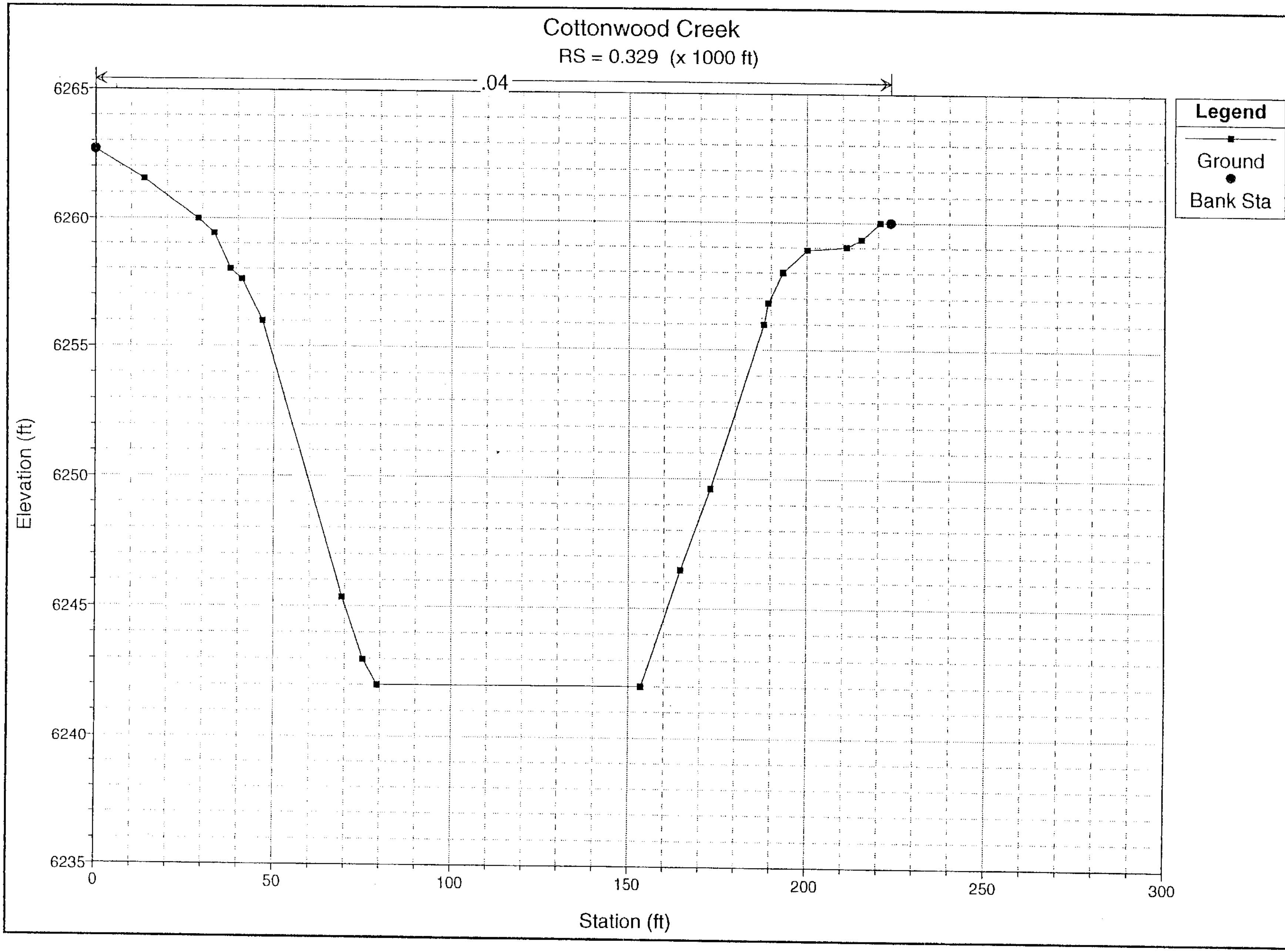
Cottonwood Creek
Corporate Center Drive RS = 0.276 BR D (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)



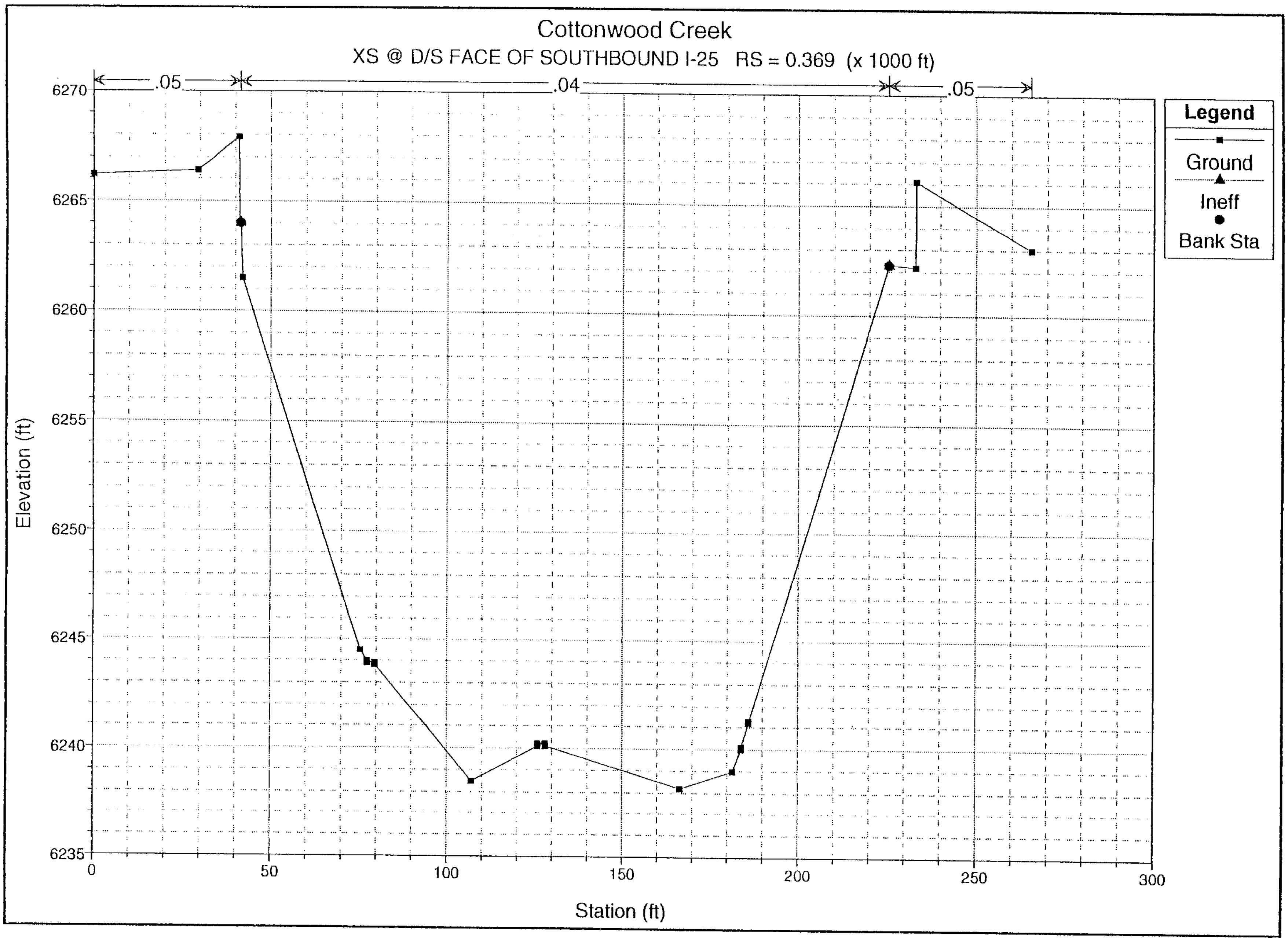
Cottonwood Creek
Corporate Center Drive RS = 0.276 BR U (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)



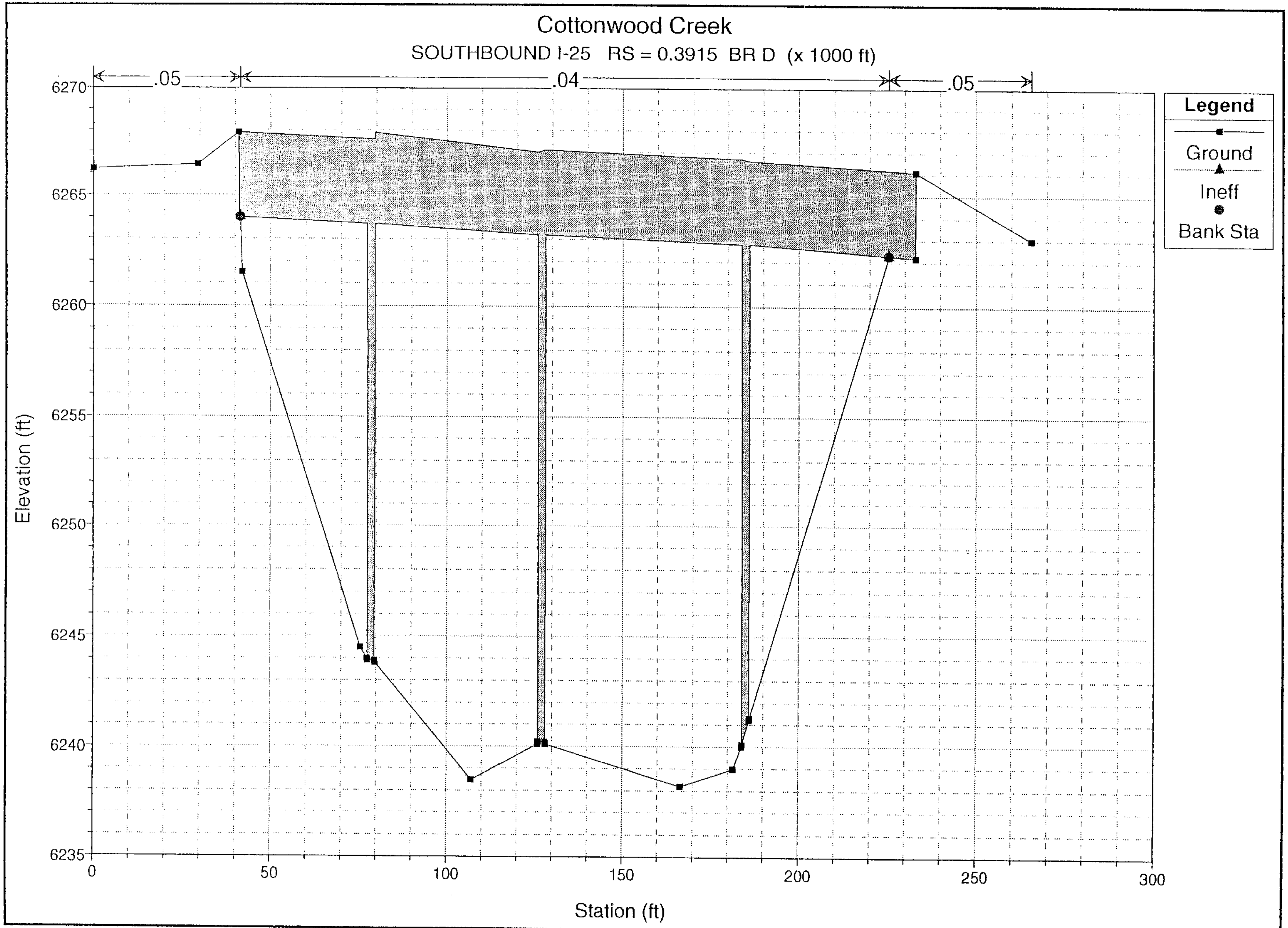
Cottonwood Creek
XS @ U/S FACE OF CORP. CENTER DR. RS = 0.299 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)

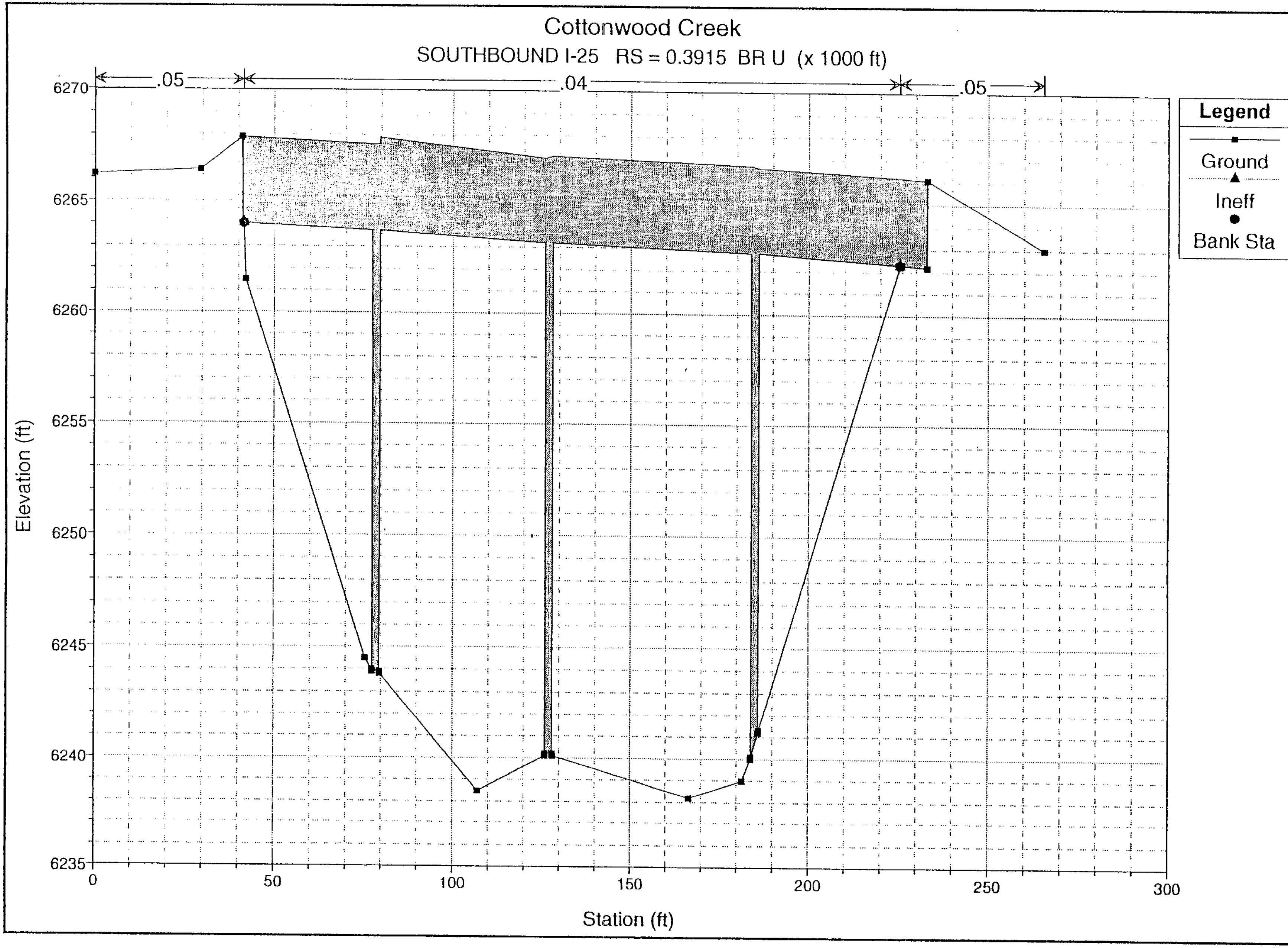


Cottonwood Creek
RS = 0.329 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)

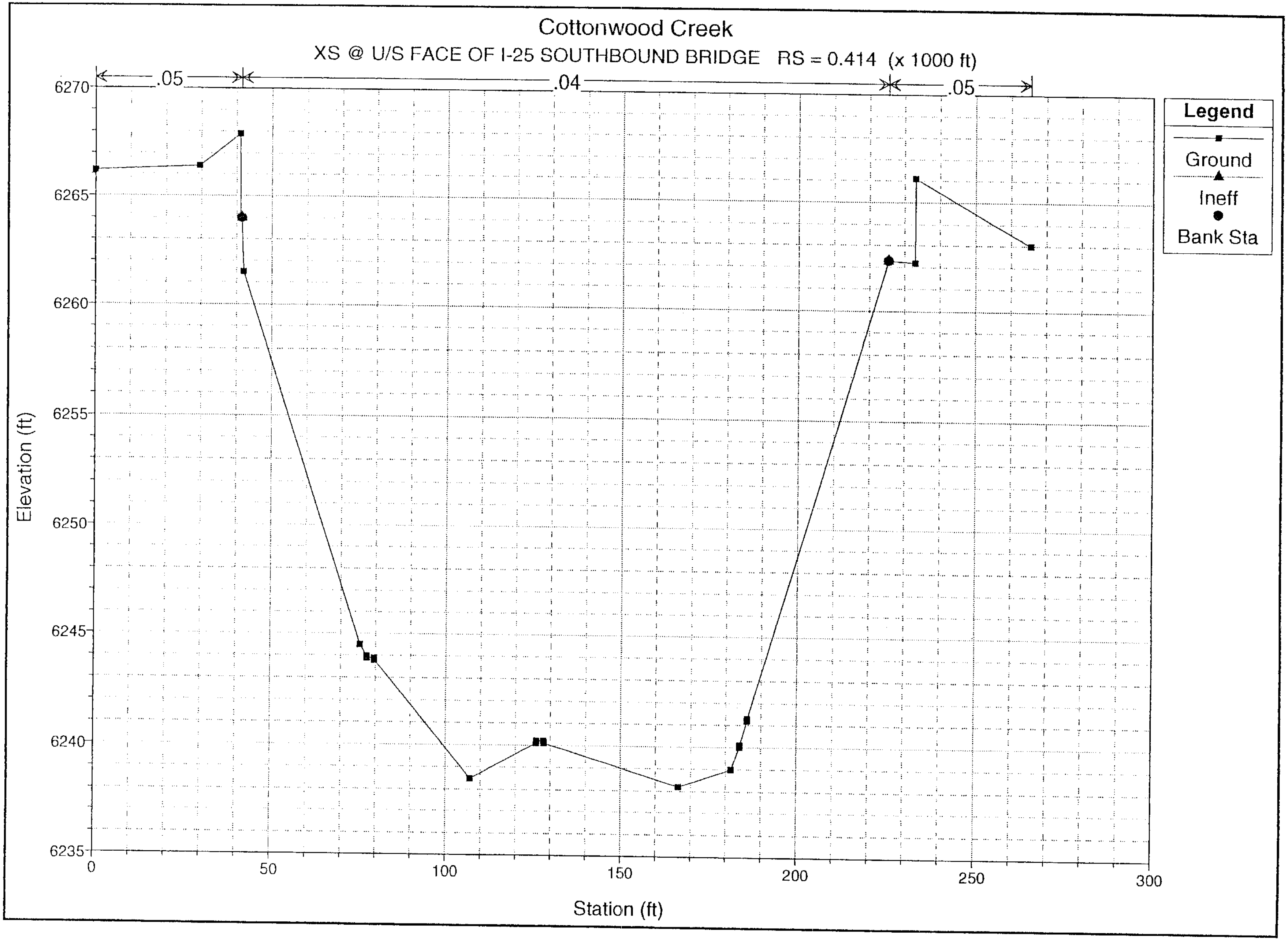


Cottonwood Creek
XS @ D/S FACE OF SOUTHBOUND I-25 RS = 0.369 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
6235
Station (ft)
0
50
100
150
200
250
300

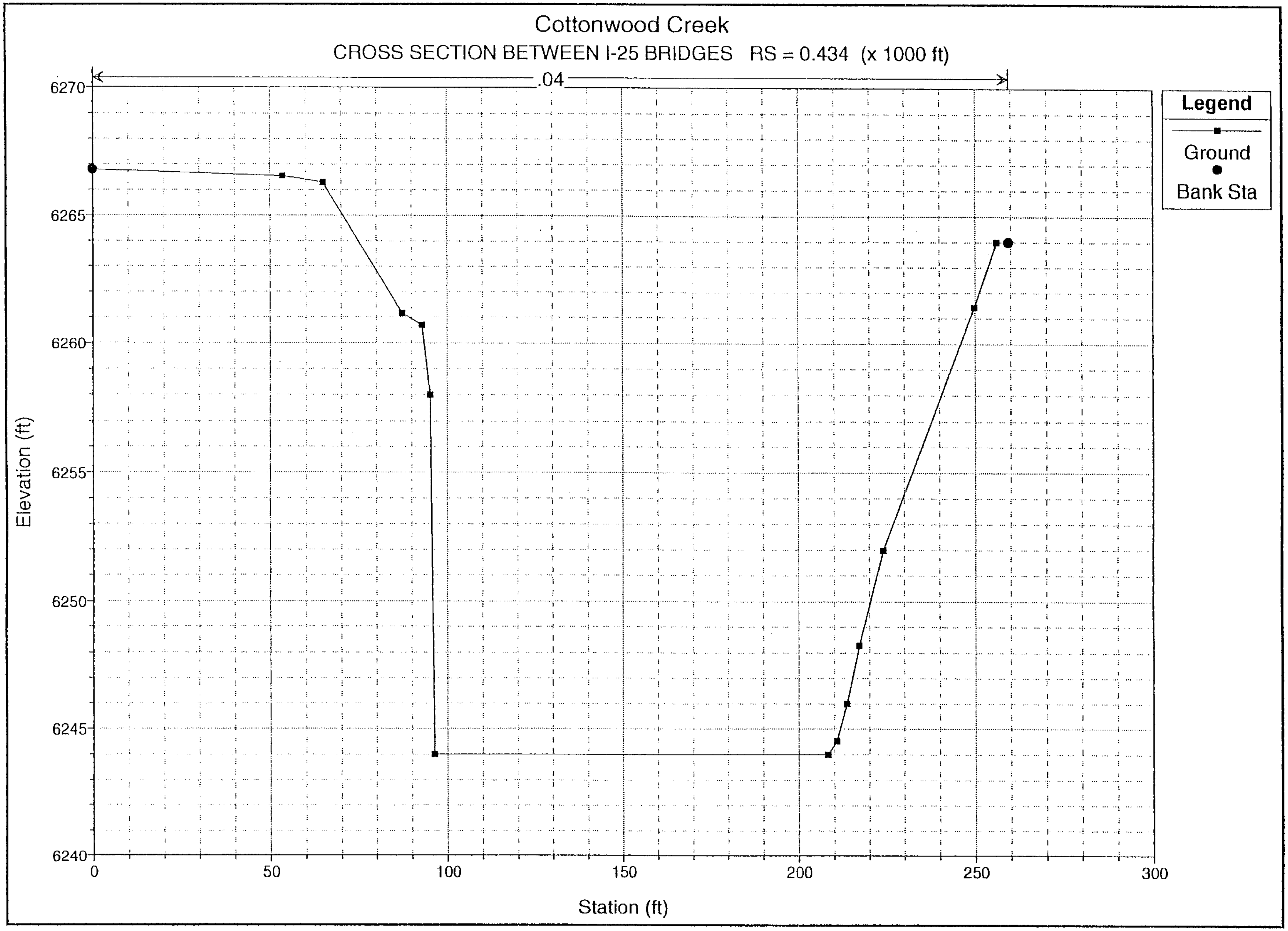

Cottonwood Creek
SOUTHBOUND I-25 RS = 0.3915 BR D (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)



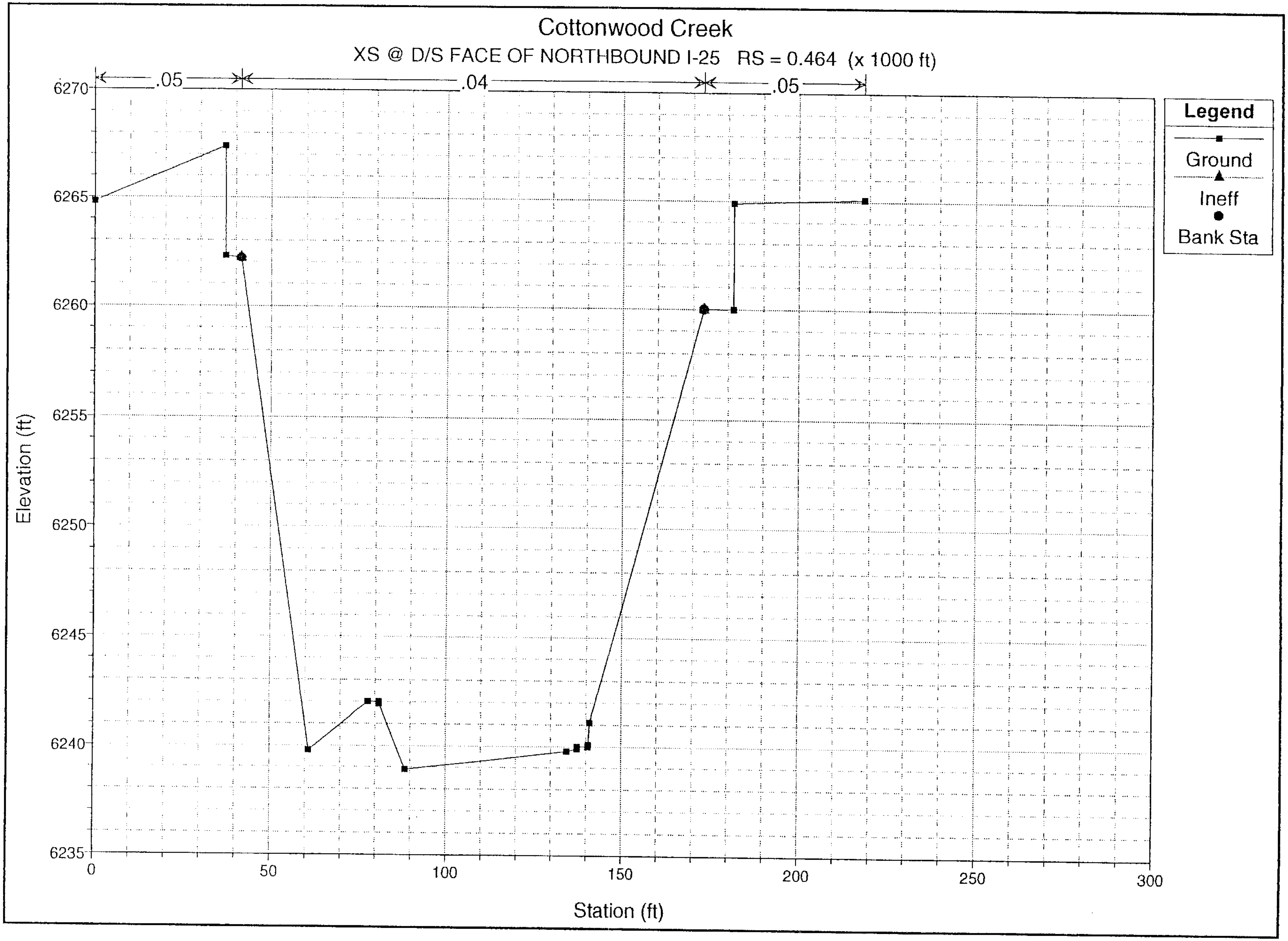
Cottonwood Creek
SOUTHBOUND I-25 RS = 0.3915 BR U (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)



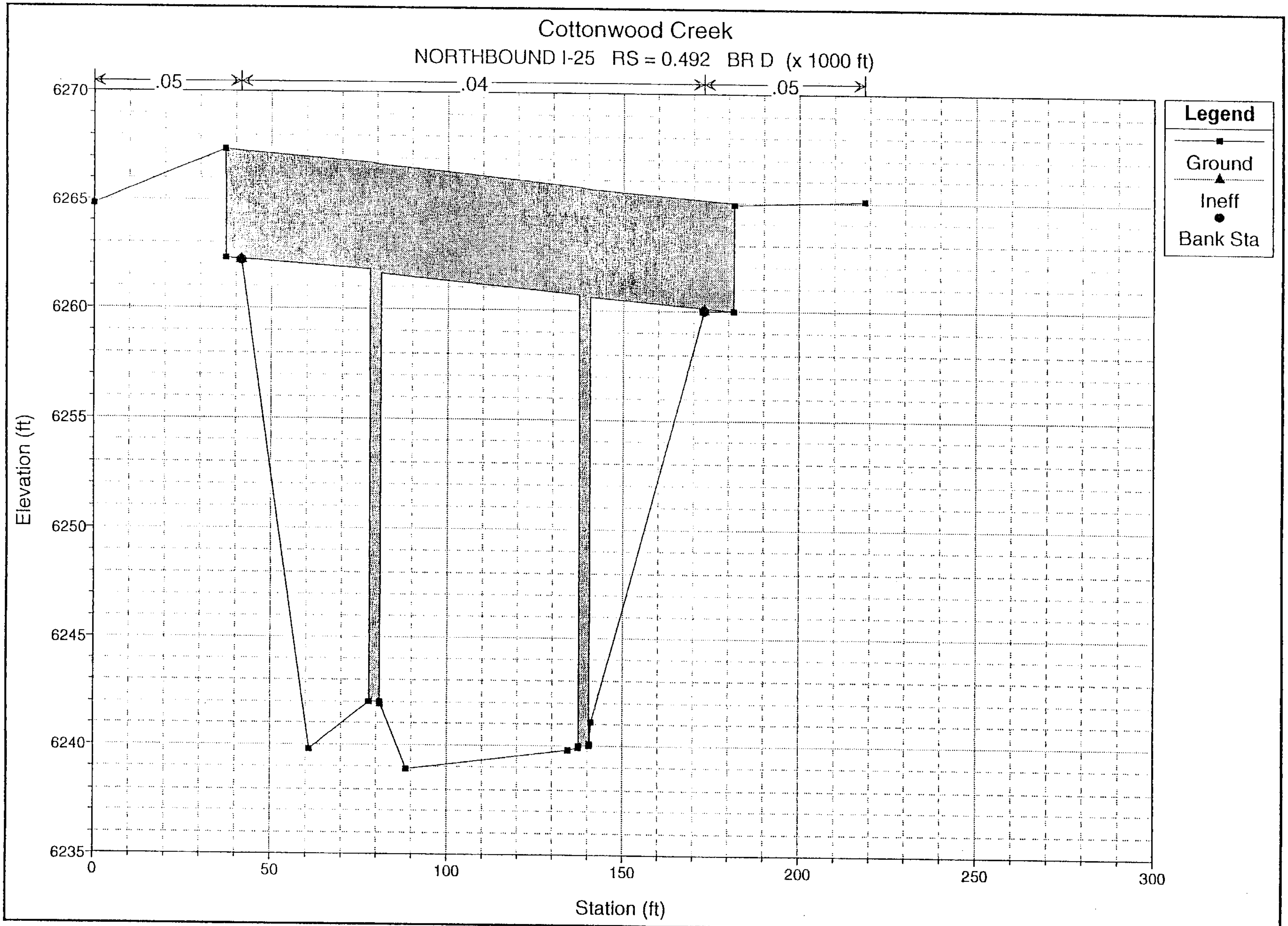
Cottonwood Creek
XS @ U/S FACE OF I-25 SOUTHBOUND BRIDGE RS = 0.414 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
6235
Station (ft)
0
50
100
150
200
250
300

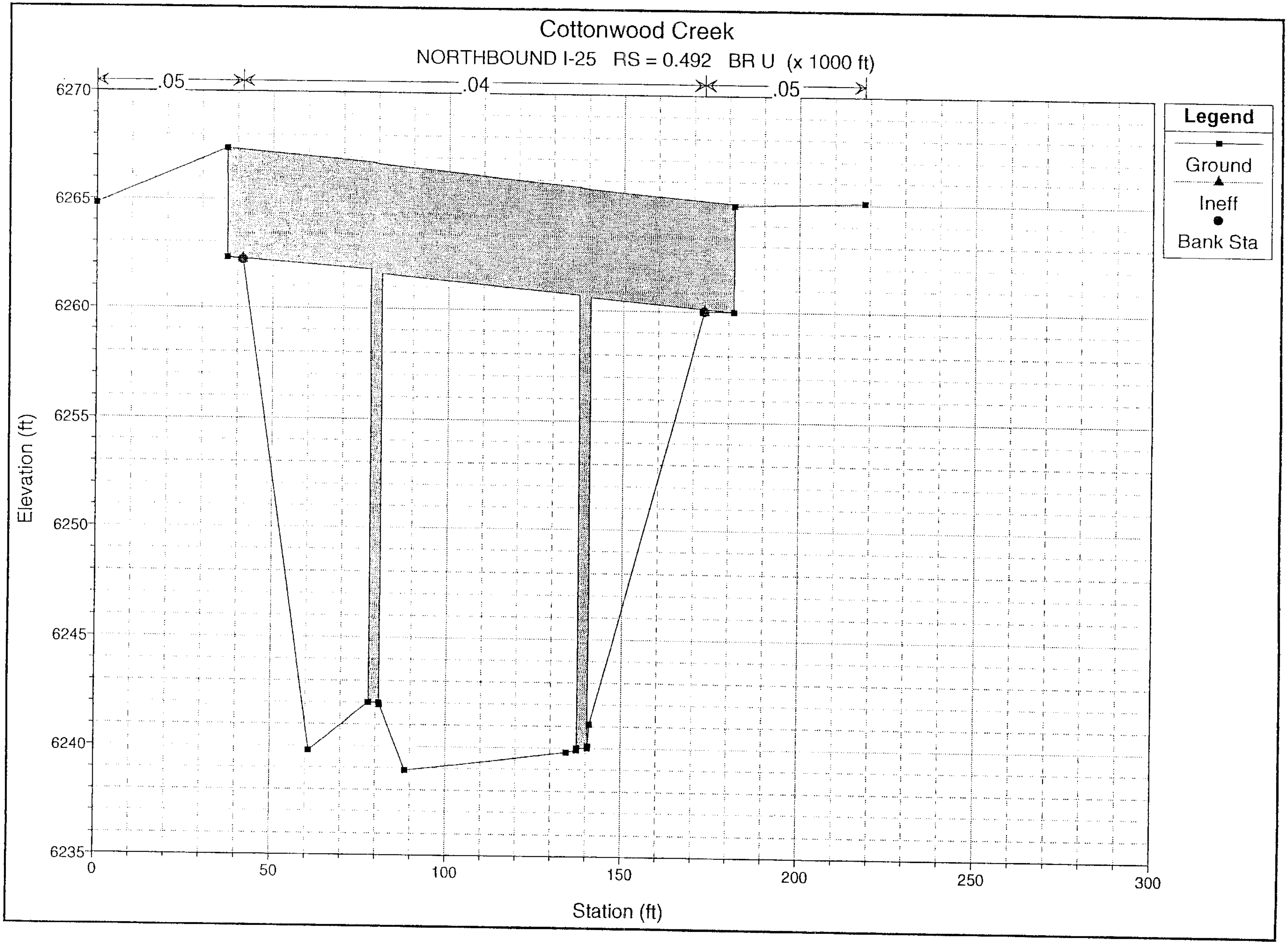


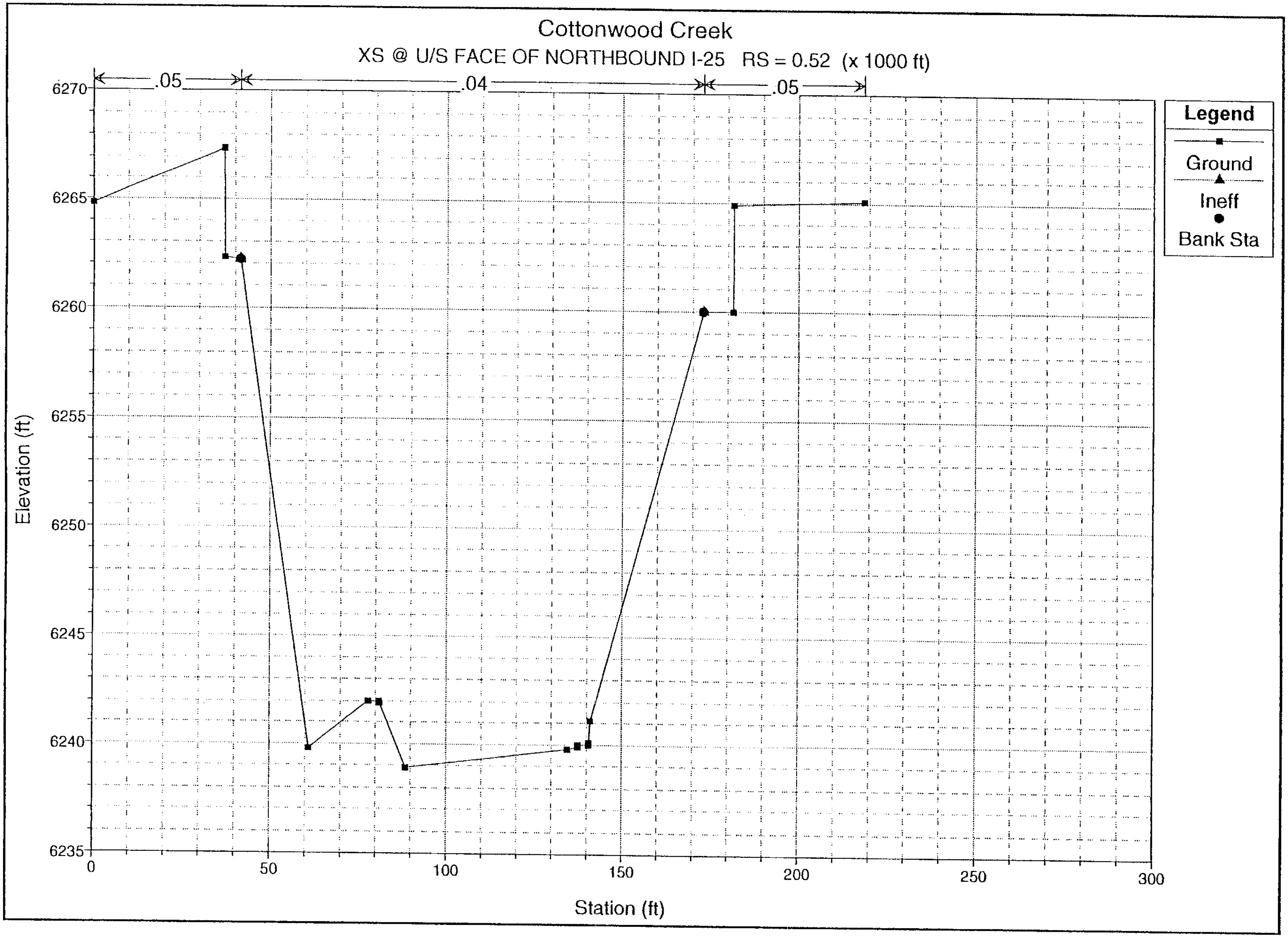
Cottonwood Creek
CROSS SECTION BETWEEN I-25 BRIDGES RS = 0.434 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
0
50
100
150
200
250
300
Station (ft)



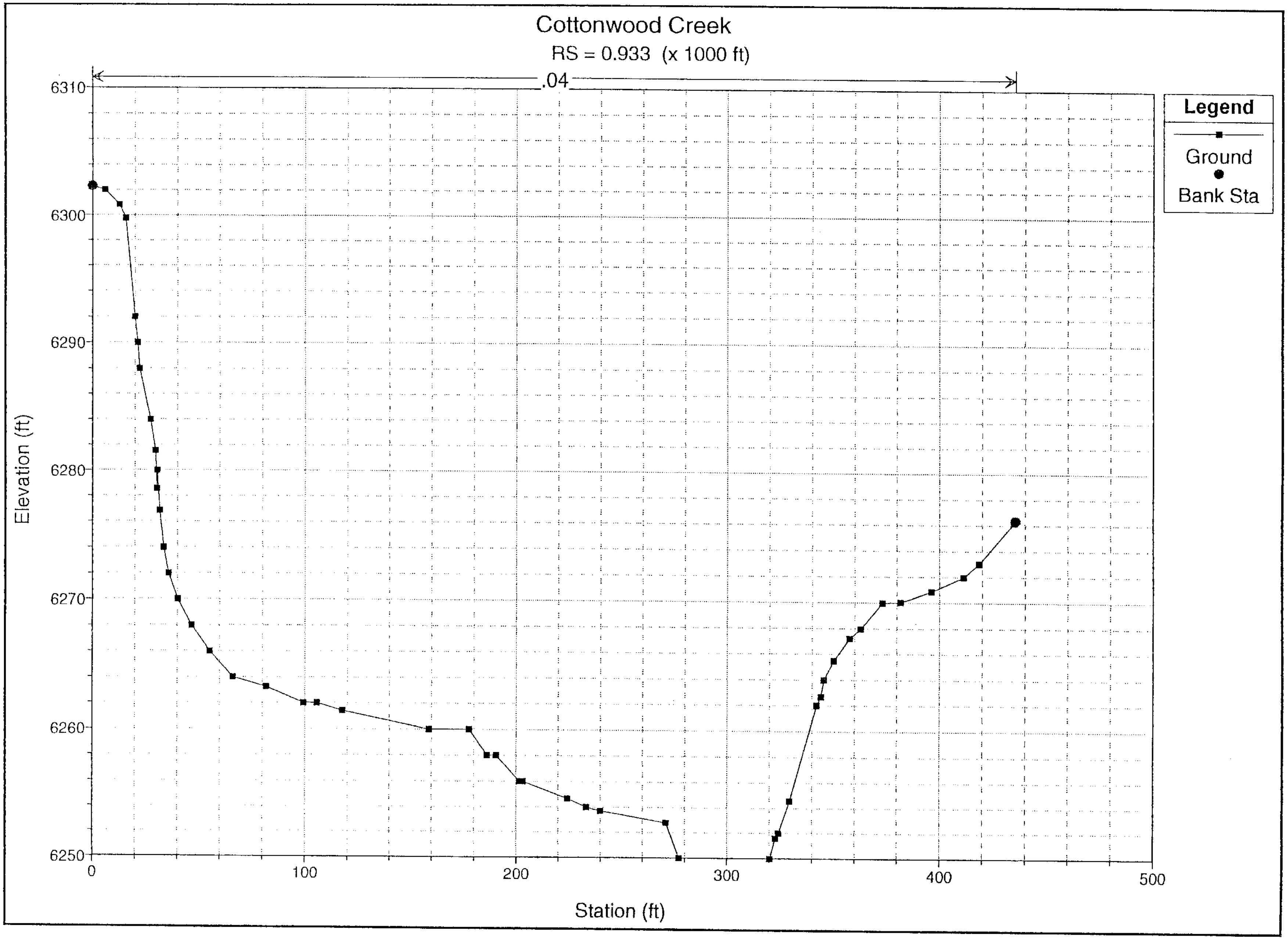
Cottonwood Creek
XS @ D/S FACE OF NORTHBOUND I-25 RS = 0.464 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)

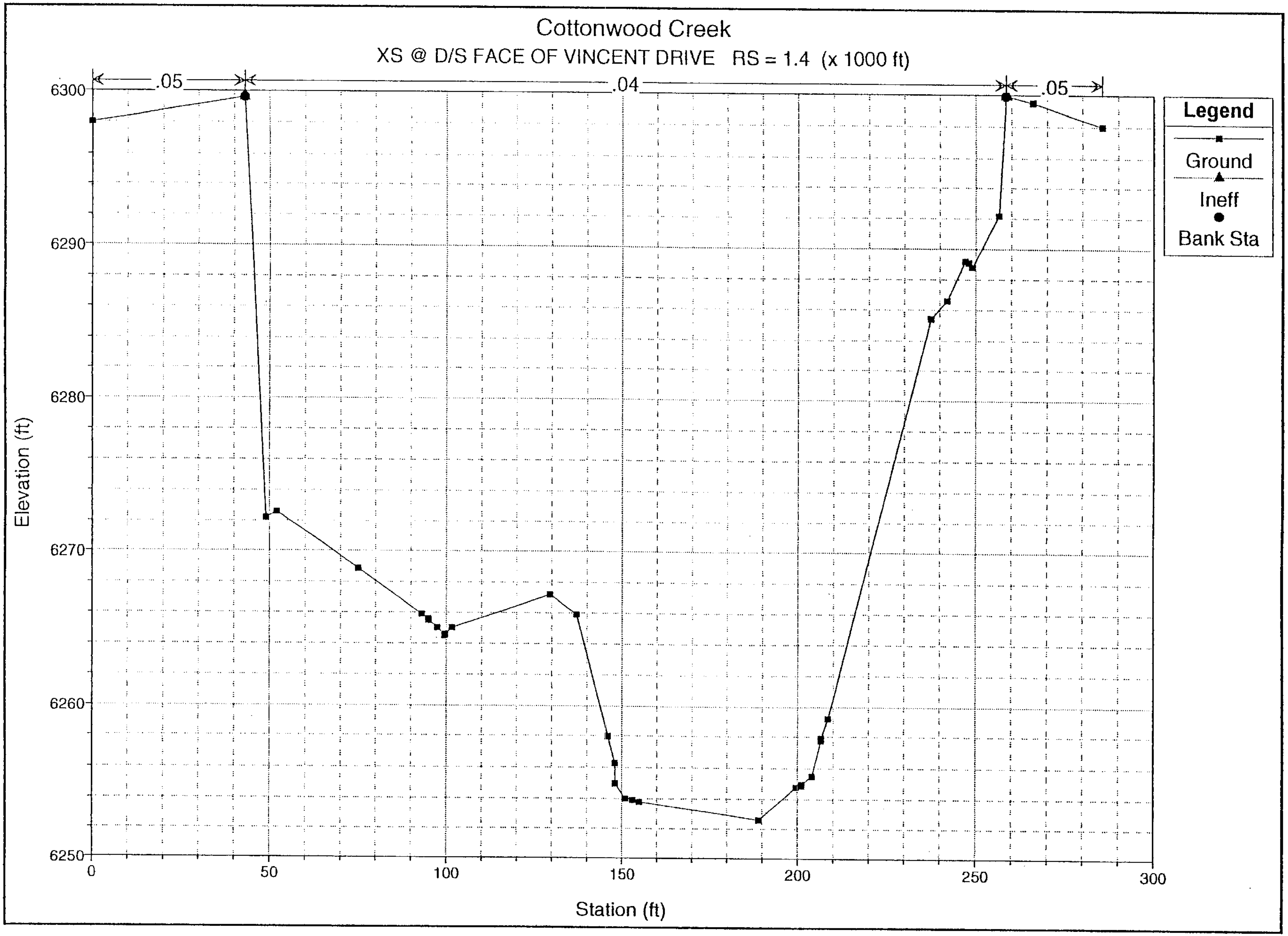

Cottonwood Creek
NORTHBOUND I-25 RS = 0.492 BR D (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
Station (ft)

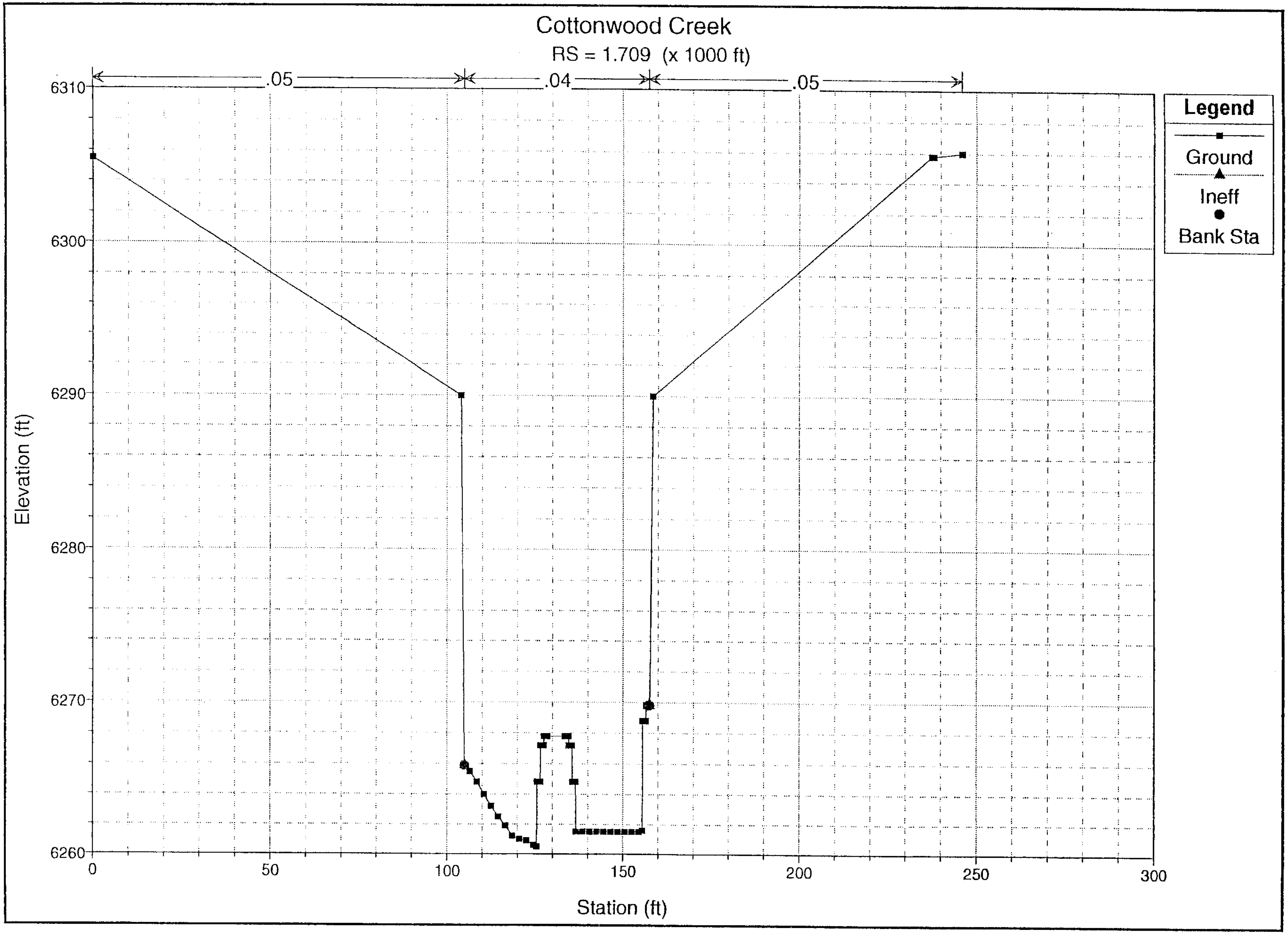

Cottonwood Creek
NORTHBOUND I-25 RS = 0.492 BR U (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6270
6265
6260
6255
6250
6245
6240
6235
Station (ft)
0
50
100
150
200
250
300

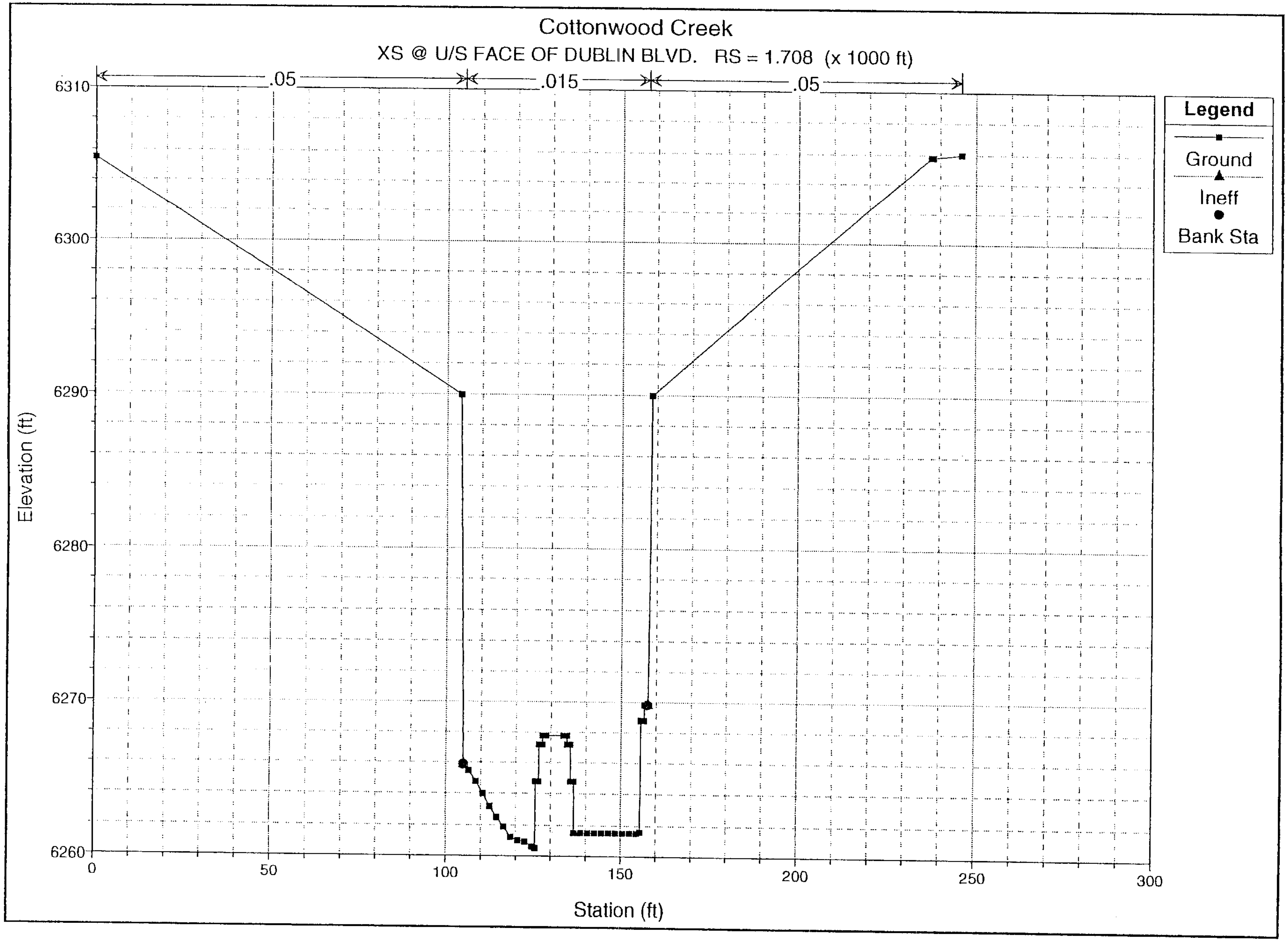


Cottonwood Creek
XS @ U/S FACE OF NORTHBOUND I-25 RS = 0.52 (x 1000 ft)
.05
.04
.05
6270
6265
6260
6255
6250
6245
6240
6235
Elevation (ft)
0
50
100
150
200
250
300
Station (ft)
Legend
Ground
Ineff
Bank Sta

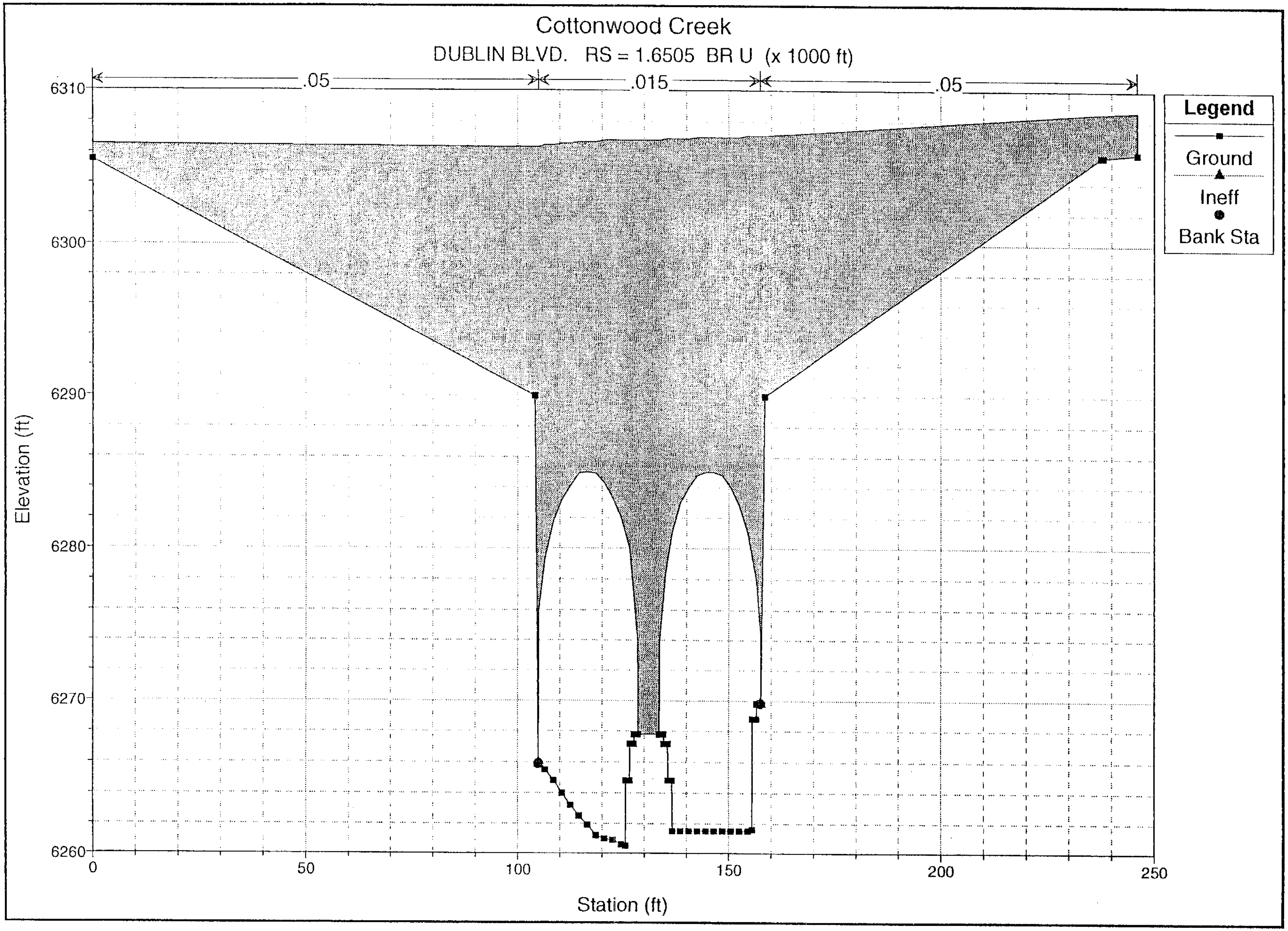

Cottonwood Creek
RS = 0.933 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6310
6300
6290
6280
6270
6260
6250
0
100
200
300
400
500
Station (ft)


Cottonwood Creek
XS @ D/S FACE OF VINCENT DRIVE RS = 1.4 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6300
6290
6280
6270
6260
6250
0
50
100
150
200
250
300
Station (ft)

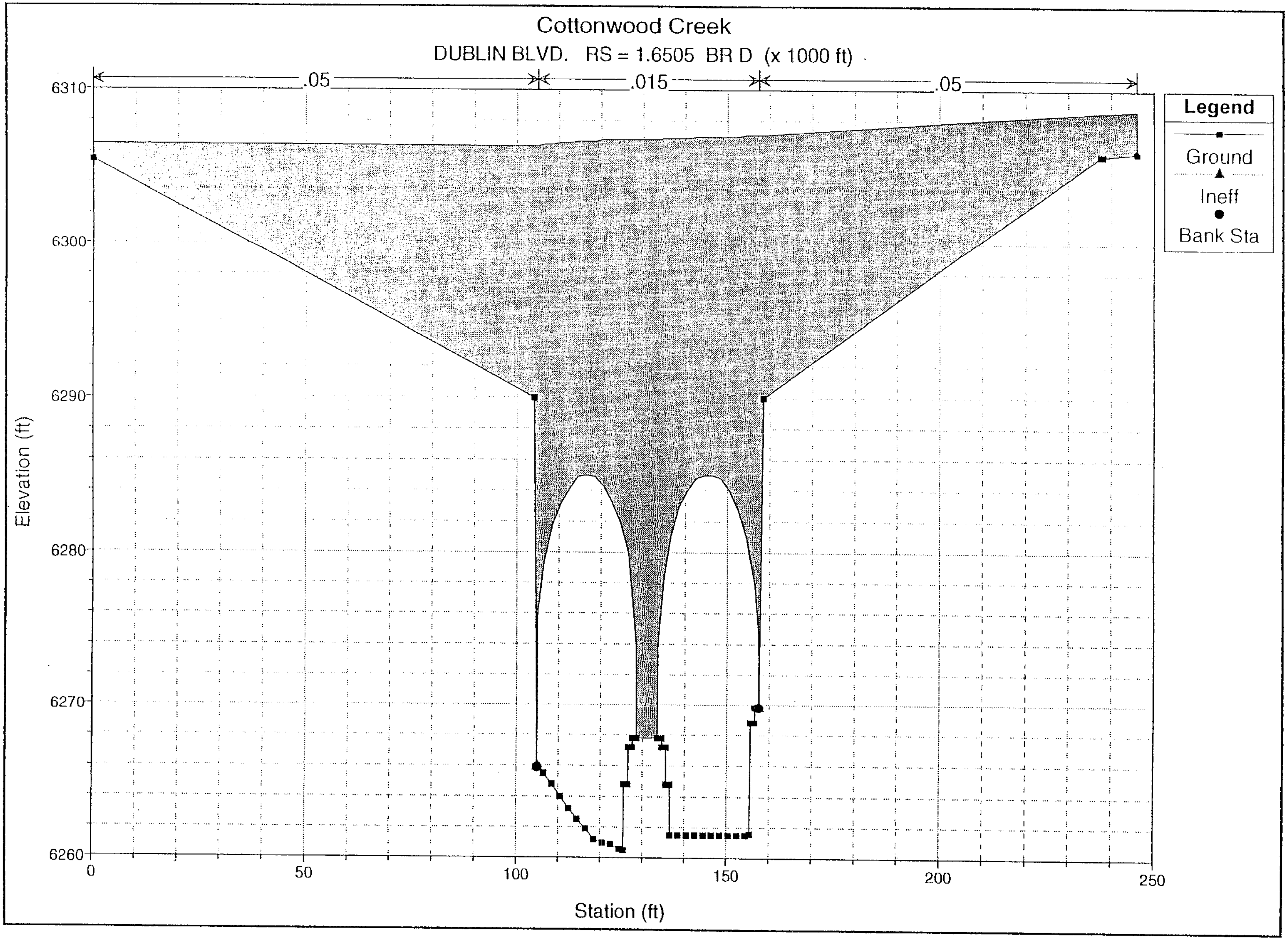

Cottonwood Creek
RS = 1.709 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
6310
6300
6290
6280
6270
6260
Elevation (ft)
0
50
100
150
200
250
300
Station (ft)

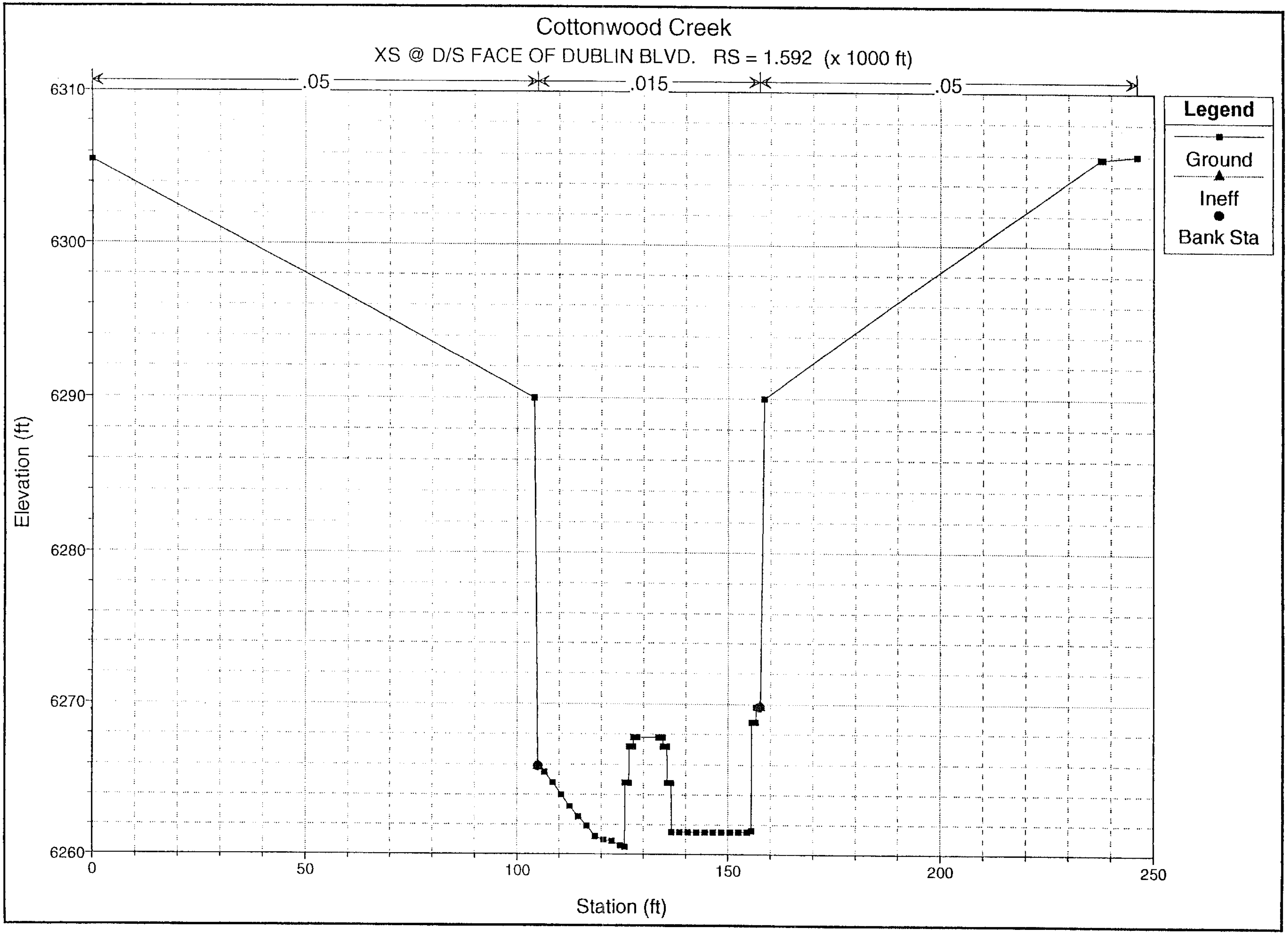


Cottonwood Creek
XS @ U/S FACE OF DUBLIN BLVD. RS = 1.708 (x 1000 ft)
.05
.015
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6310
6300
6290
6280
6270
6260
0
50
100
150
200
250
300
Station (ft)

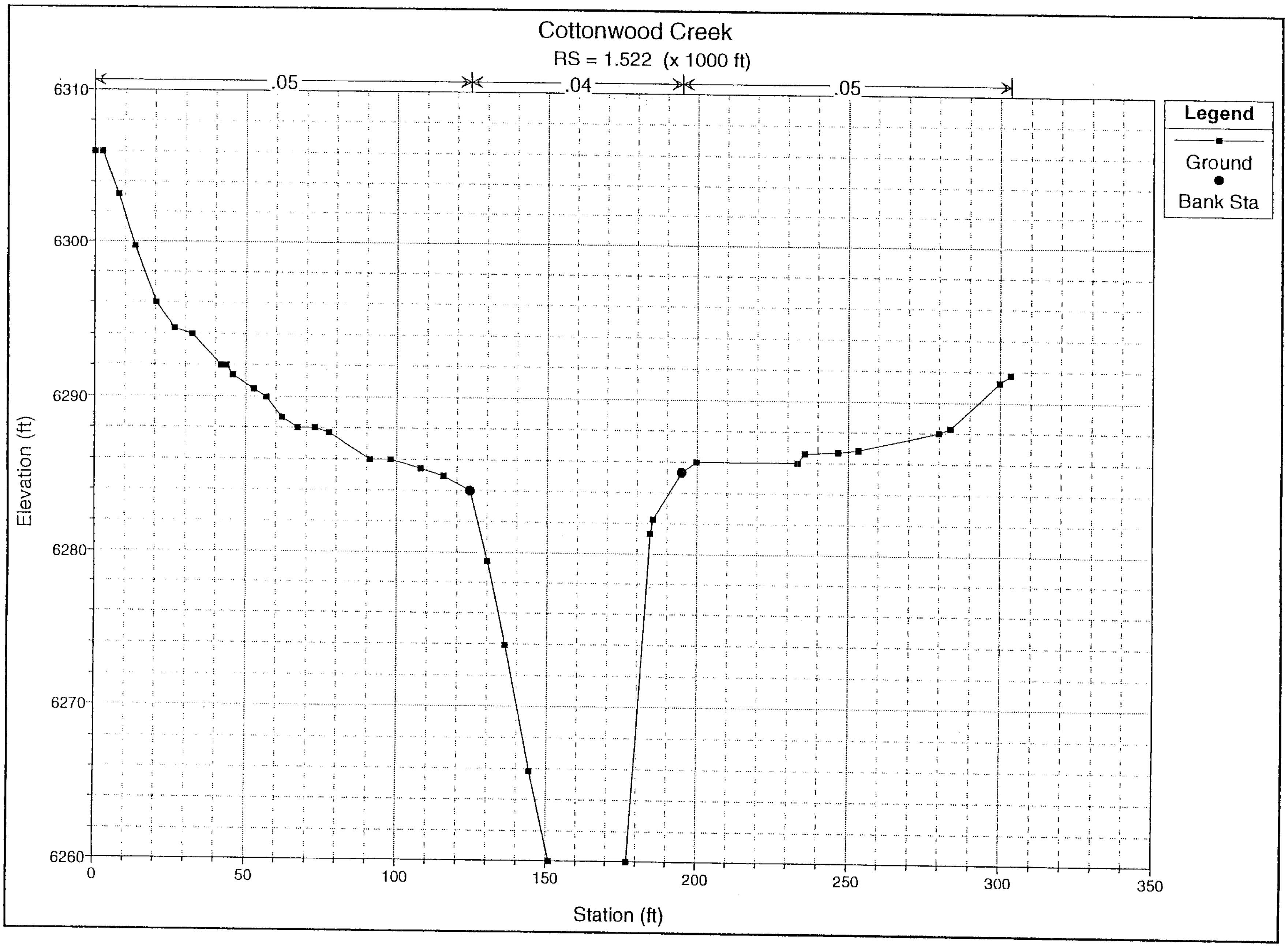


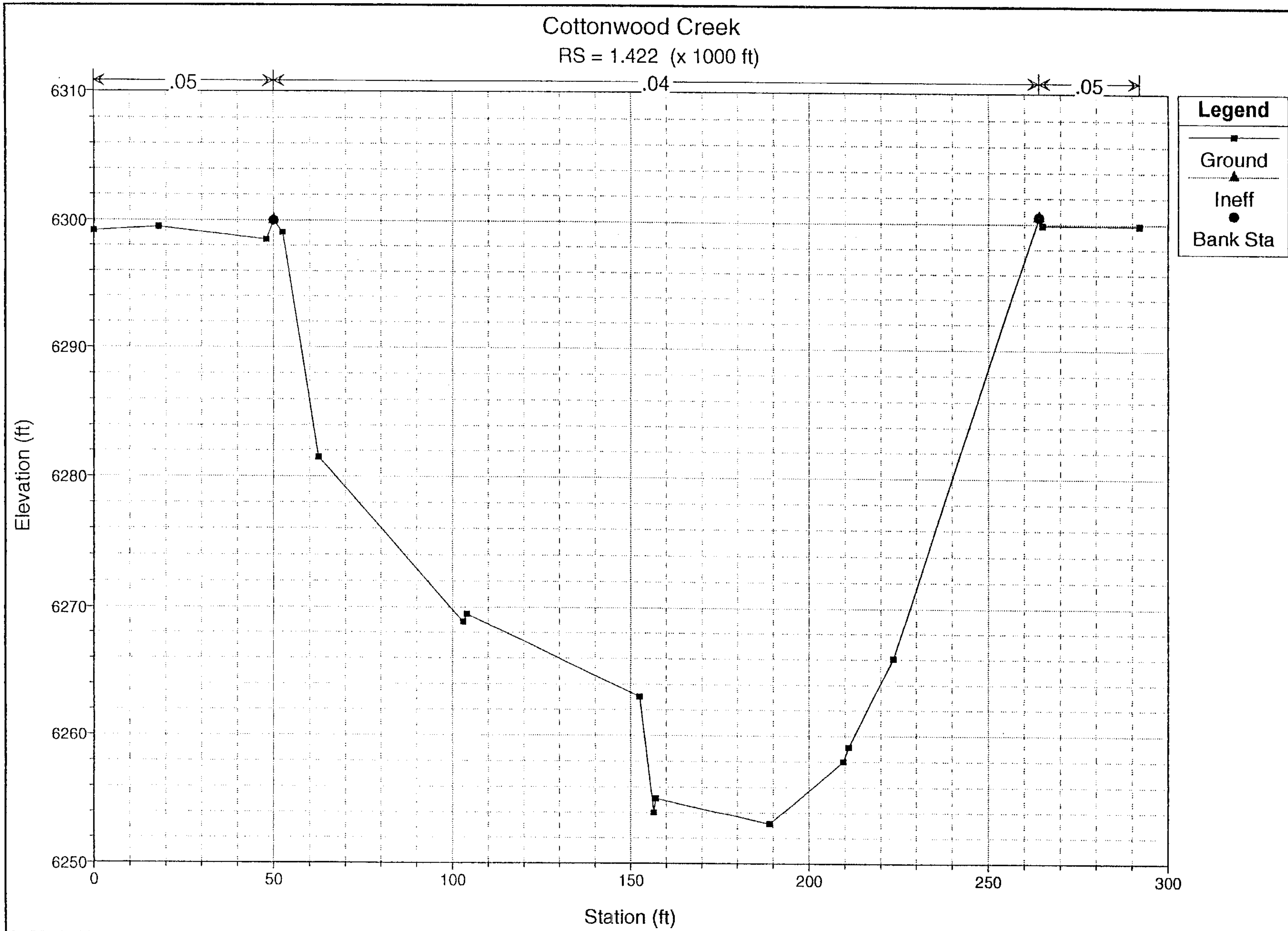
Cottonwood Creek
DUBLIN BLVD. RS = 1.6505 BR U (x 1000 ft)
.05
.015
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6310
6300
6290
6280
6270
6260
0
50
100
150
200
250
Station (ft)


Cottonwood Creek
DUBLIN BLVD. RS = 1.6505 BR D (x 1000 ft)
.05
.015
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6310
6300
6290
6280
6270
6260
0
50
100
150
200
250
Station (ft)

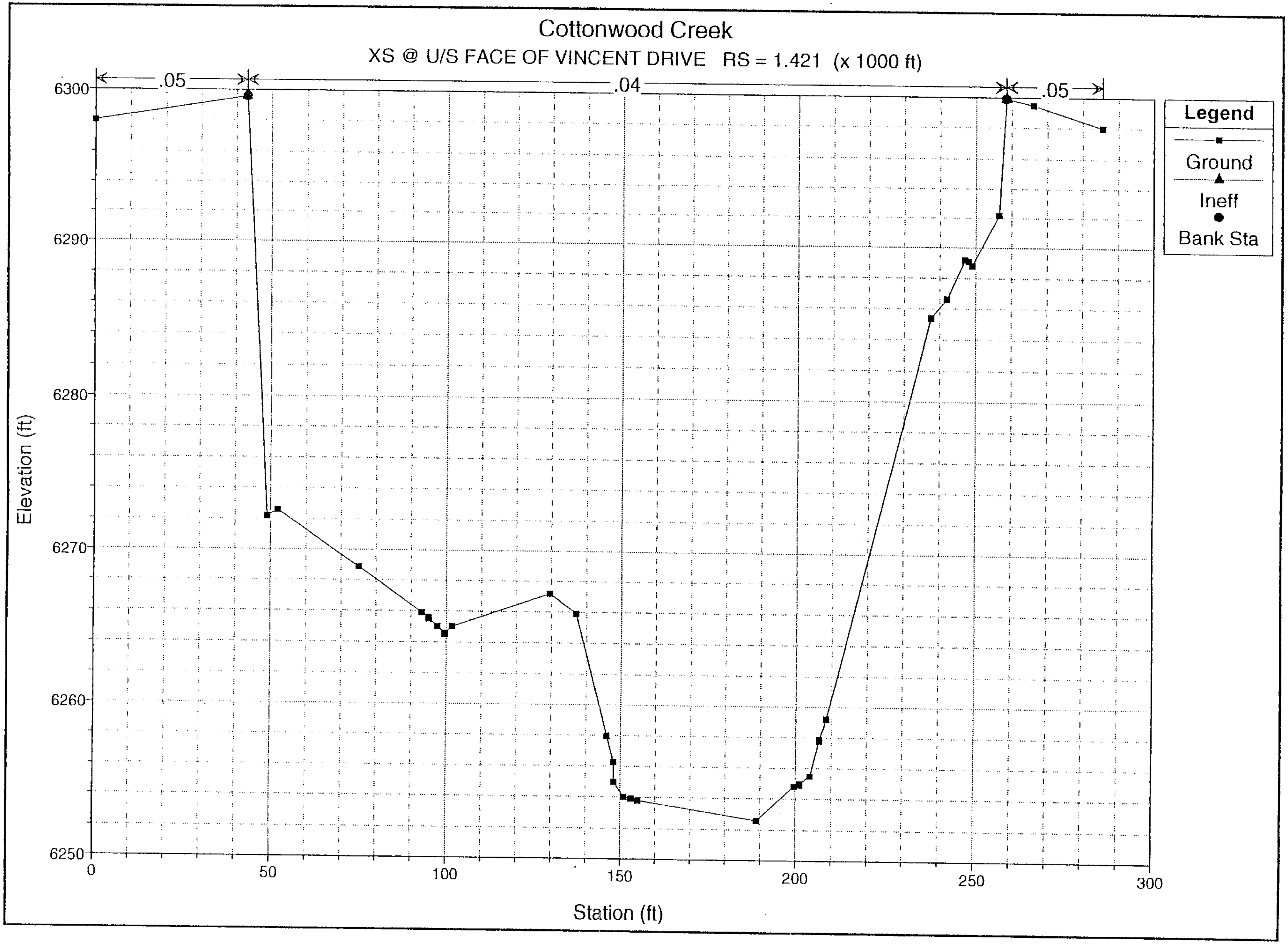


Cottonwood Creek
XS @ D/S FACE OF DUBLIN BLVD. RS = 1.592 (x 1000 ft)
.05
.015
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6310
6300
6290
6280
6270
6260
0
50
100
150
200
250
Station (ft)

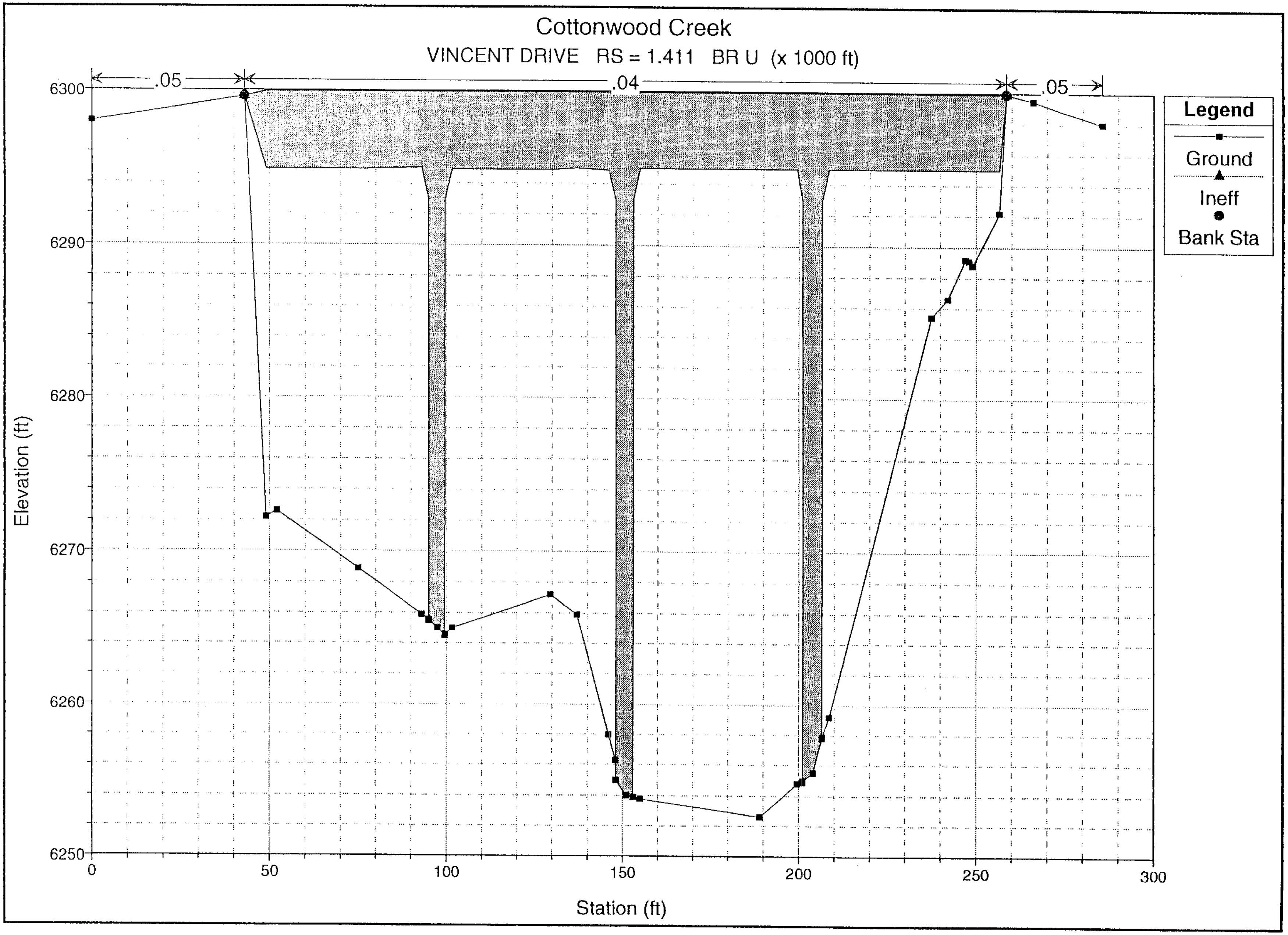

Cottonwood Creek
RS = 1.522 (x 1000 ft)
.05
.04
.05
Legend
Ground
Bank Sta
Elevation (ft)
6310
6300
6290
6280
6270
6260
0
50
100
150
200
250
300
350
Station (ft)



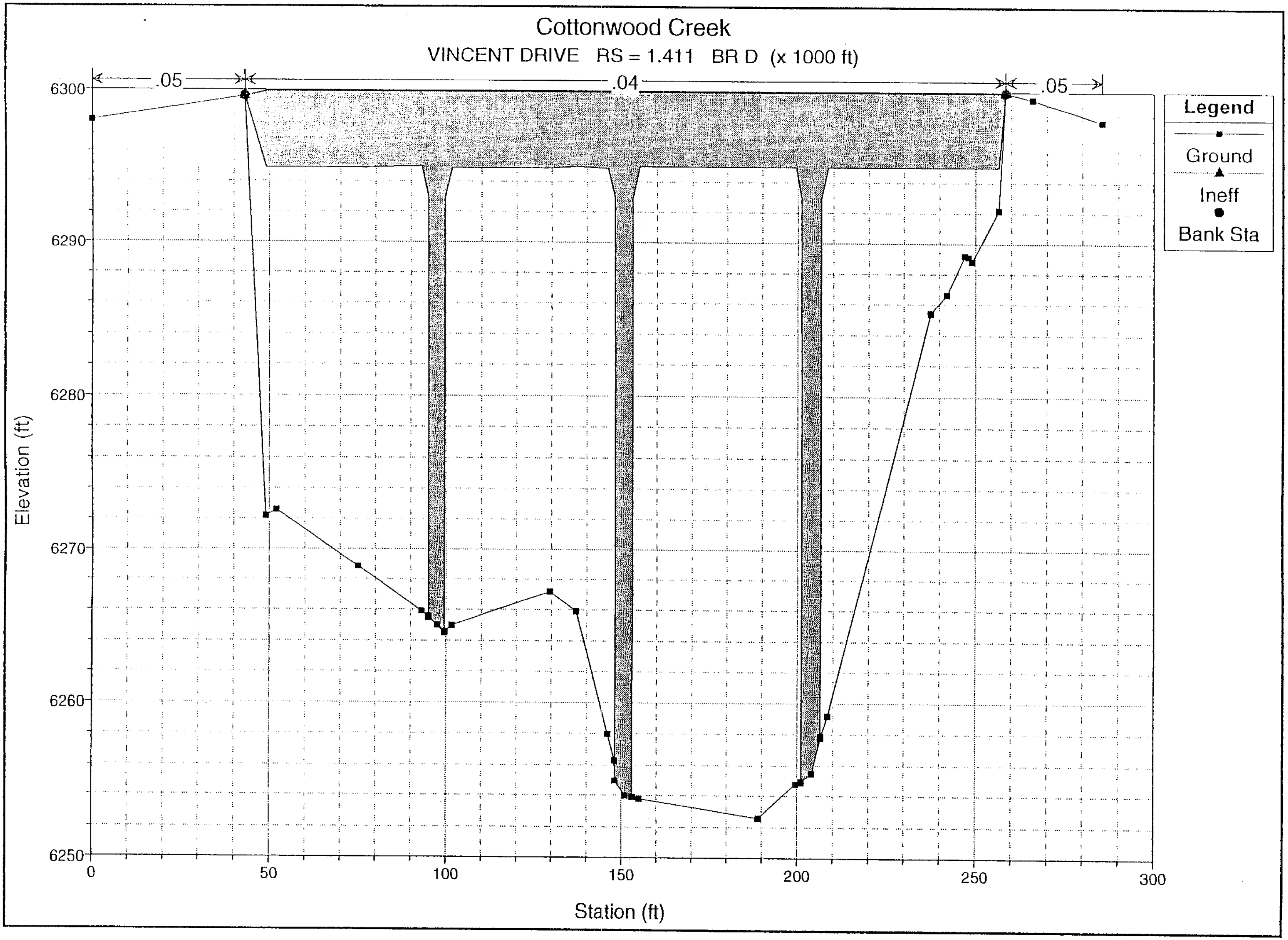
Cottonwood Creek
RS = 1.422 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6310
6300
6290
6280
6270
6260
6250
0
50
100
150
200
250
300
Station (ft)

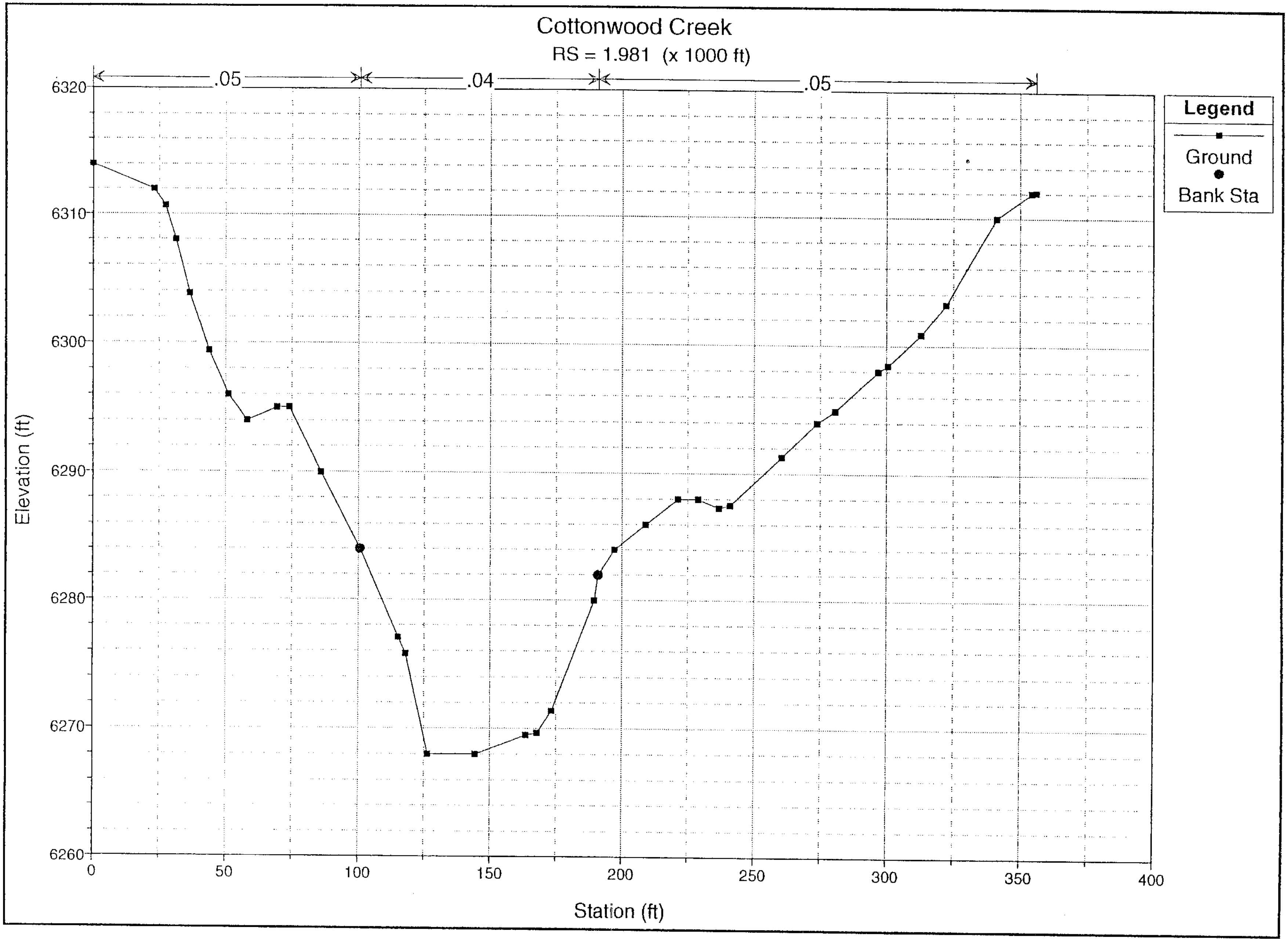


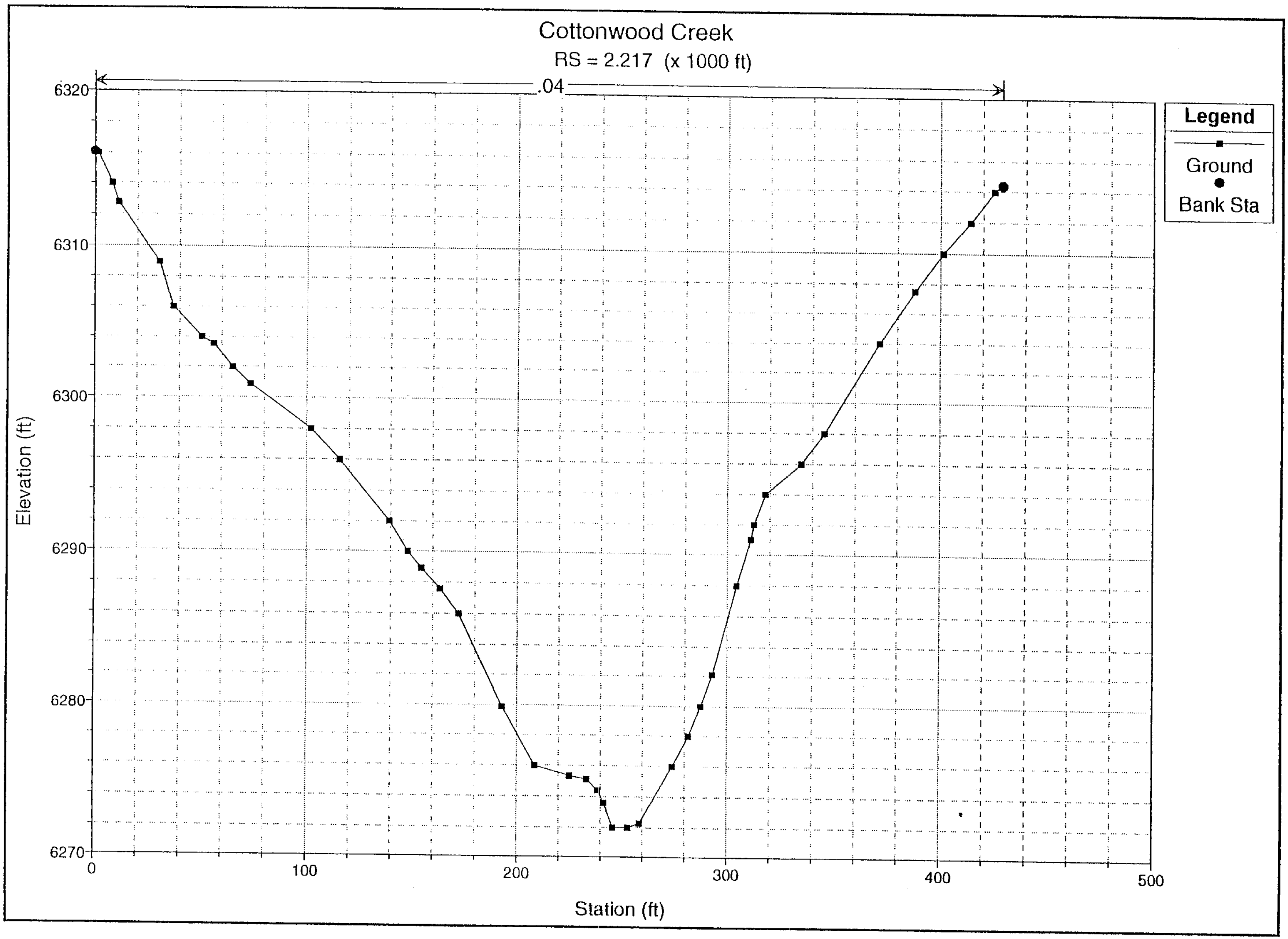
Cottonwood Creek
XS @ U/S FACE OF VINCENT DRIVE RS = 1.421 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6300
6290
6280
6270
6260
6250
Station (ft)
0
50
100
150
200
250
300

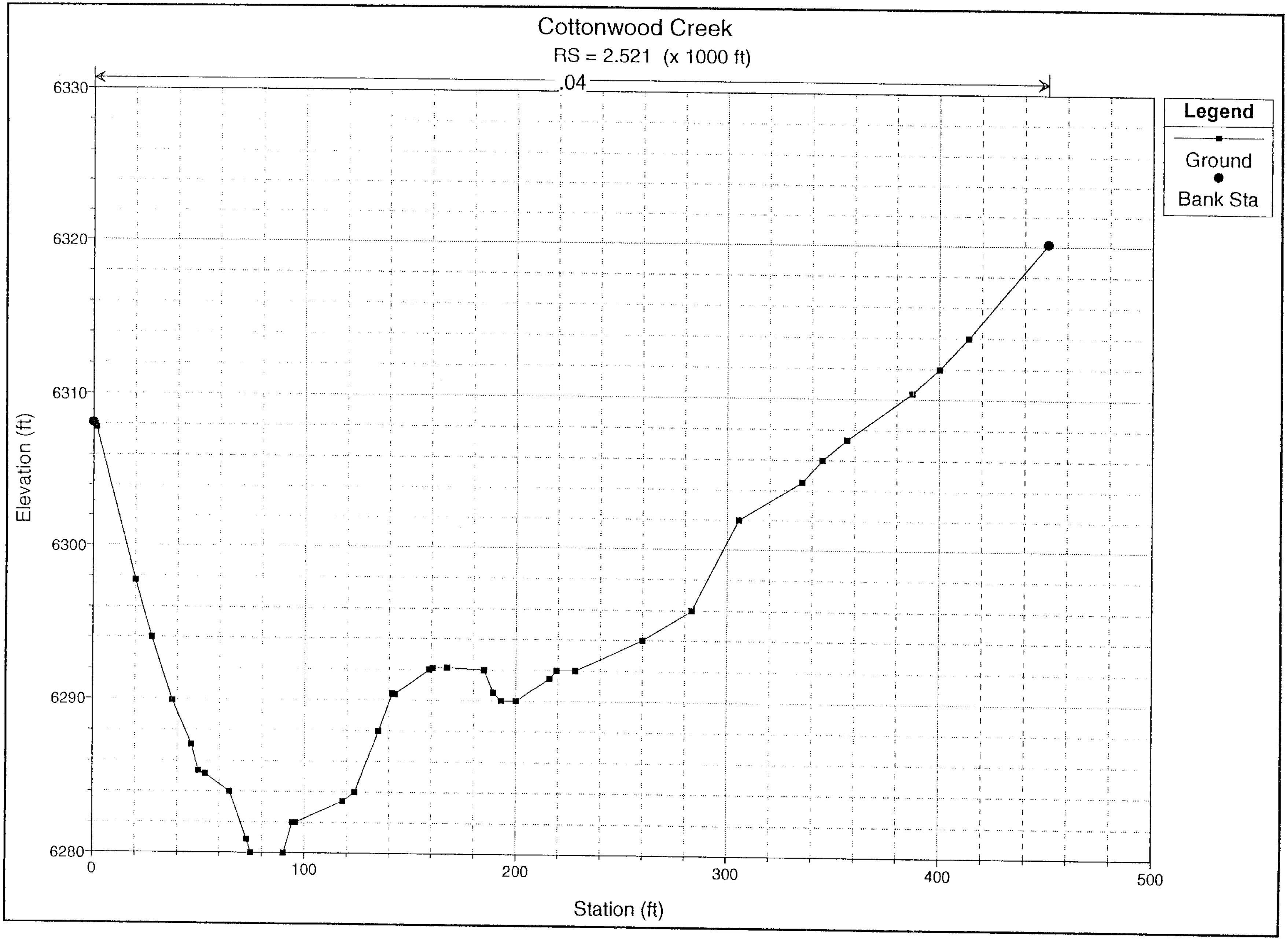


Cottonwood Creek
VINCENT DRIVE RS = 1.411 BR U (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6300
6290
6280
6270
6260
6250
Station (ft)
0
50
100
150
200
250
300

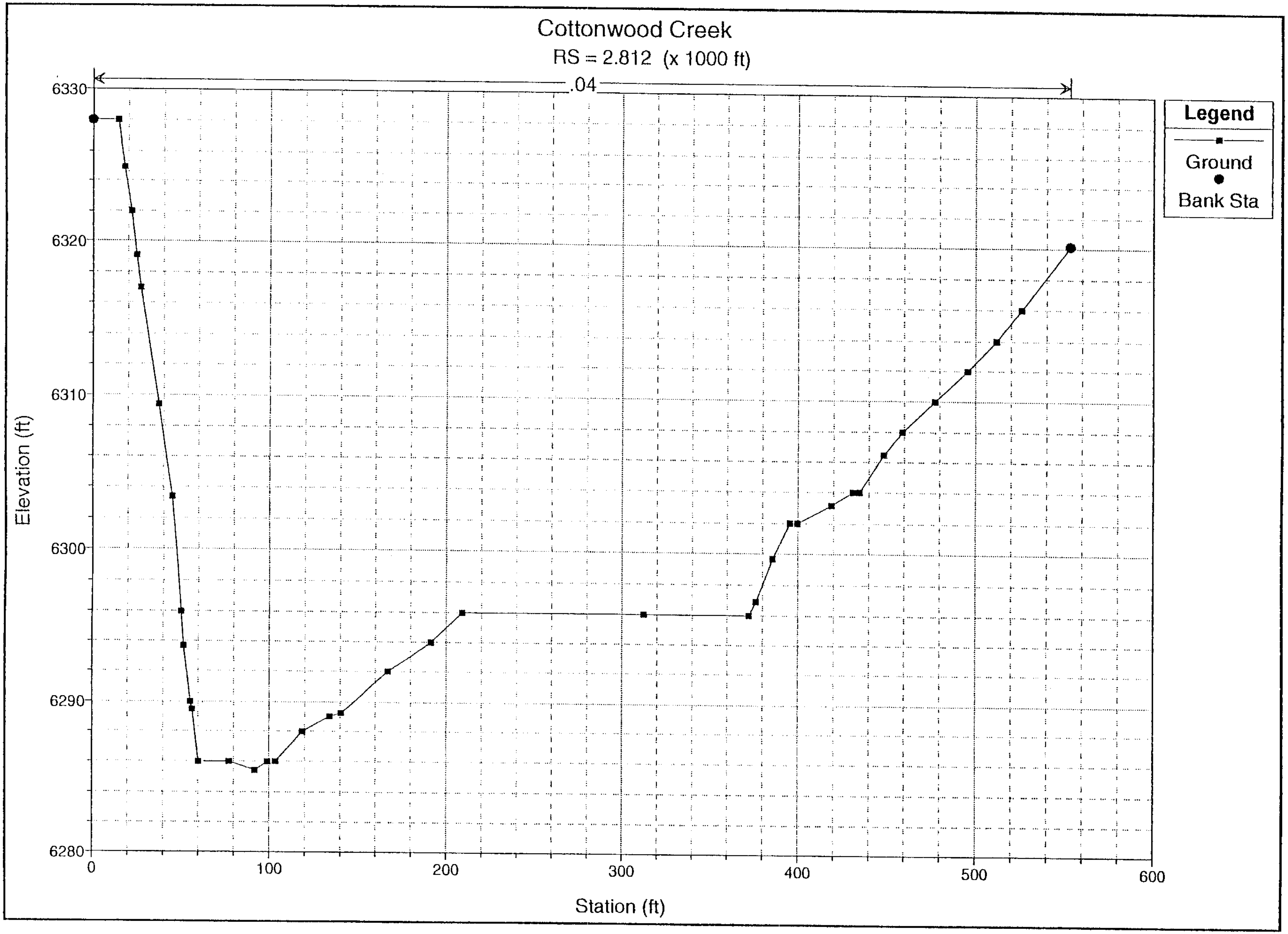

Cottonwood Creek
VINCENT DRIVE RS = 1.411 BR D (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6300
6290
6280
6270
6260
6250
Station (ft)
0
50
100
150
200
250
300

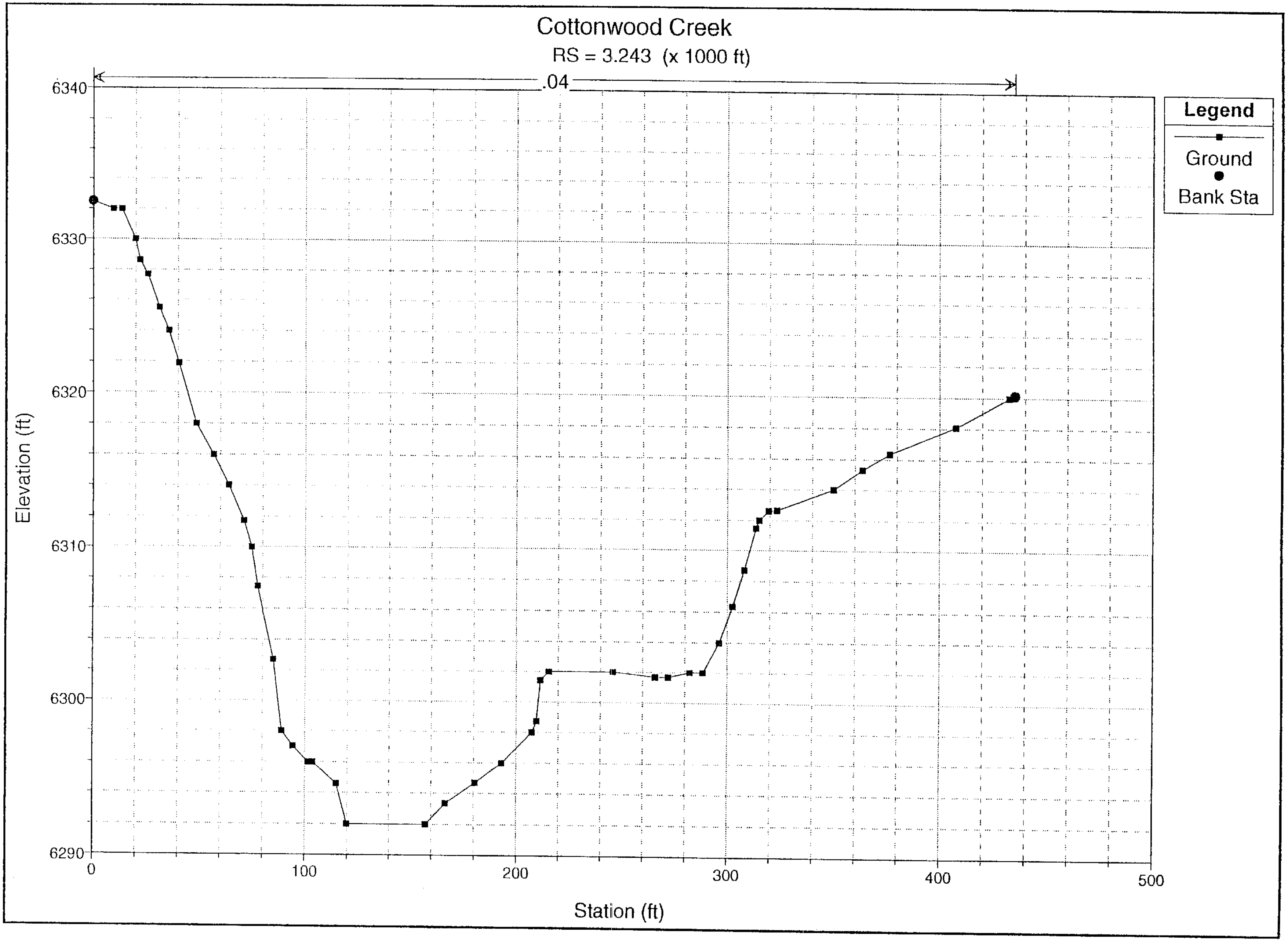

Cottonwood Creek
RS = 1.981 (x 1000 ft)
.05
.04
.05
Legend
Ground
Bank Sta
Elevation (ft)
6320
6310
6300
6290
6280
6270
6260
Station (ft)
0
50
100
150
200
250
300
350
400


Cottonwood Creek
RS = 2.217 (x 1000 ft)
.04
Legend
Ground
Bank Sta
6320
6310
6300
6290
6280
6270
Elevation (ft)
0
100
200
300
400
500
Station (ft)

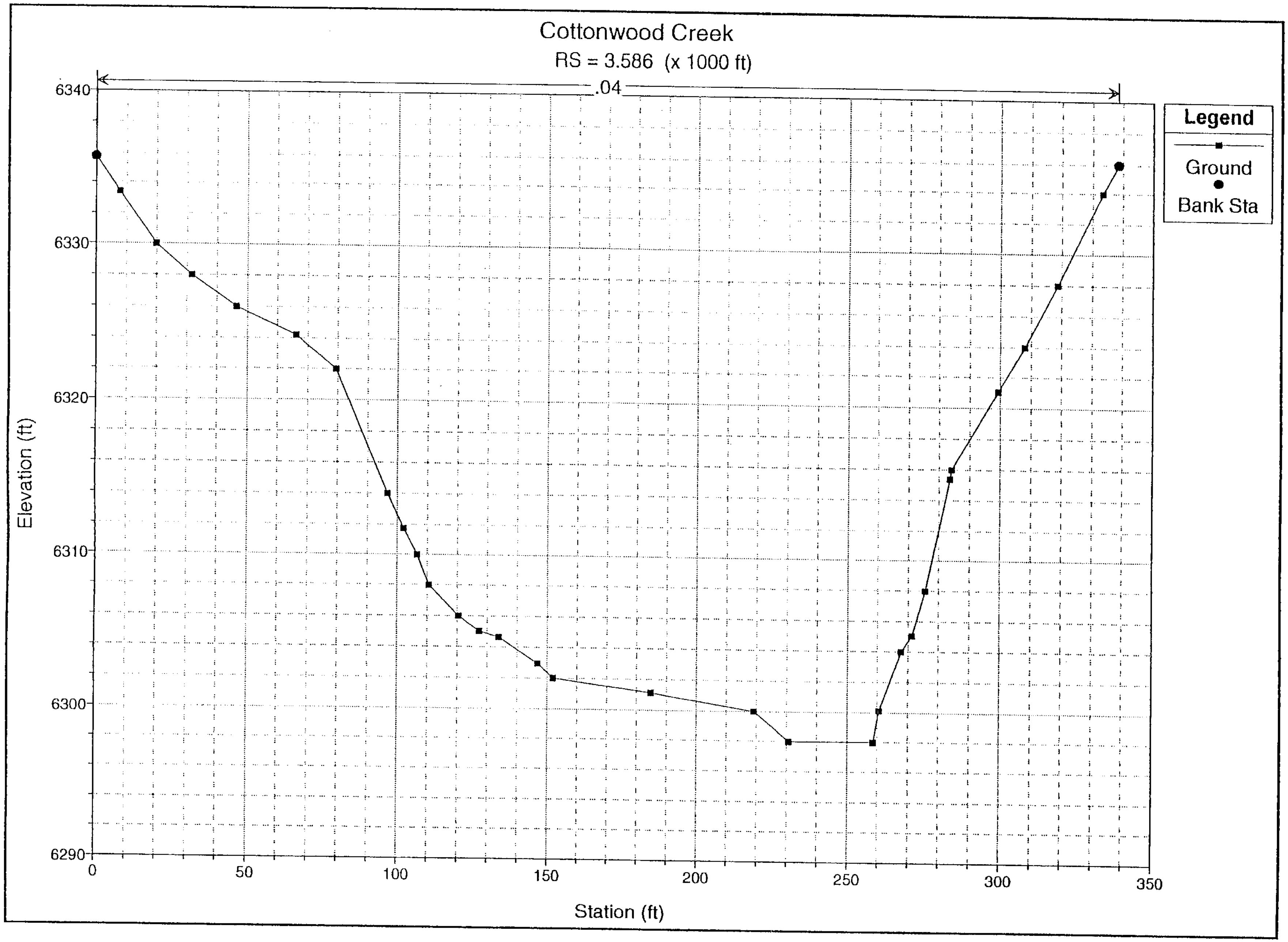


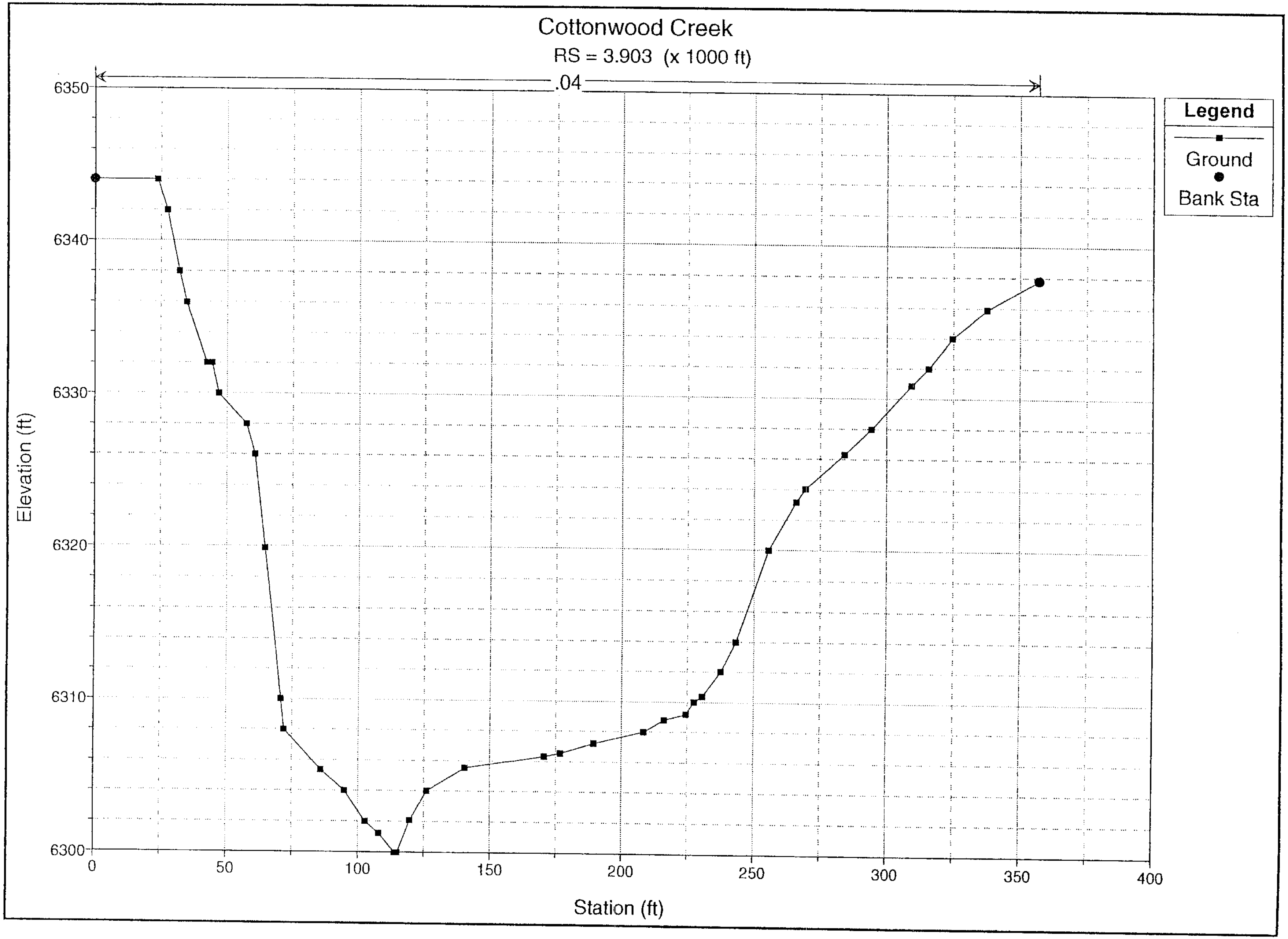
Cottonwood Creek
RS = 2.521 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6330
6320
6310
6300
6290
6280
0
100
200
300
400
500
Station (ft)


Cottonwood Creek
RS = 2.812 (x 1000 ft)
.04
Legend
Ground
Bank Sta
6330
6320
6310
6300
6290
6280
Elevation (ft)
0
100
200
300
400
500
600
Station (ft)

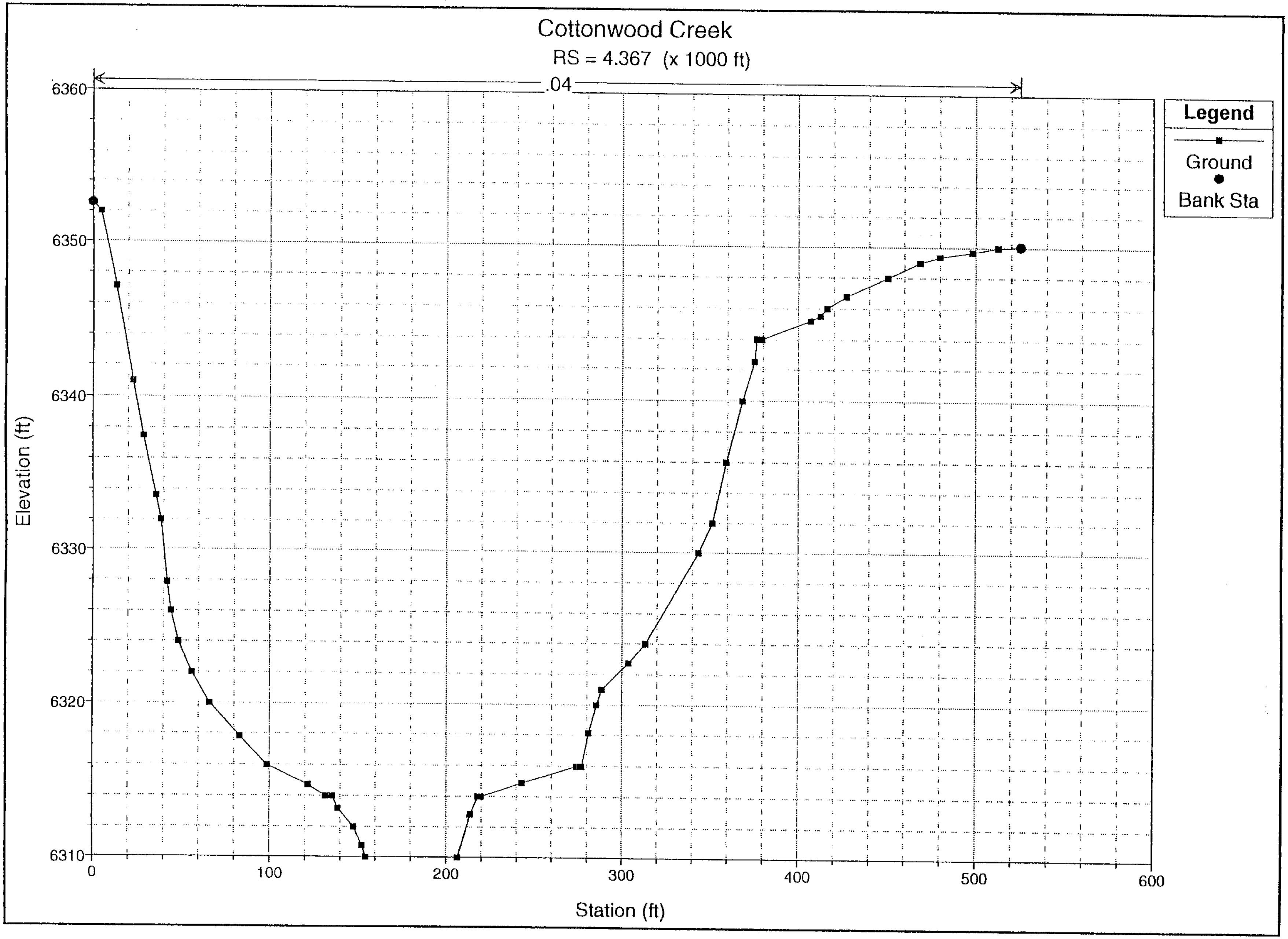


Cottonwood Creek
RS = 3.243 (x 1000 ft)
.04
Legend
Ground
Bank Sta
6340
6330
6320
6310
6300
6290
Elevation (ft)
0
100
200
300
400
500
Station (ft)

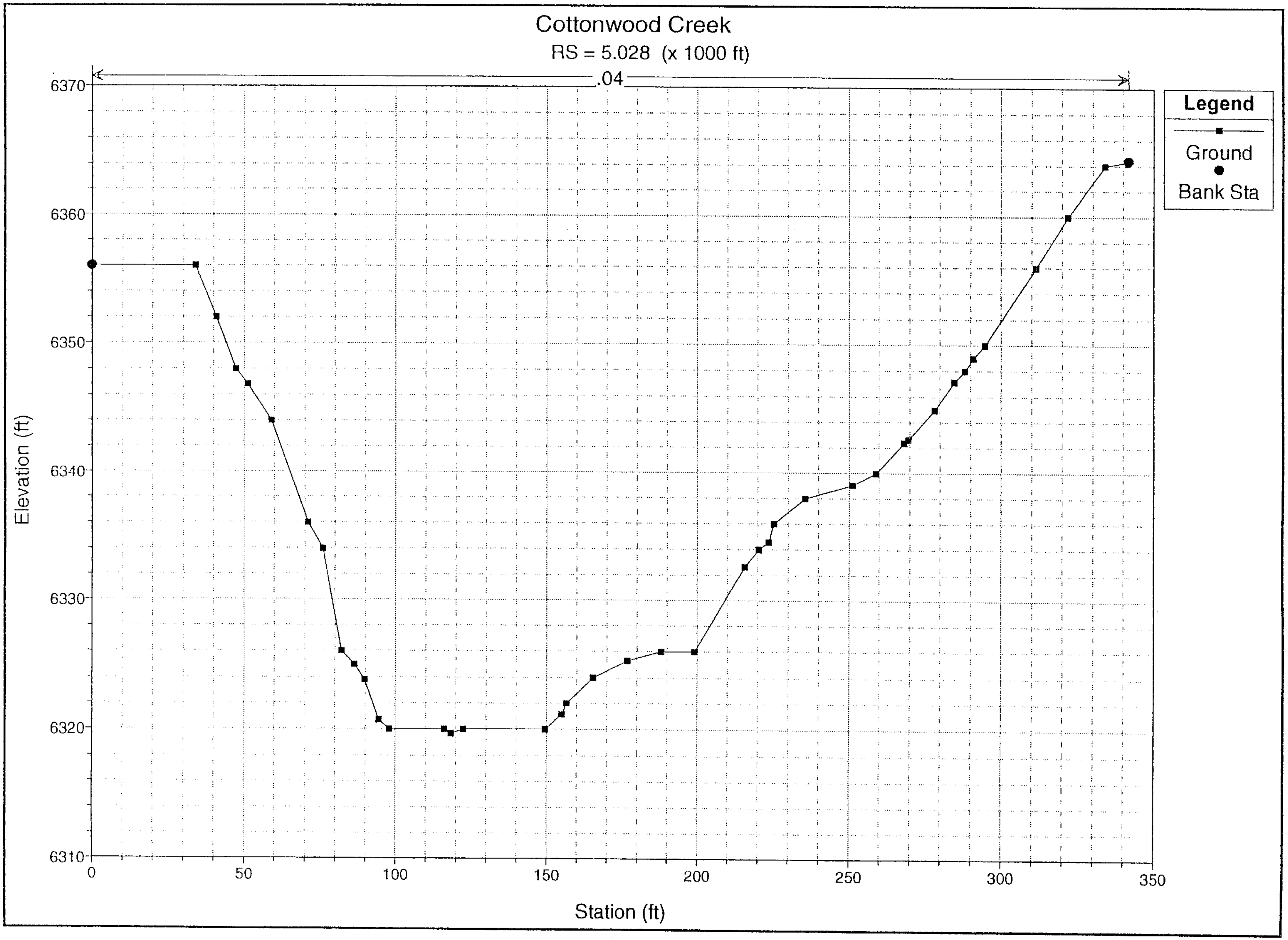

Cottonwood Creek
RS = 3.586 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6340
6330
6320
6310
6300
6290
0
50
100
150
200
250
300
350
Station (ft)



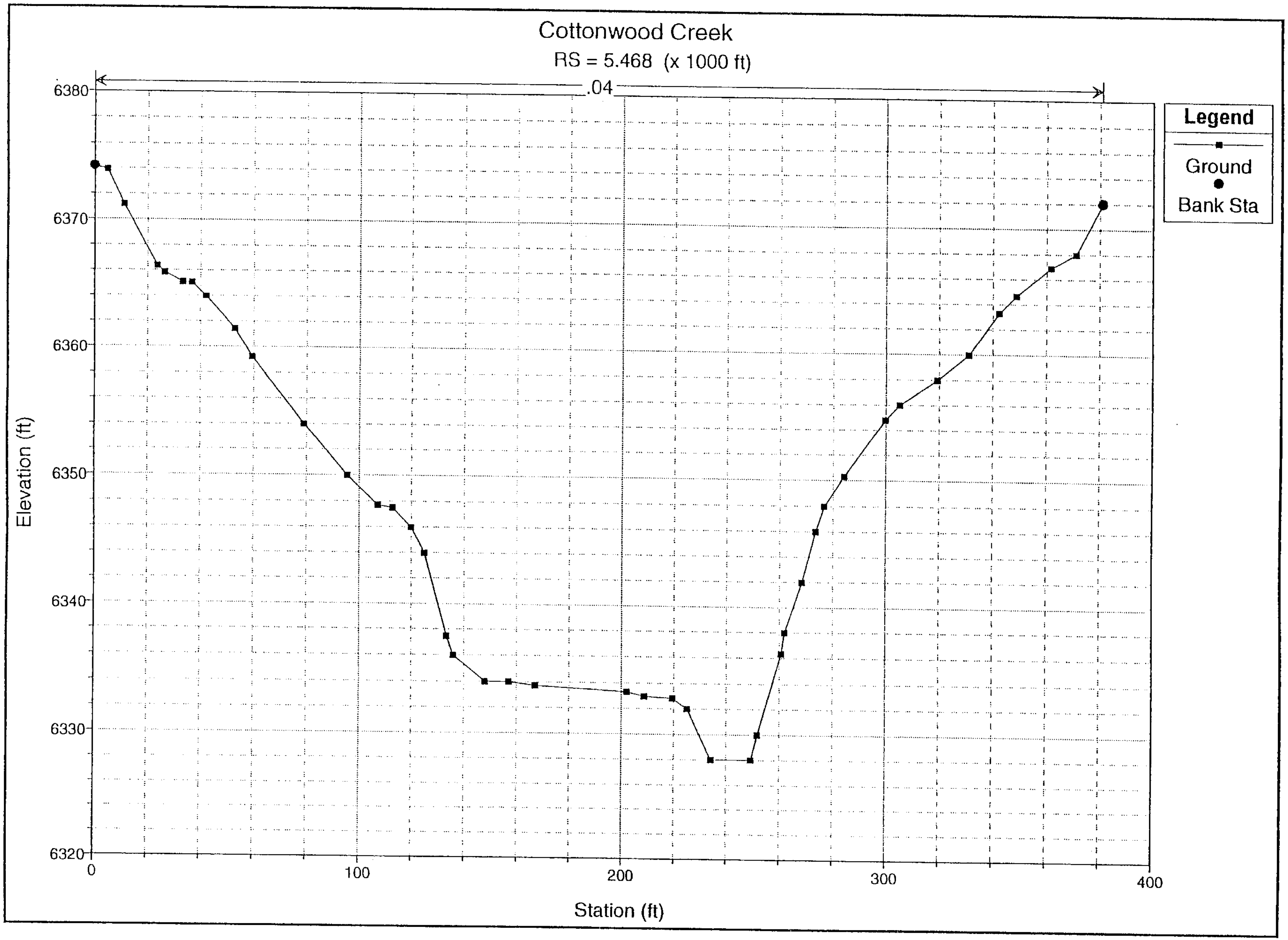
Cottonwood Creek
RS = 3.903 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6350
6340
6330
6320
6310
6300
0
50
100
150
200
250
300
350
400
Station (ft)



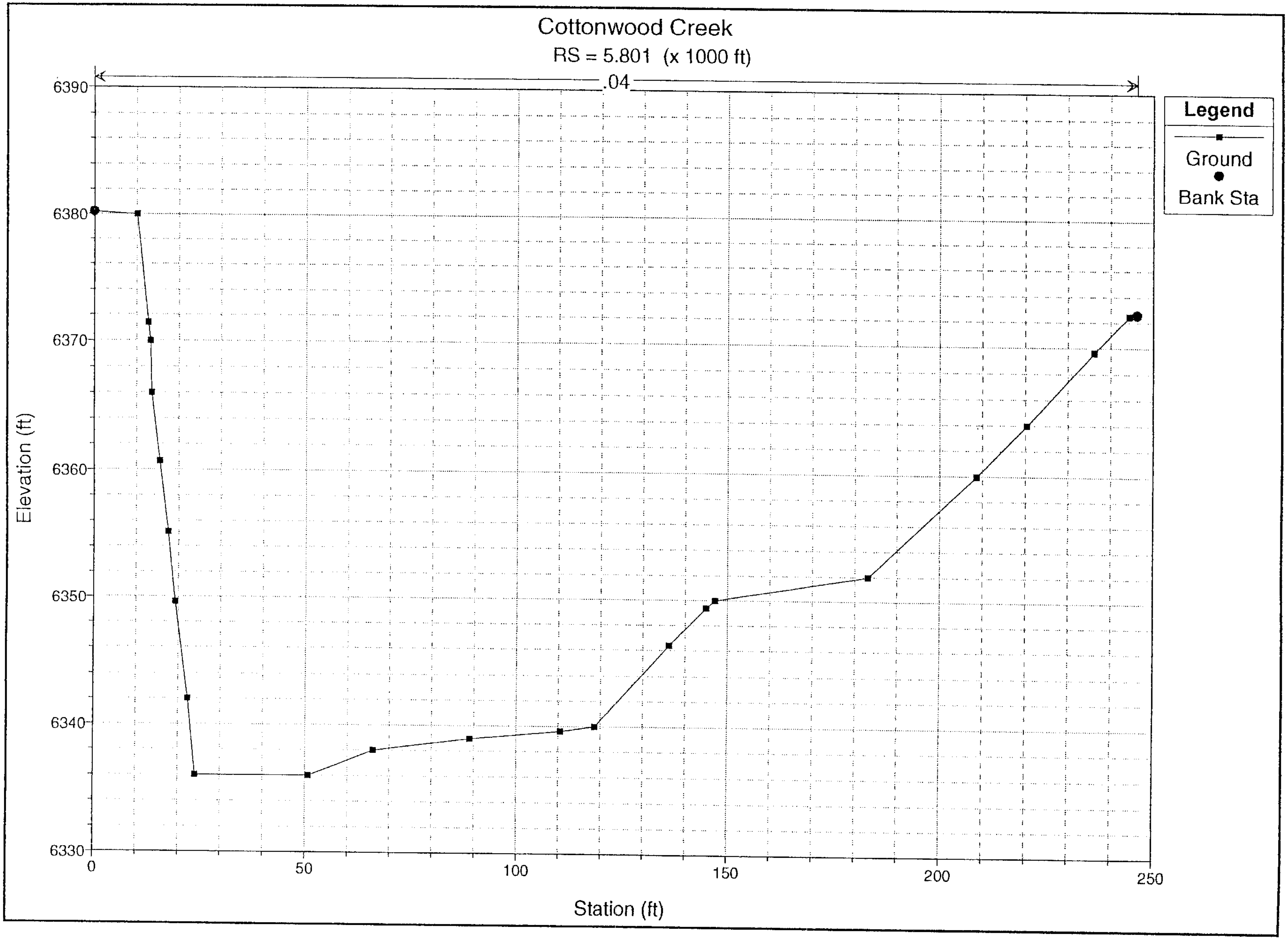
Cottonwood Creek
RS = 4.367 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6360
6350
6340
6330
6320
6310
0
100
200
300
400
500
600
Station (ft)



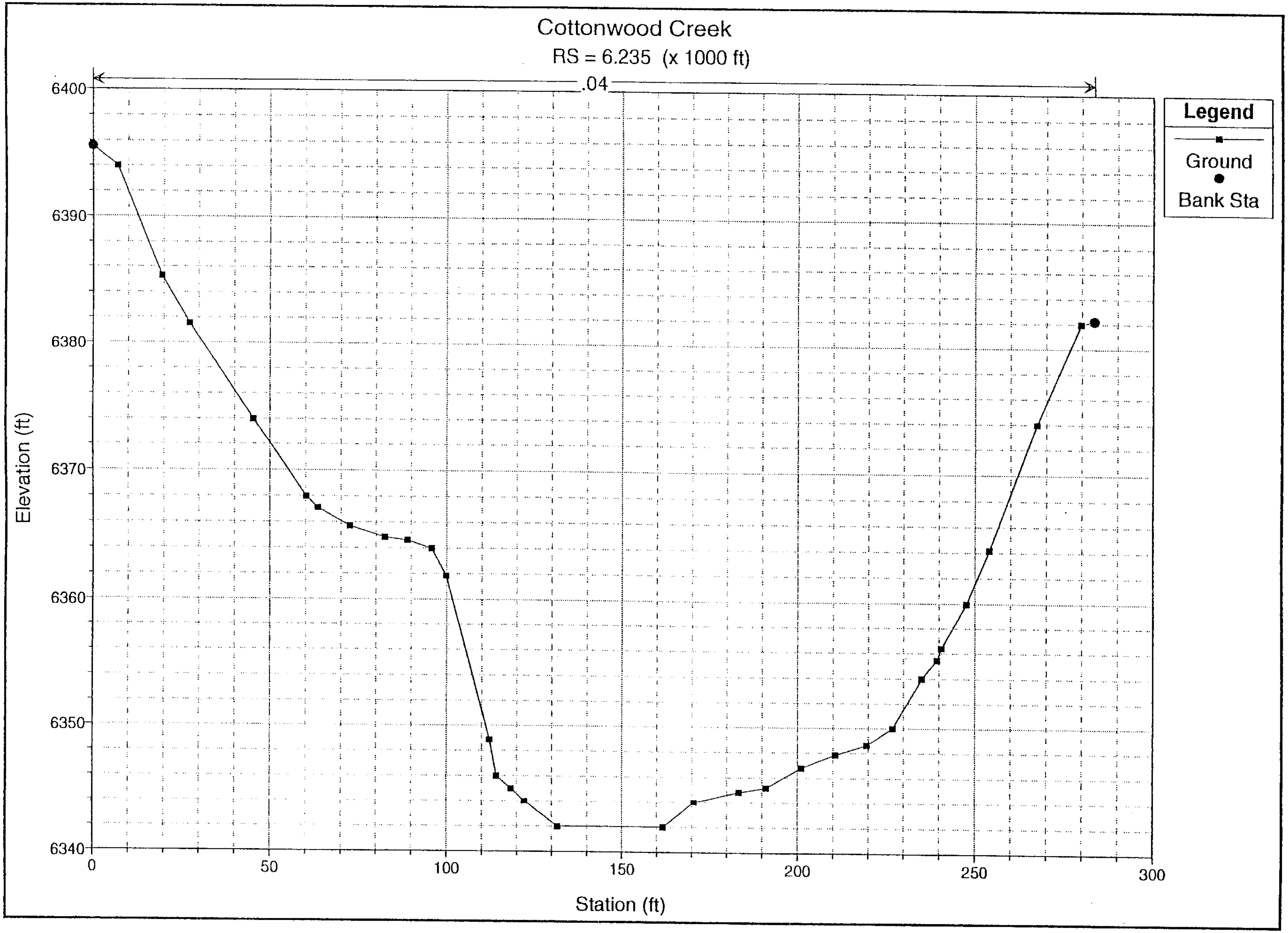
Cottonwood Creek
RS = 5.028 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6370
6360
6350
6340
6330
6320
6310
0
50
100
150
200
250
300
350
Station (ft)



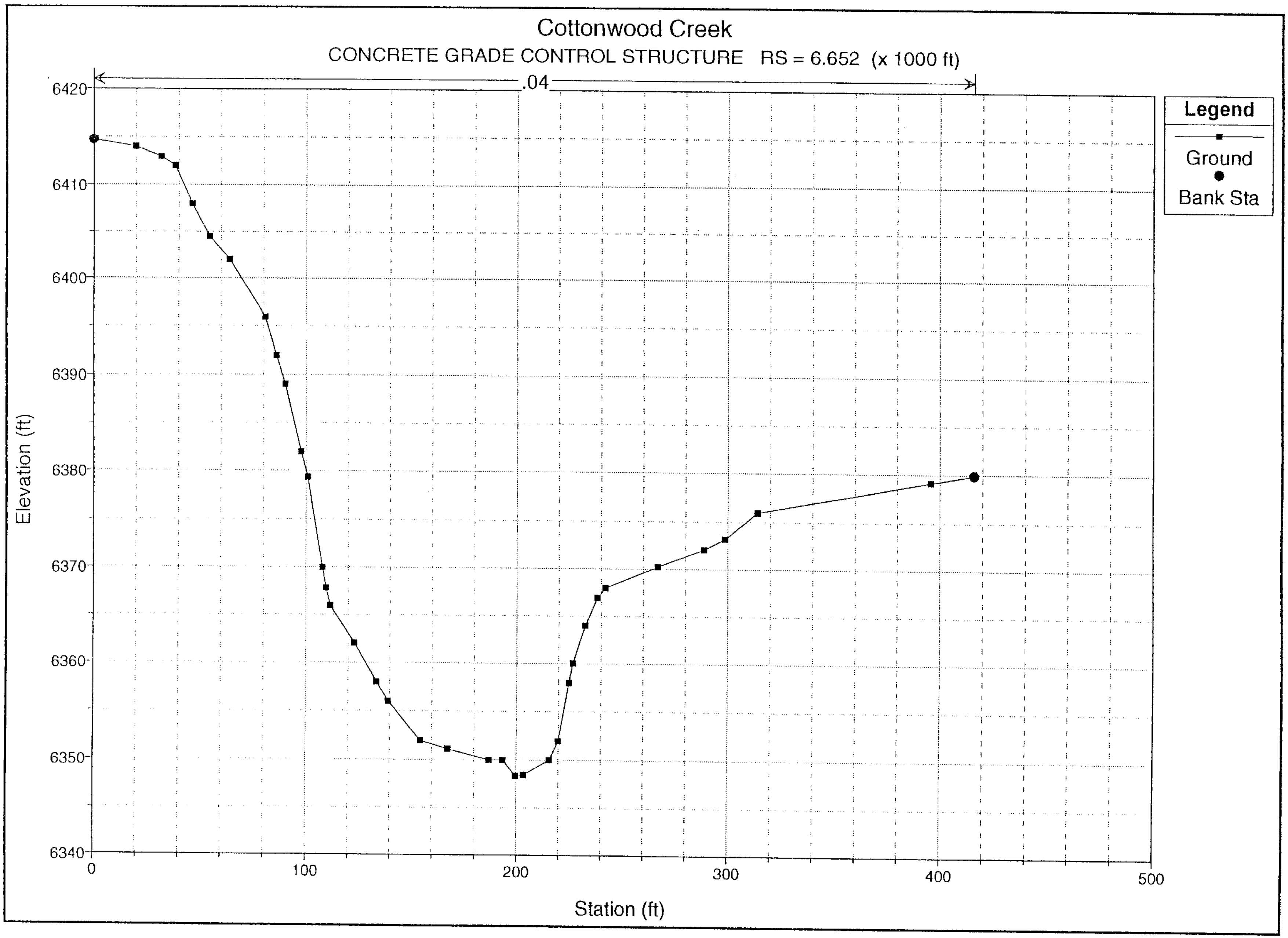
Cottonwood Creek
RS = 5.468 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6380
6370
6360
6350
6340
6330
6320
0
100
200
300
400
Station (ft)

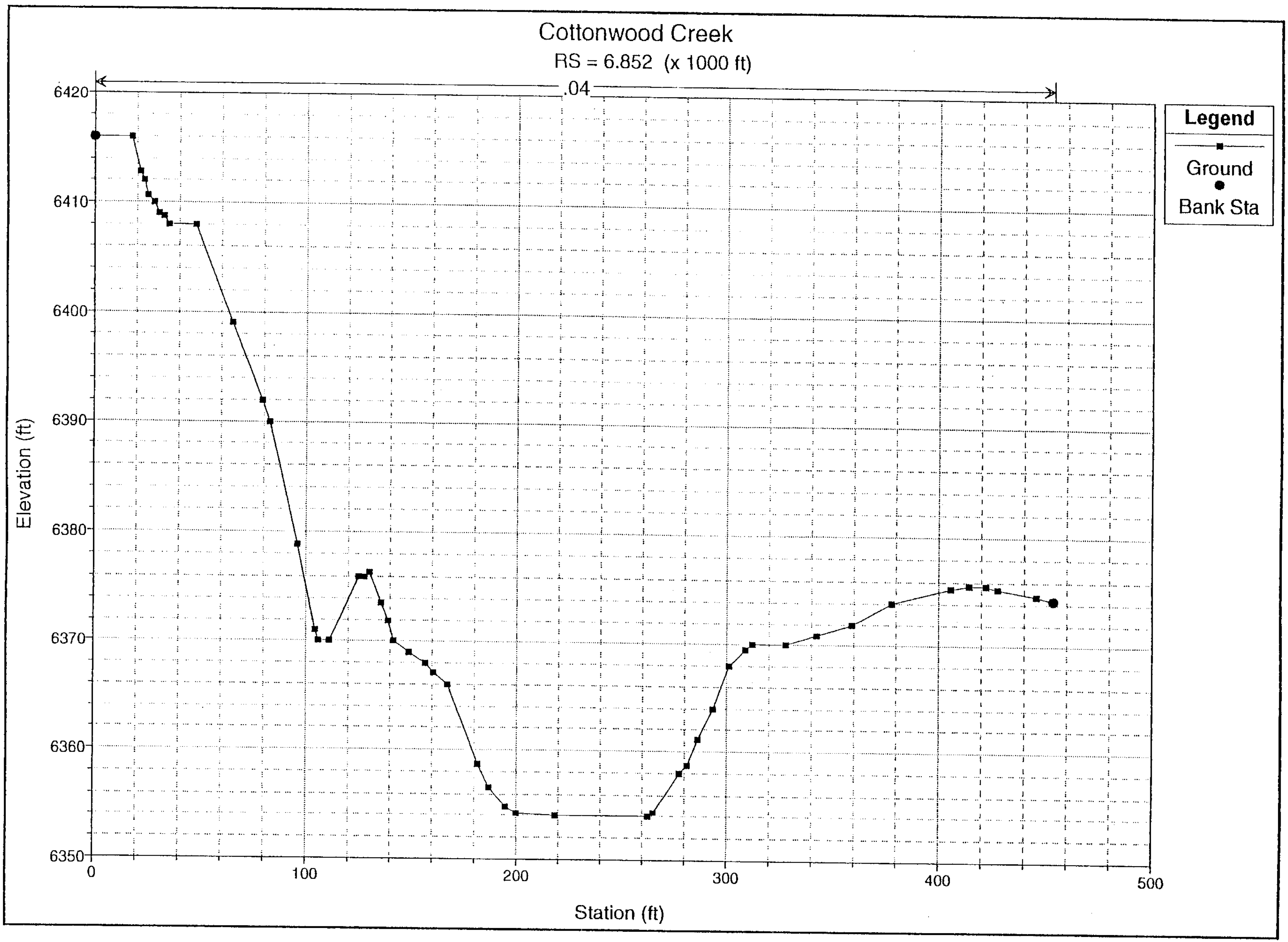


Cottonwood Creek
RS = 5.801 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6390
6380
6370
6360
6350
6340
6330
0
50
100
150
200
250
Station (ft)

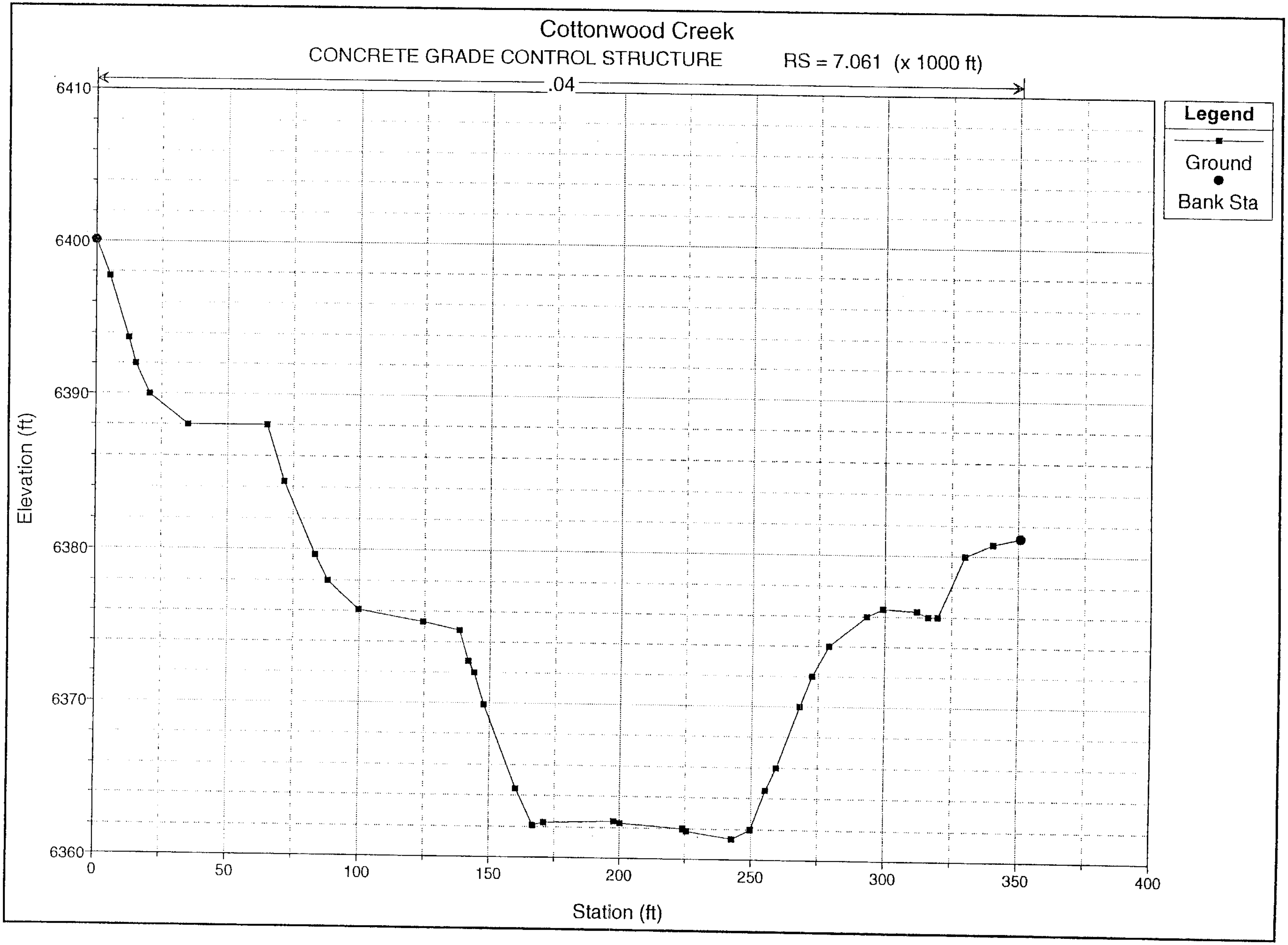


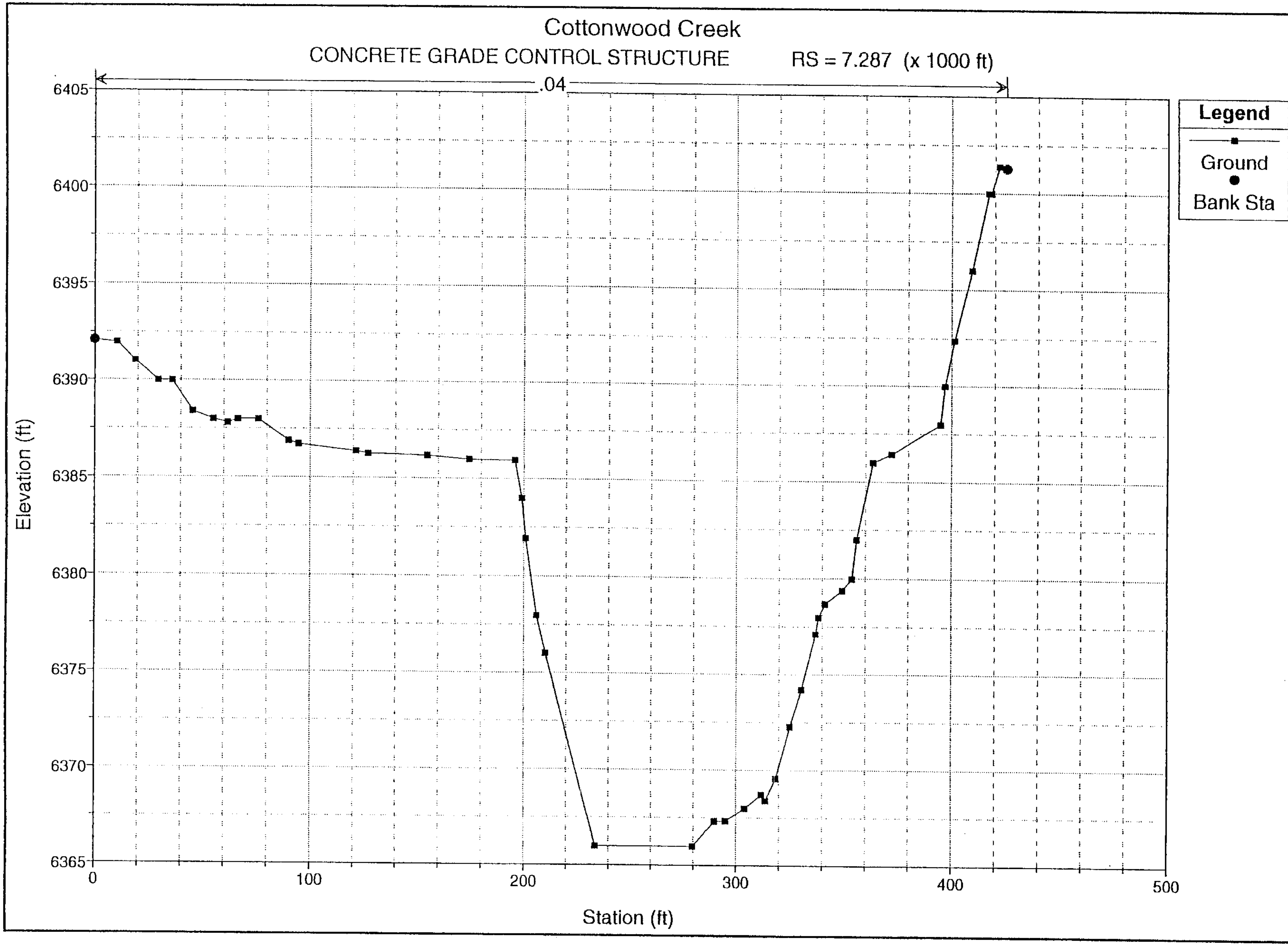
Cottonwood Creek
RS = 6.235 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6400
6390
6380
6370
6360
6350
6340
0
50
100
150
200
250
300
Station (ft)


Cottonwood Creek
CONCRETE GRADE CONTROL STRUCTURE RS = 6.652 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6420
6410
6400
6390
6380
6370
6360
6350
6340
0
100
200
300
400
500
Station (ft)

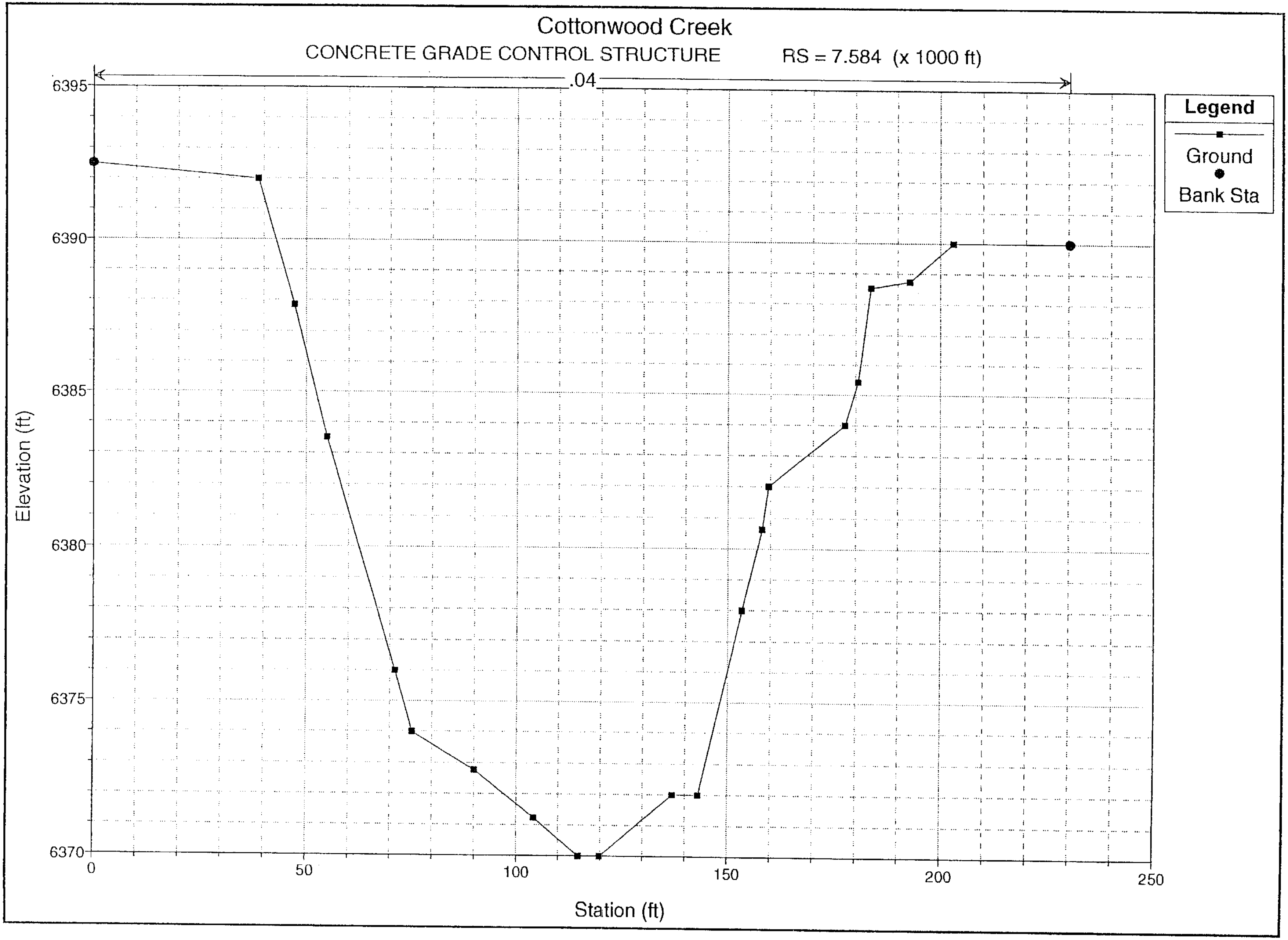


Cottonwood Creek
RS = 6.852 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6420
6410
6400
6390
6380
6370
6360
6350
0
100
200
300
400
500
Station (ft)

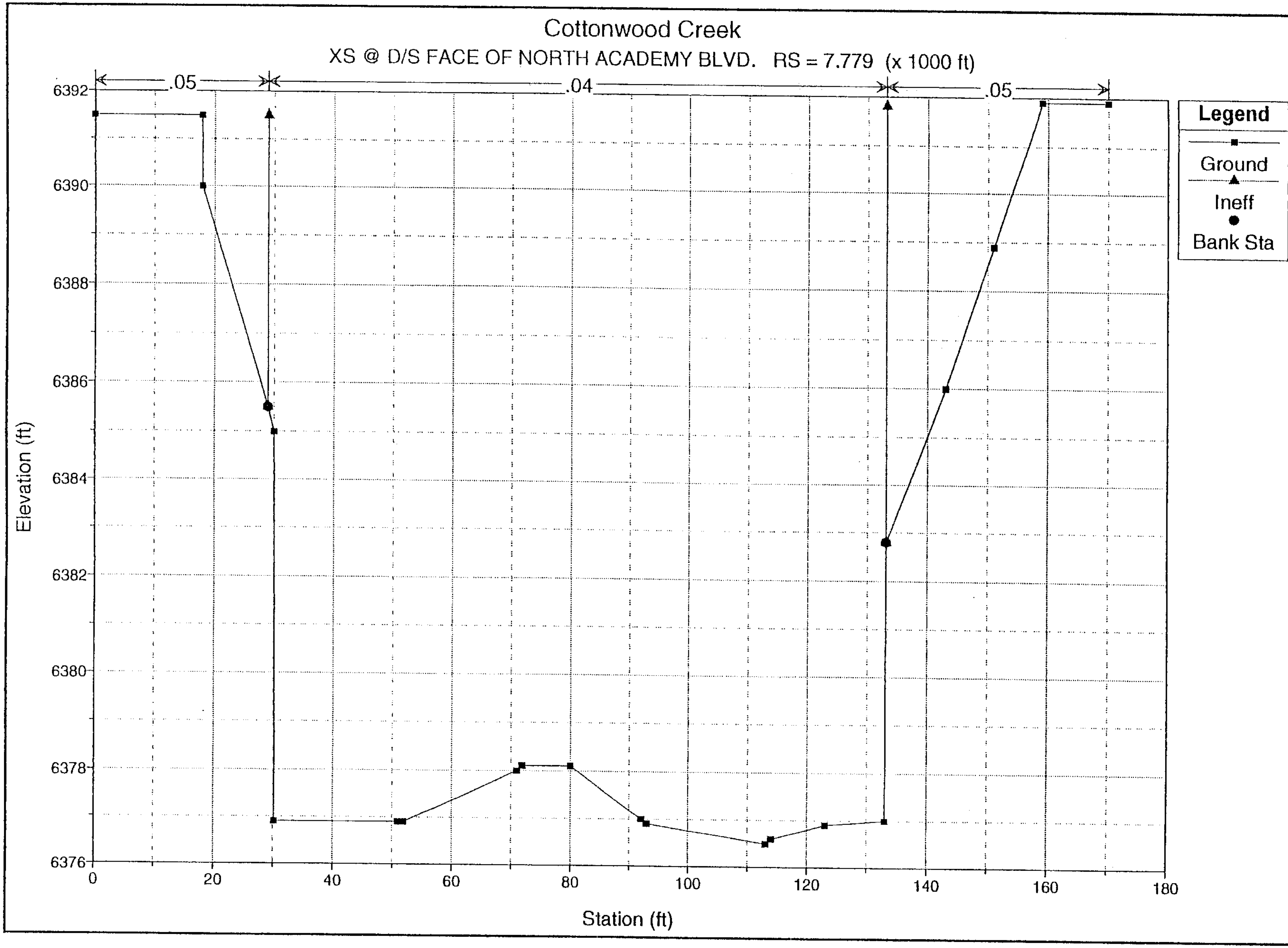

Cottonwood Creek
CONCRETE GRADE CONTROL STRUCTURE
RS = 7.061 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6410
6400
6390
6380
6370
6360
Station (ft)
0
50
100
150
200
250
300
350
400



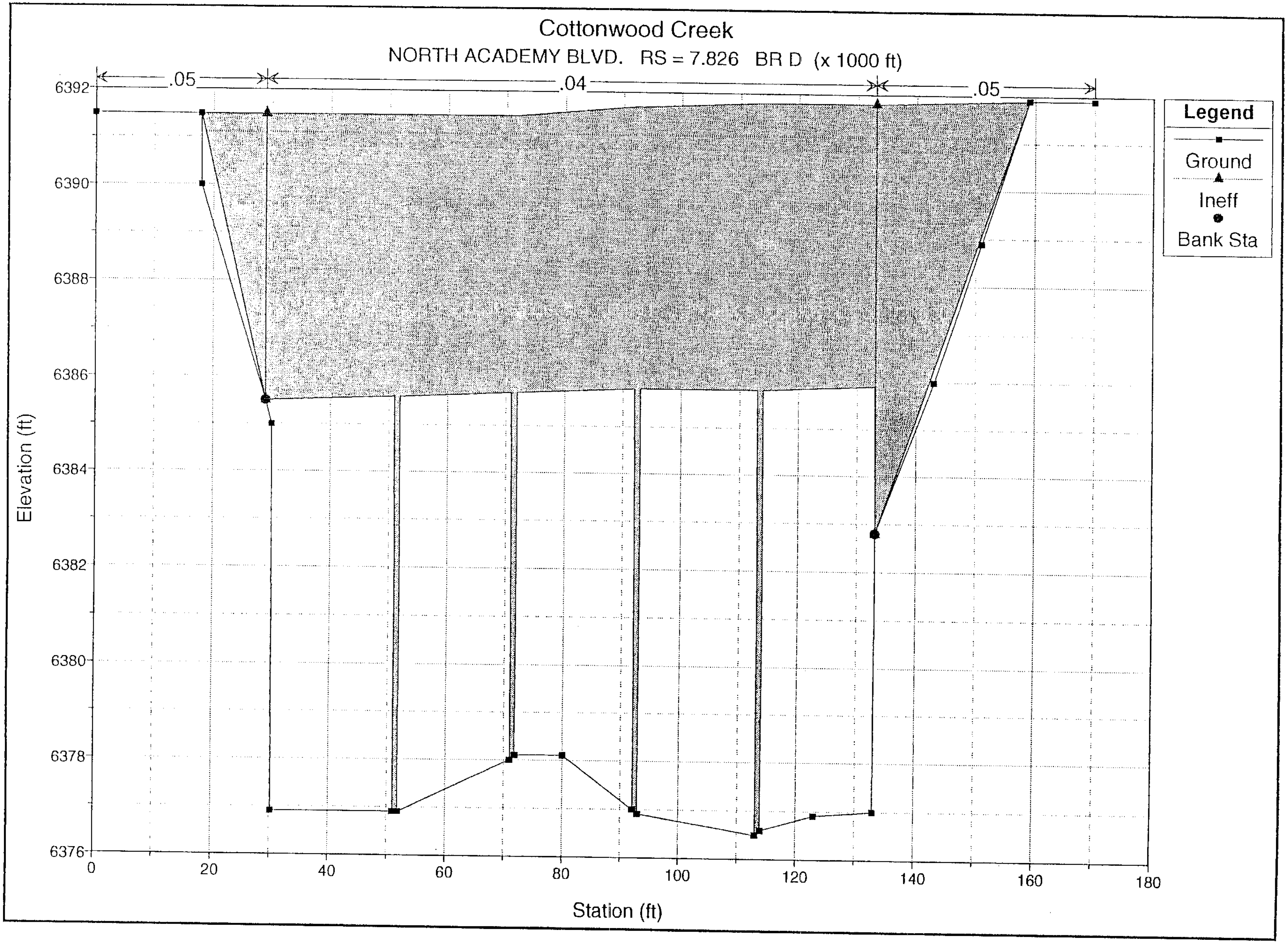
Cottonwood Creek
CONCRETE GRADE CONTROL STRUCTURE
RS = 7.287 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6405
6400
6395
6390
6385
6380
6375
6370
6365
0
100
200
300
400
500
Station (ft)



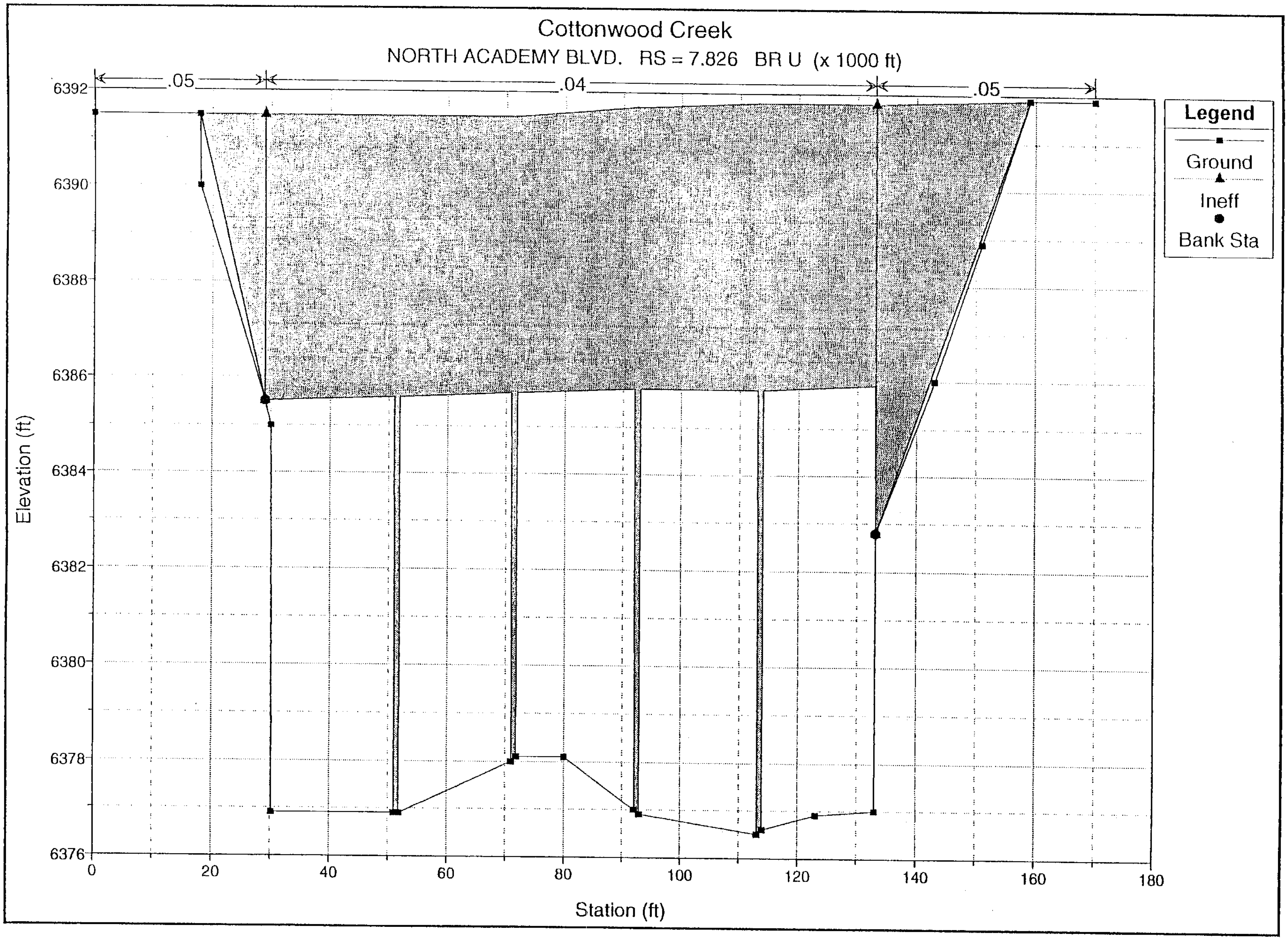
Cottonwood Creek
CONCRETE GRADE CONTROL STRUCTURE
RS = 7.584 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6395
6390
6385
6380
6375
6370
Station (ft)
0
50
100
150
200
250



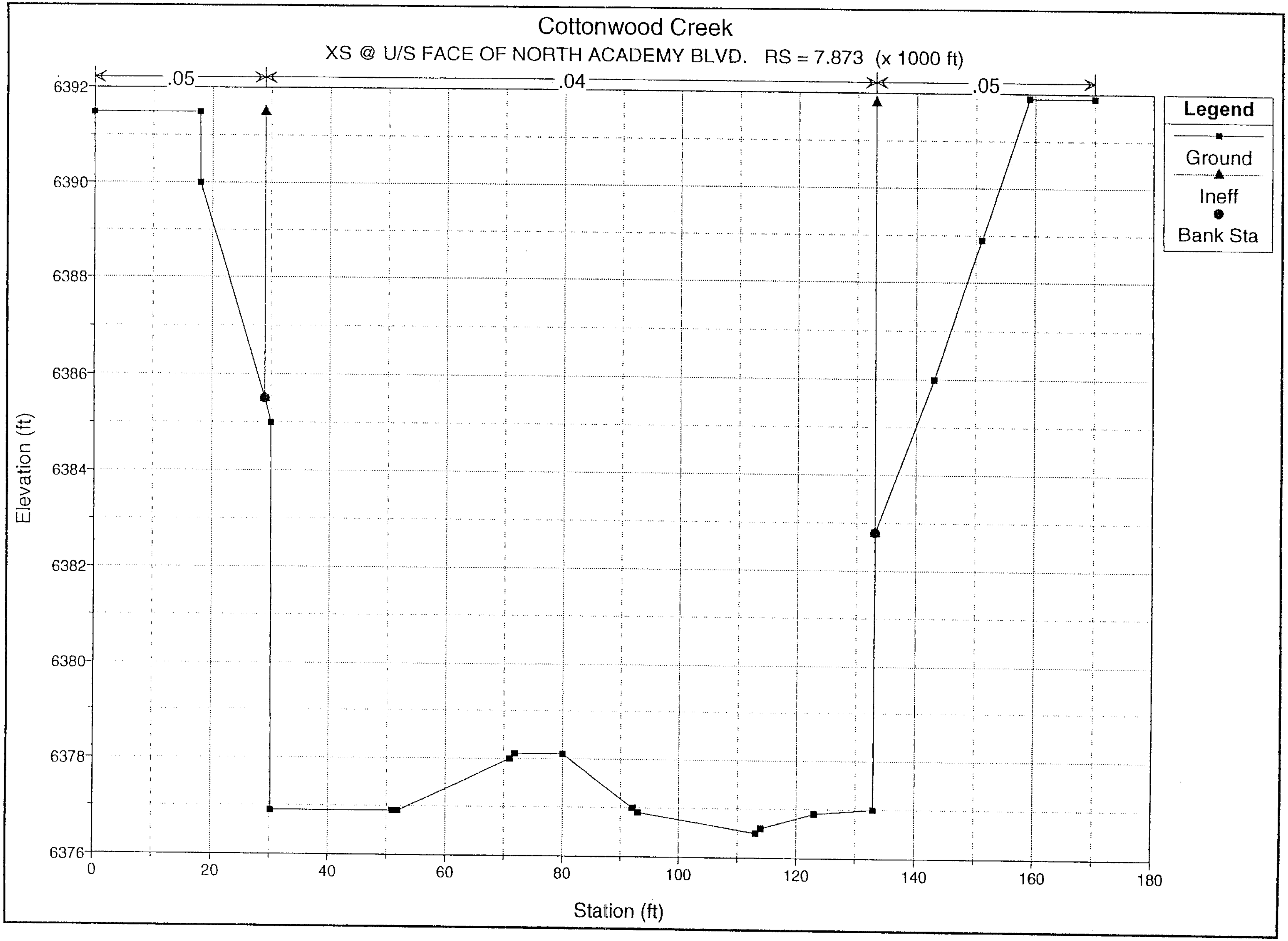
Cottonwood Creek
XS @ D/S FACE OF NORTH ACADEMY BLVD. RS = 7.779 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6392
6390
6388
6386
6384
6382
6380
6378
6376
Station (ft)
0
20
40
60
80
100
120
140
160
180



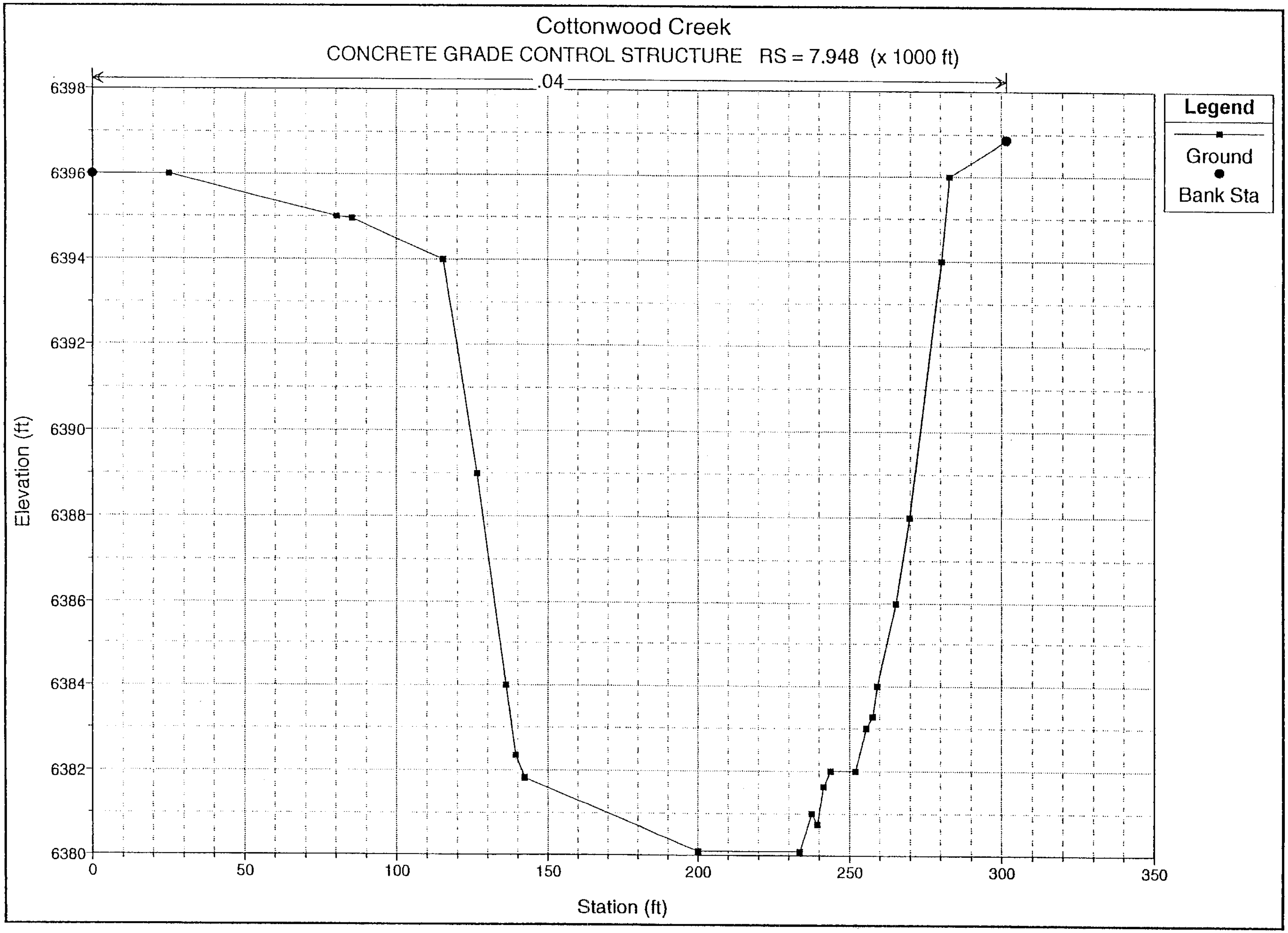
Cottonwood Creek
NORTH ACADEMY BLVD. RS = 7.826 BR D (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6392
6390
6388
6386
6384
6382
6380
6378
6376
0
20
40
60
80
100
120
140
160
180
Station (ft)



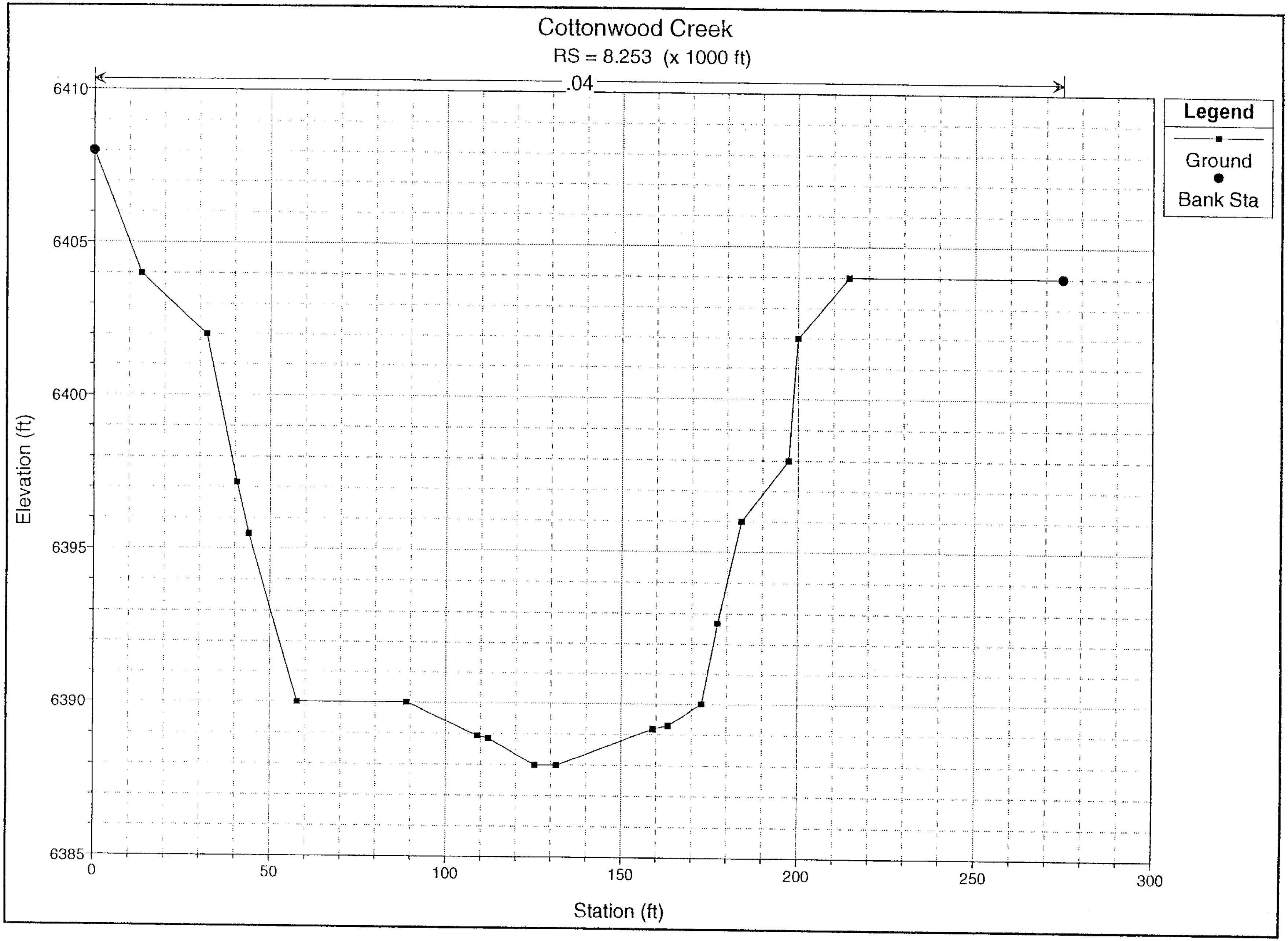
Cottonwood Creek
NORTH ACADEMY BLVD. RS = 7.826 BR U (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6392
6390
6388
6386
6384
6382
6380
6378
6376
0
20
40
60
80
100
120
140
160
180
Station (ft)



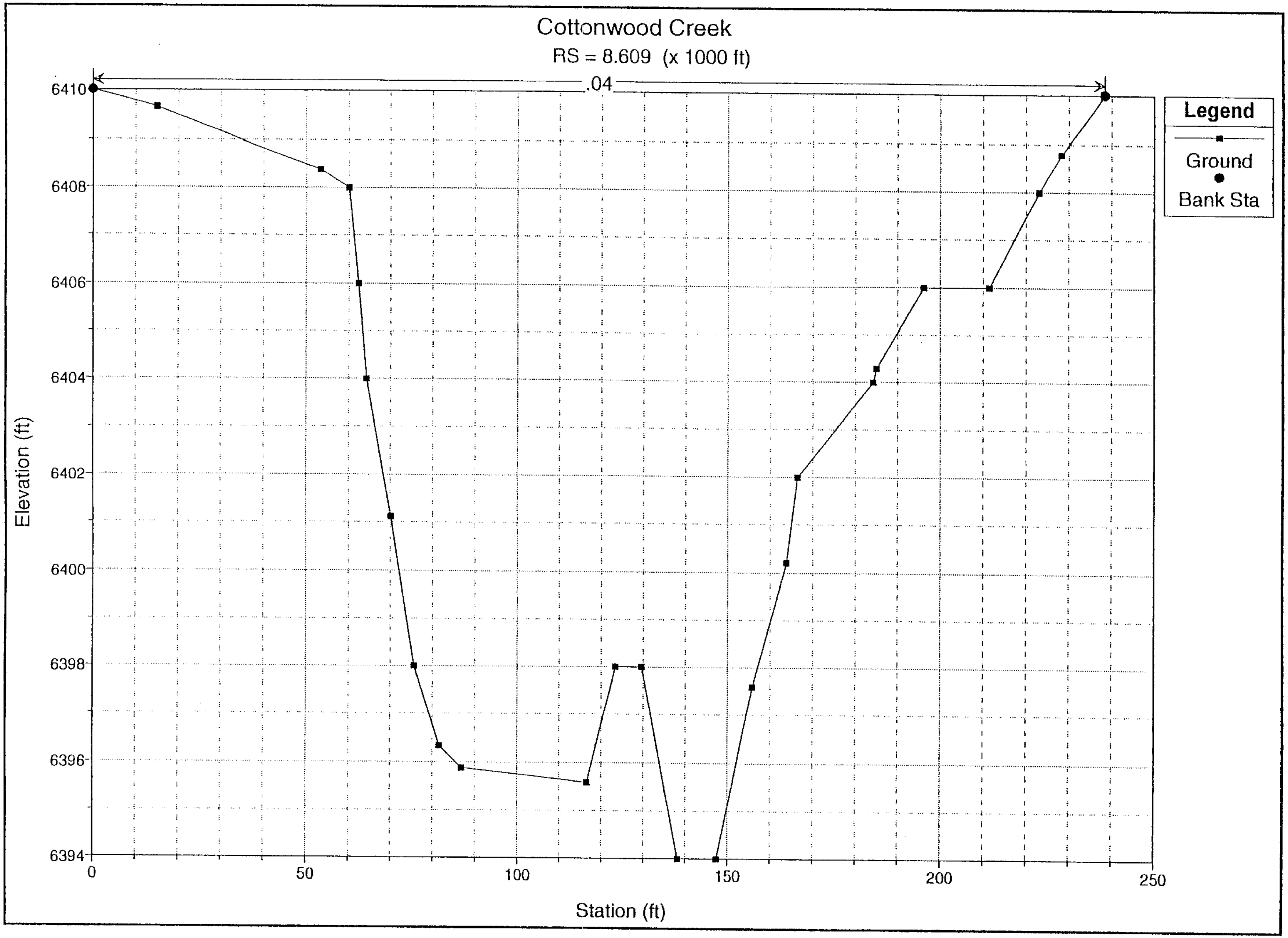
Cottonwood Creek
XS @ U/S FACE OF NORTH ACADEMY BLVD. RS = 7.873 (x 1000 ft)
.05
.04
.05
Elevation (ft)
6376
6378
6380
6382
6384
6386
6388
6390
6392
Station (ft)
0
20
40
60
80
100
120
140
160
180
Legend
Ground
Ineff
Bank Sta

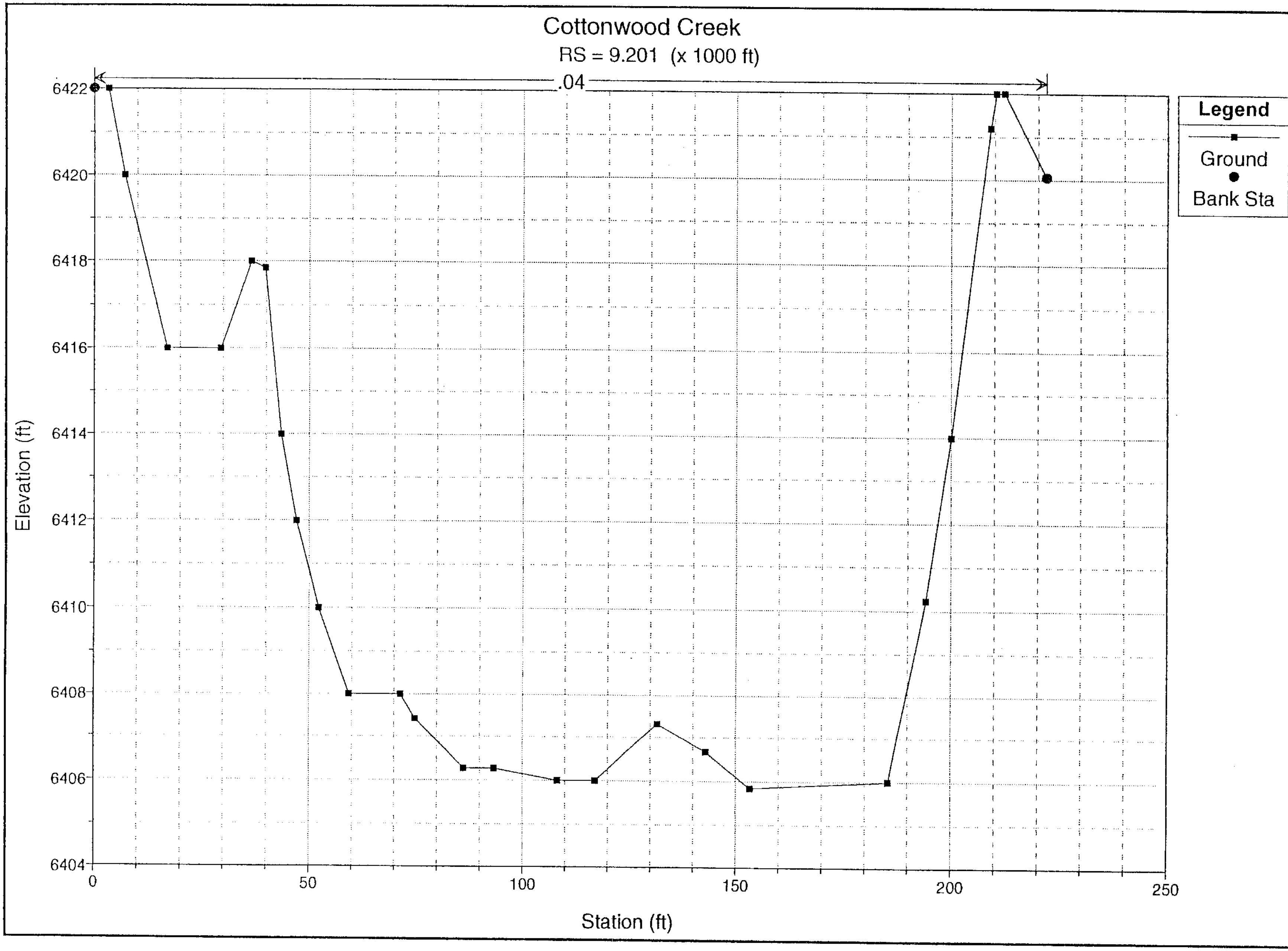


Cottonwood Creek
CONCRETE GRADE CONTROL STRUCTURE RS = 7.948 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6398
6396
6394
6392
6390
6388
6386
6384
6382
6380
0
50
100
150
200
250
300
350
Station (ft)

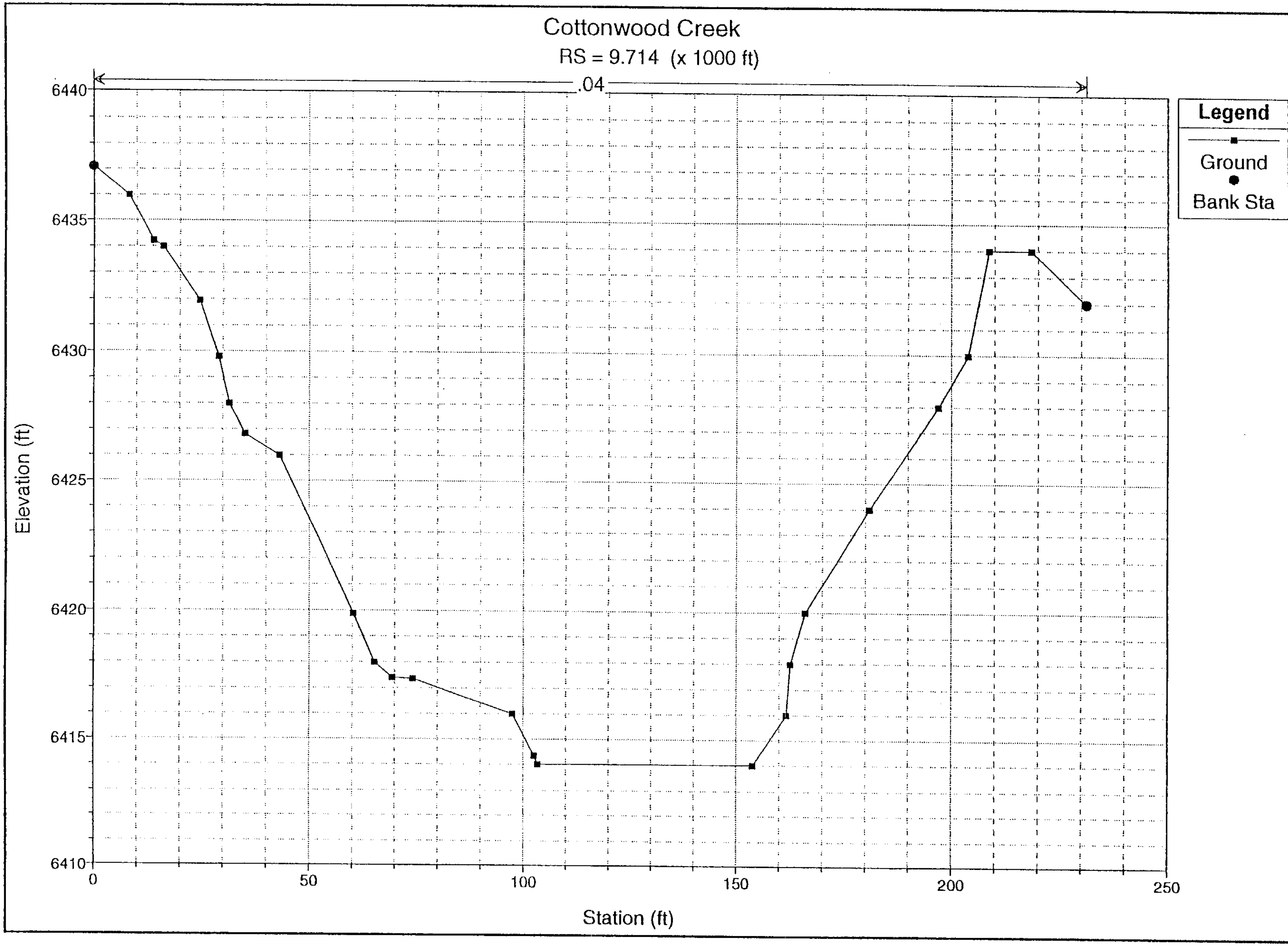


Cottonwood Creek
RS = 8.253 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6410
6405
6400
6395
6390
6385
0
50
100
150
200
250
300
Station (ft)

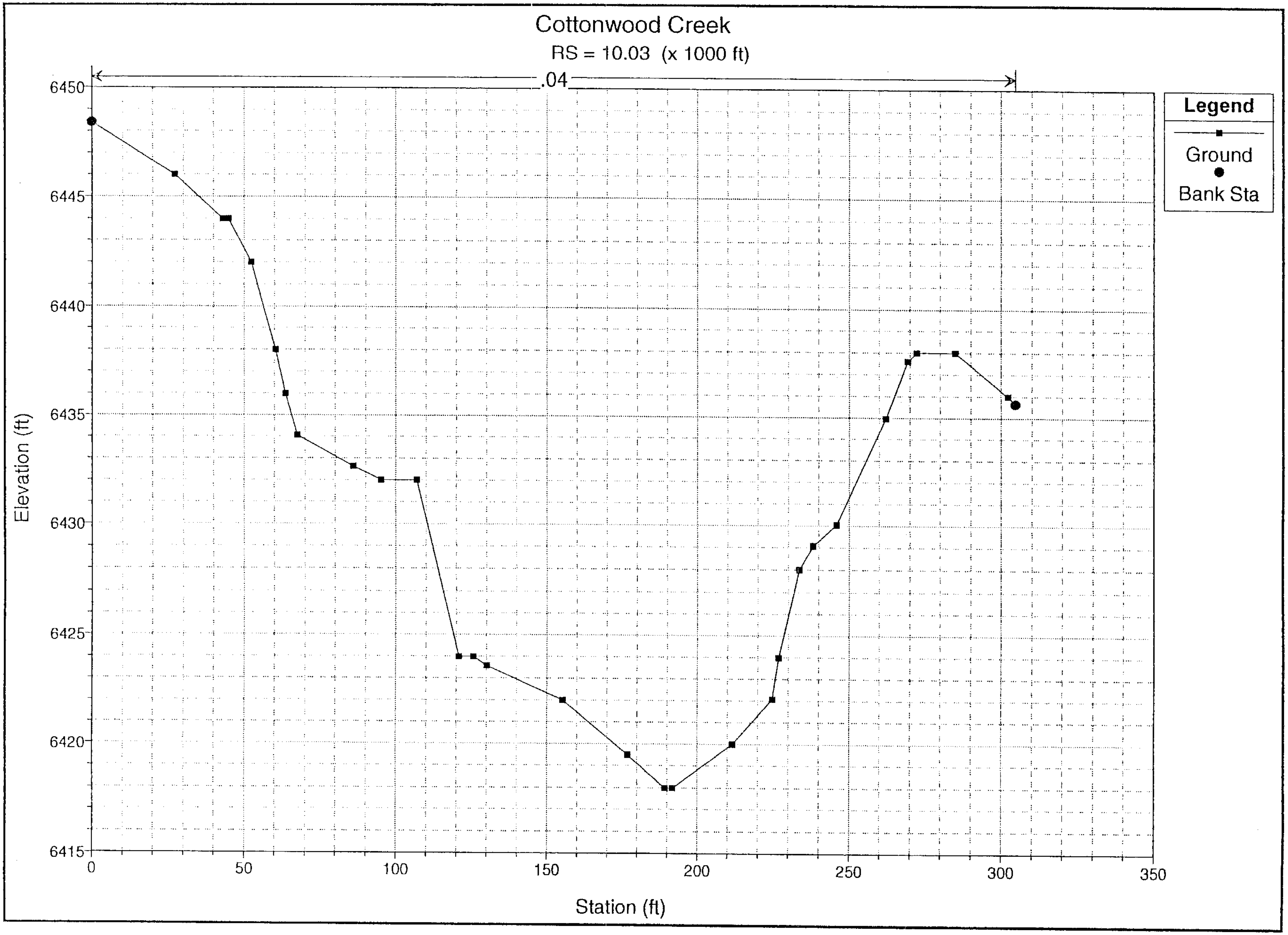

Cottonwood Creek
RS = 8.609 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6410
6408
6406
6404
6402
6400
6398
6396
6394
0
50
100
150
200
250
Station (ft)



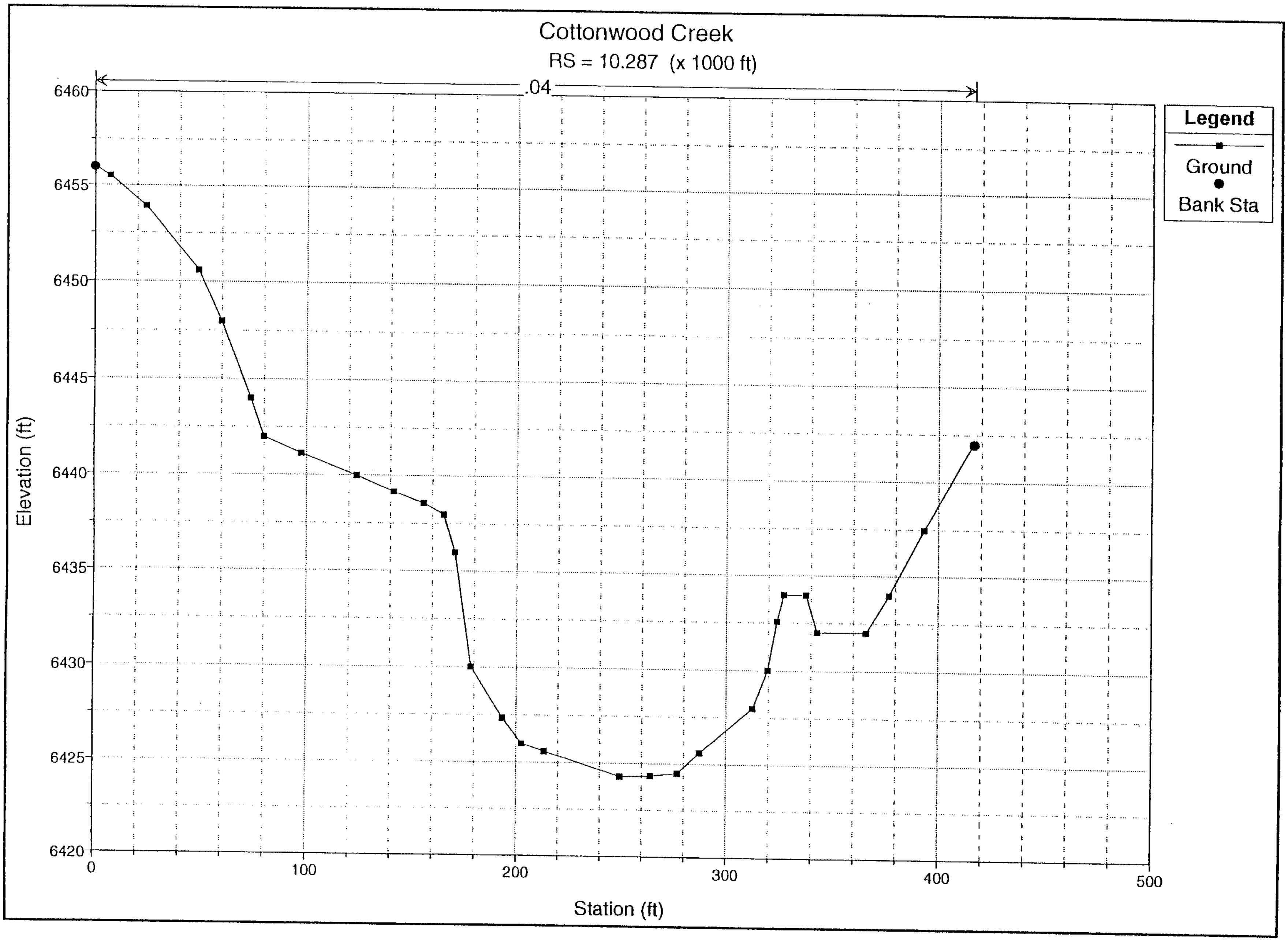
Cottonwood Creek
RS = 9.201 (x 1000 ft)
.04
6422
6420
6418
6416
6414
6412
6410
6408
6406
6404
Elevation (ft)
0
50
100
150
200
250
Station (ft)
Legend
Ground
Bank Sta

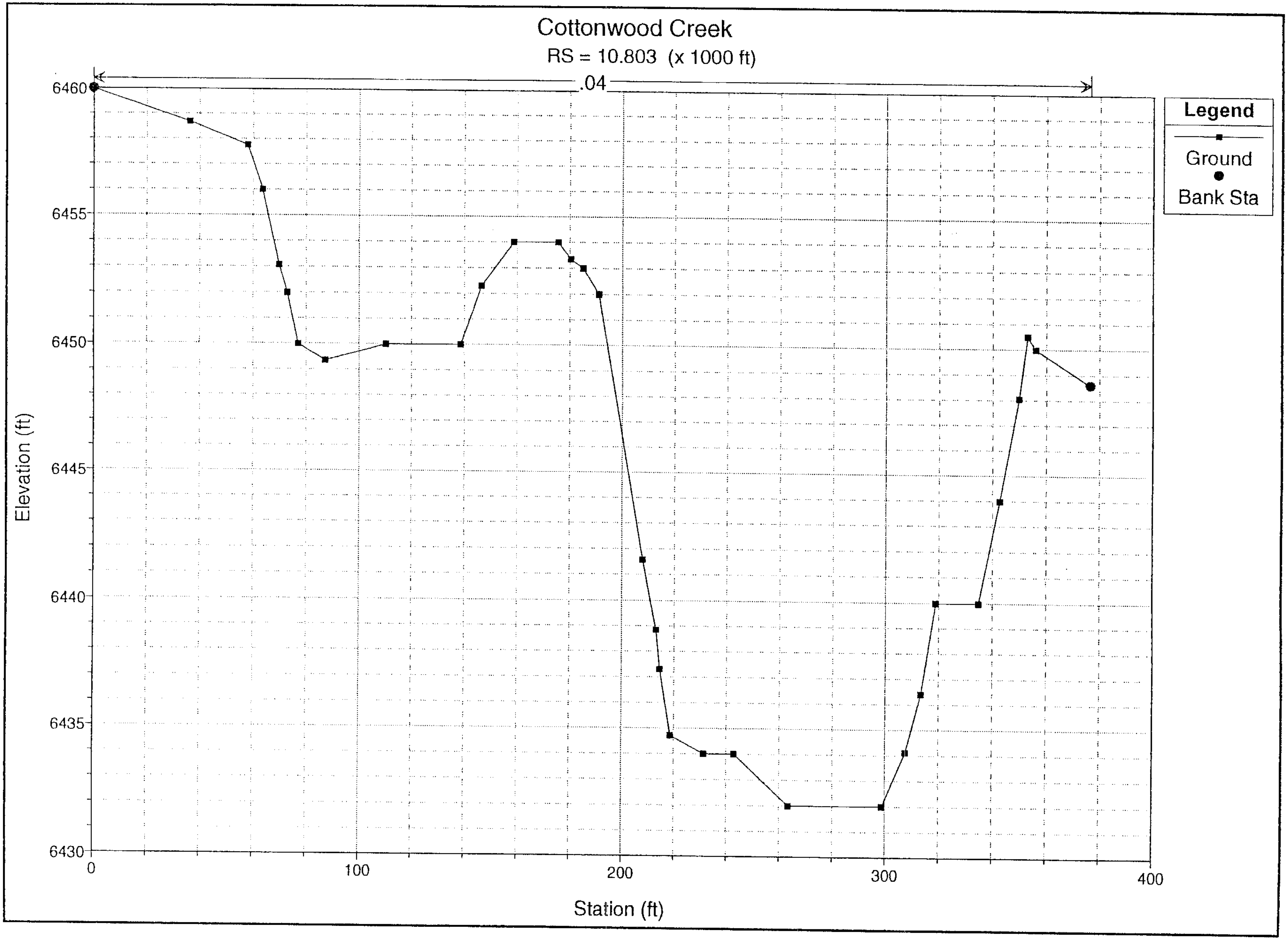


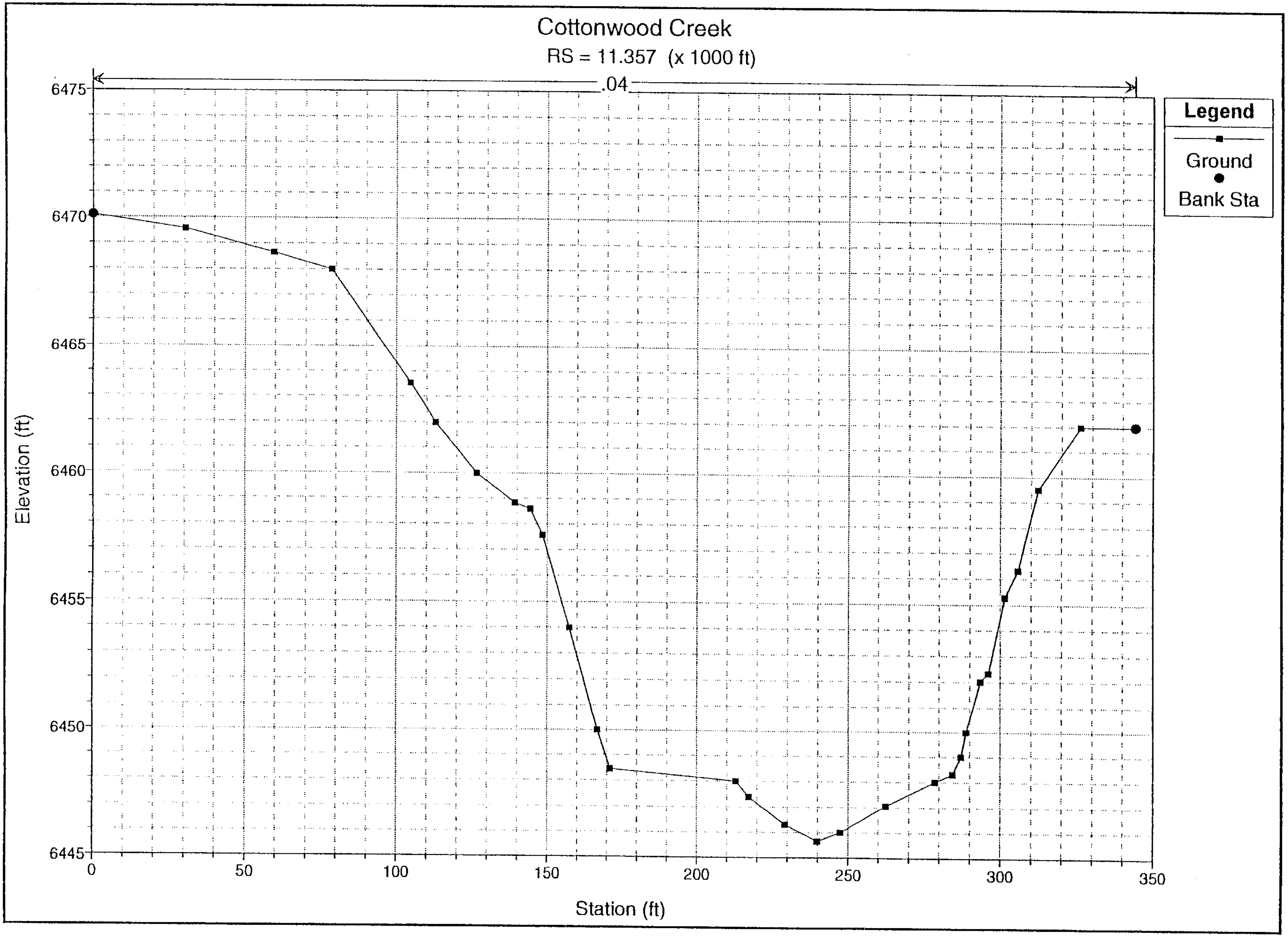
Cottonwood Creek
RS = 9.714 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6440
6435
6430
6425
6420
6415
6410
0
50
100
150
200
250
Station (ft)



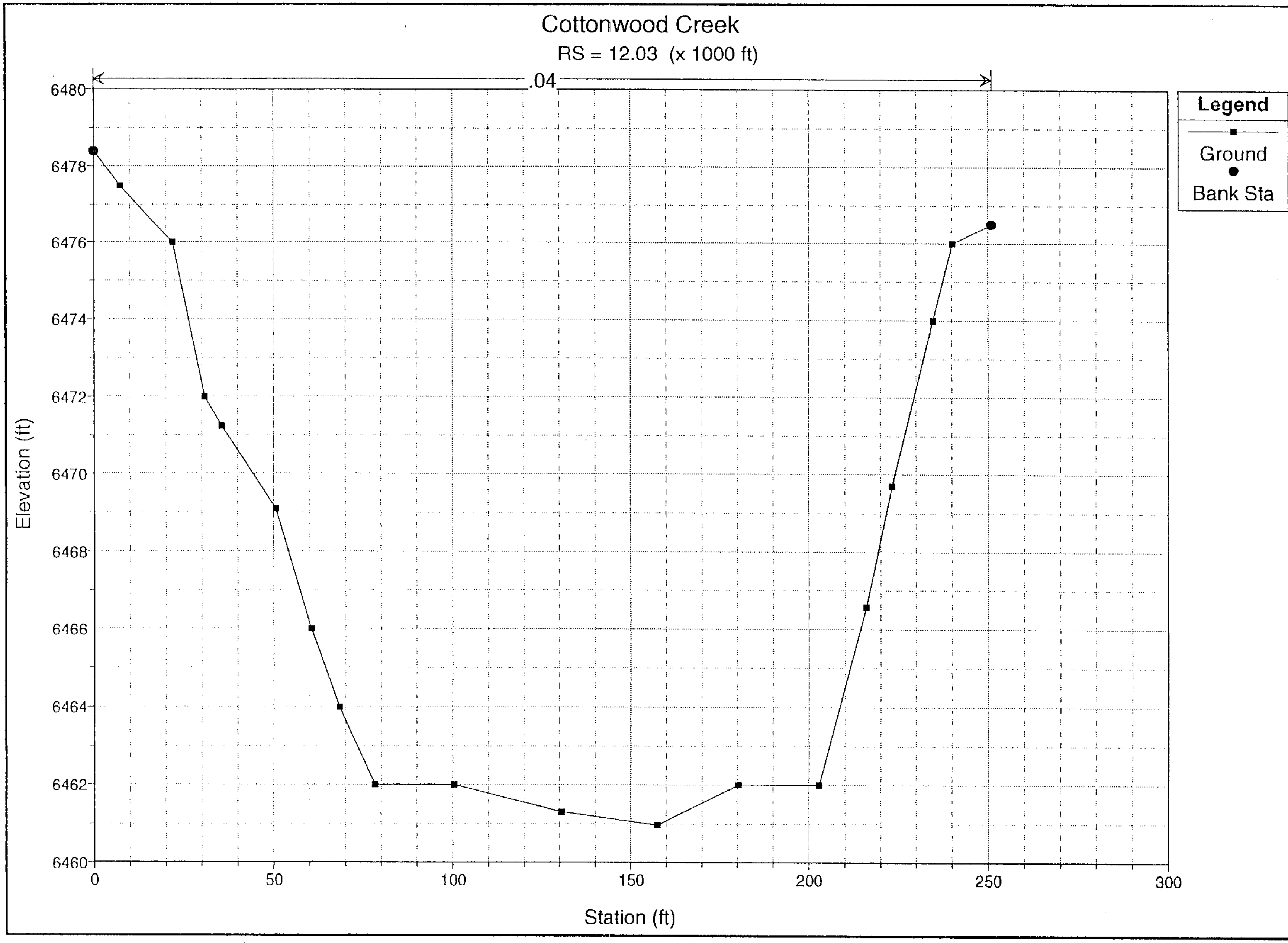
Cottonwood Creek
RS = 10.03 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6450
6445
6440
6435
6430
6425
6420
6415
0
50
100
150
200
250
300
350
Station (ft)


Cottonwood Creek
RS = 10.287 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6460
6455
6450
6445
6440
6435
6430
6425
6420
0
100
200
300
400
500
Station (ft)

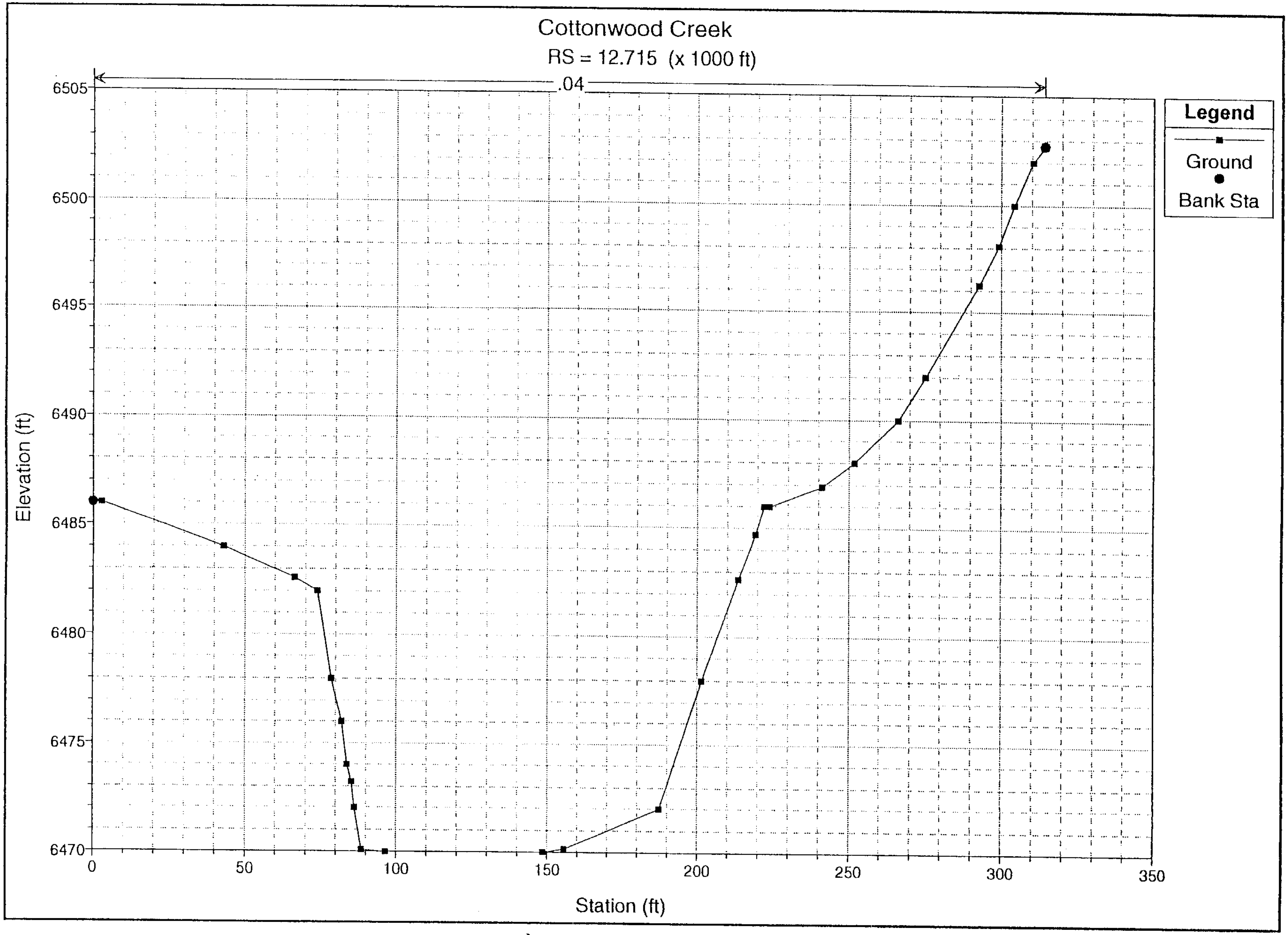

Cottonwood Creek
RS = 10.803 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6460
6455
6450
6445
6440
6435
6430
0
100
200
300
400
Station (ft)

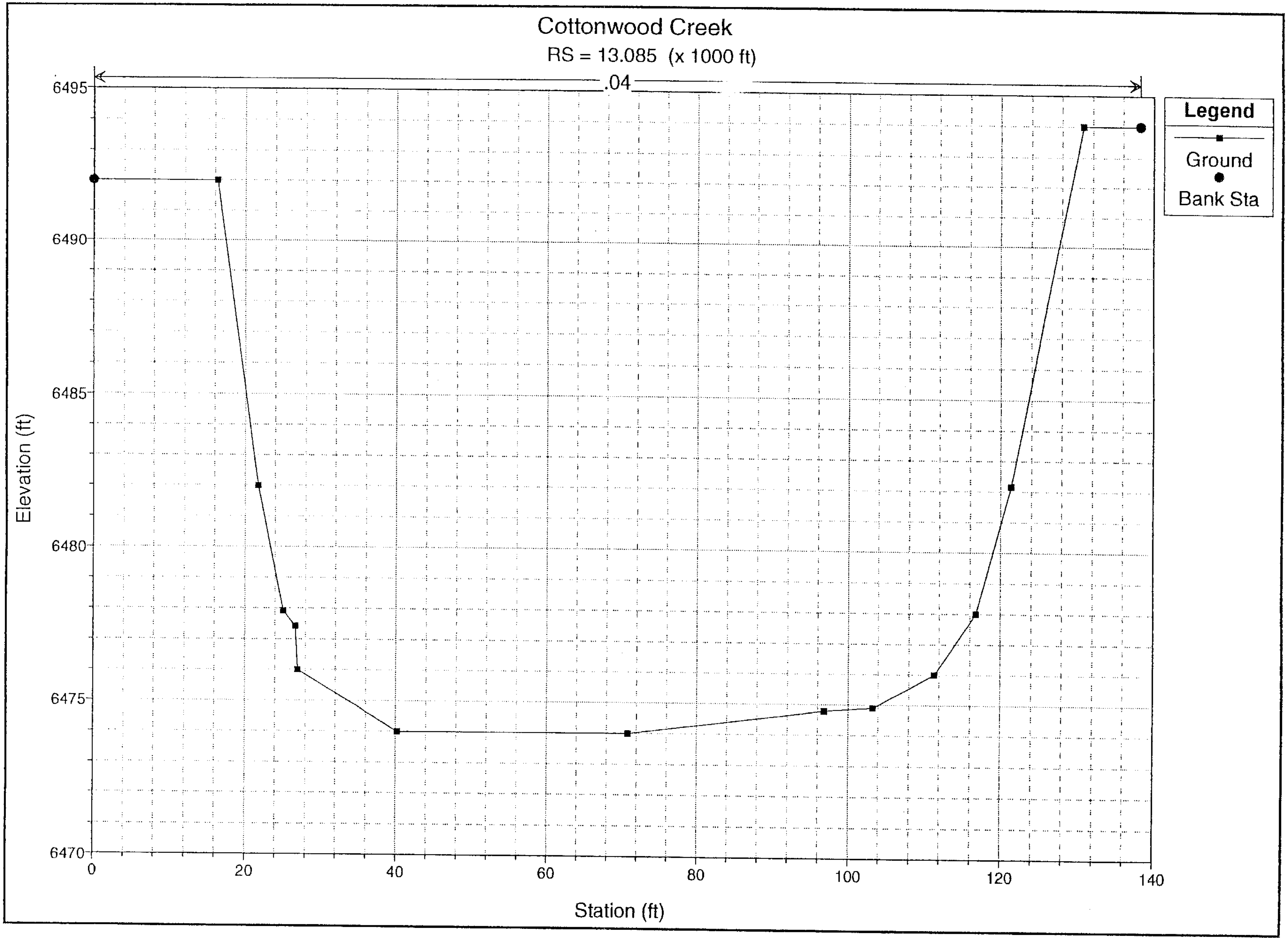


Cottonwood Creek
RS = 11.357 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6475
6470
6465
6460
6455
6450
6445
0
50
100
150
200
250
300
350
Station (ft)

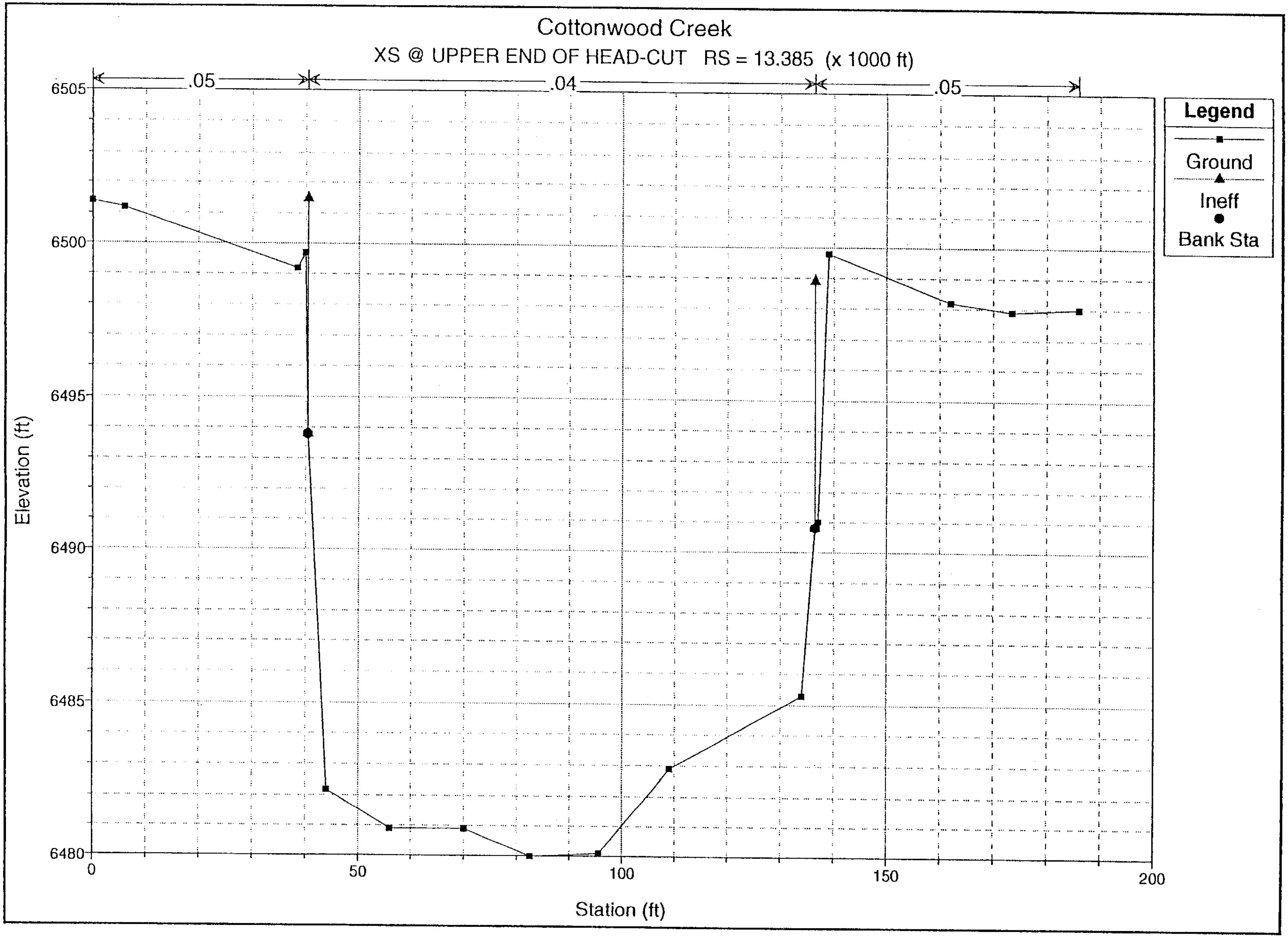


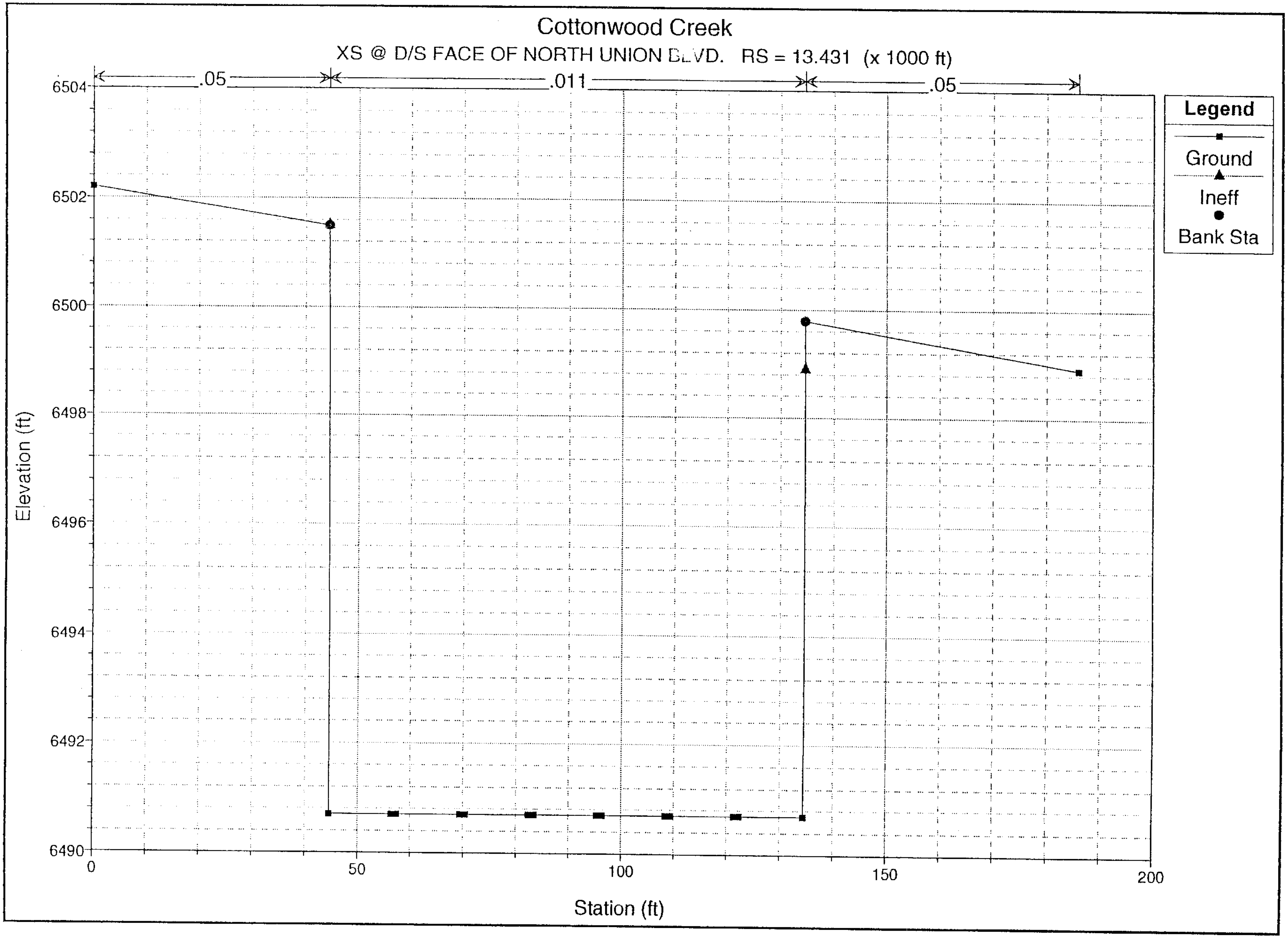
Cottonwood Creek
RS = 12.03 (x 1000 ft)
.04
Elevation (ft)
6480
6478
6476
6474
6472
6470
6468
6466
6464
6462
6460
0
50
100
150
200
250
300
Station (ft)
Legend
Ground
Bank Sta

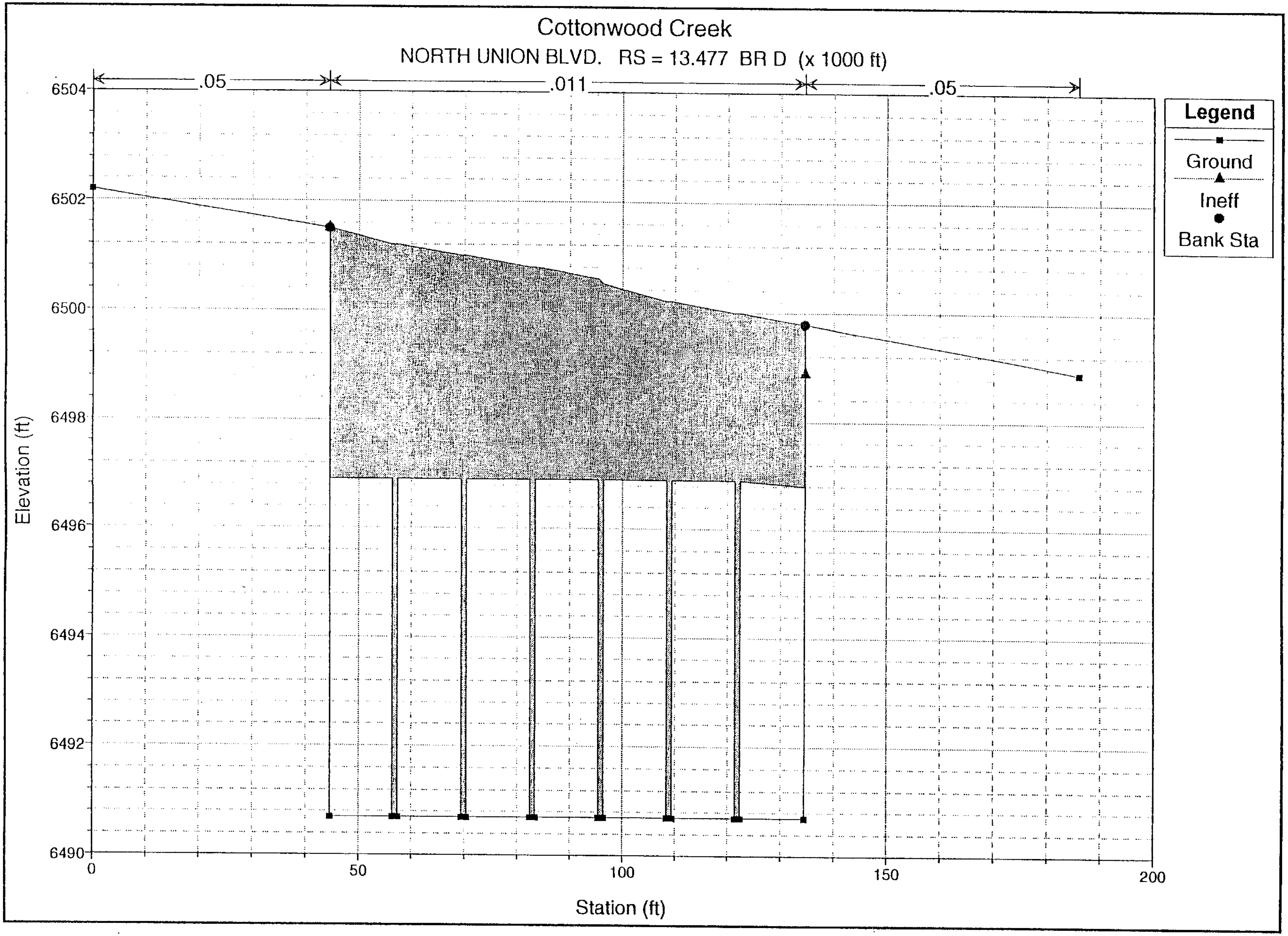

Cottonwood Creek
RS = 12.715 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6505
6500
6495
6490
6485
6480
6475
6470
0
50
100
150
200
250
300
350
Station (ft)



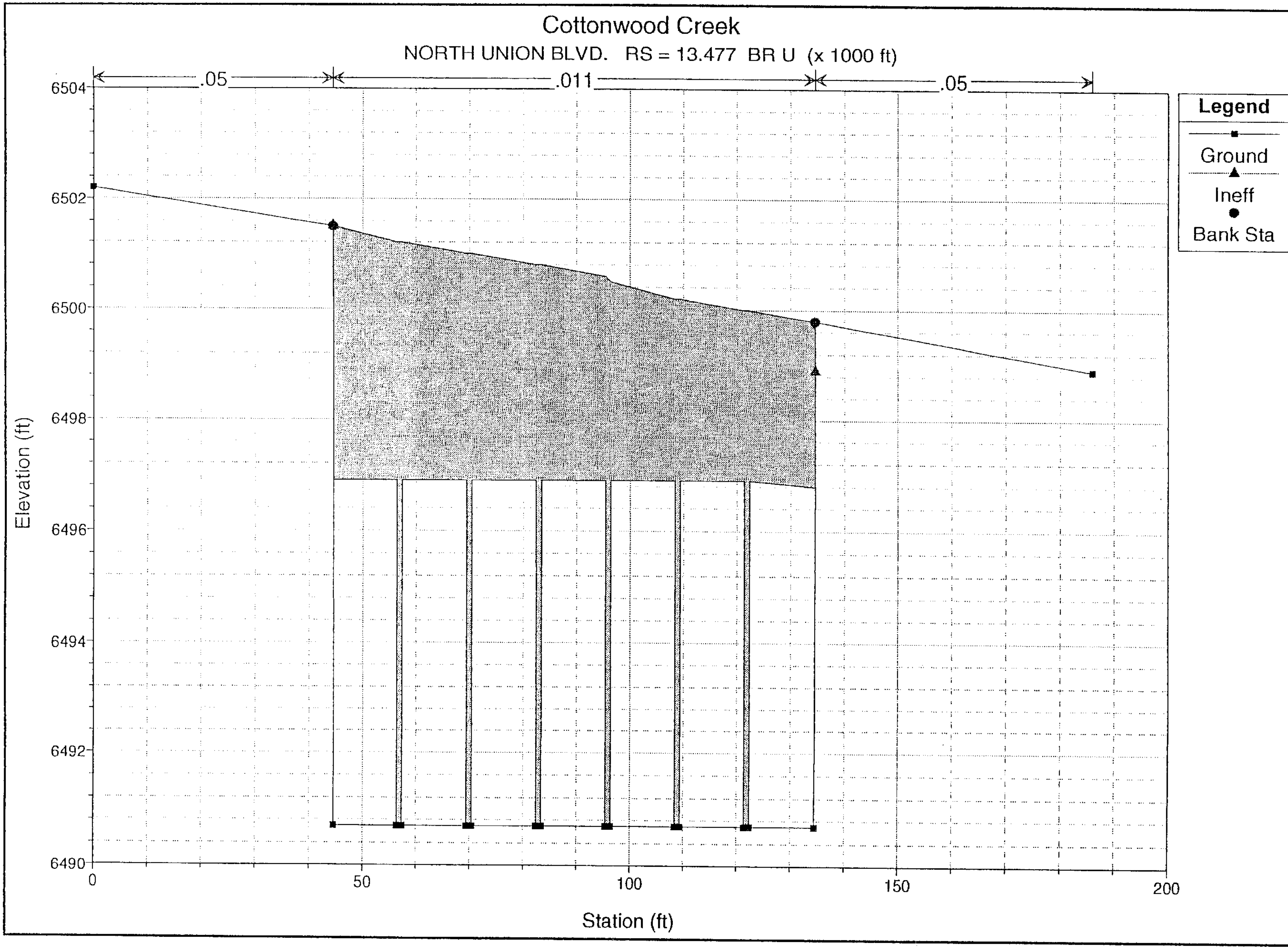
Cottonwood Creek
RS = 13.085 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6495
6490
6485
6480
6475
6470
0
20
40
60
80
100
120
140
Station (ft)


Cottonwood Creek
XS @ UPPER END OF HEAD-CUT RS = 13.385 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6505
6500
6495
6490
6485
6480
0
50
100
150
200
Station (ft)


Cottonwood Creek
XS @ D/S FACE OF NORTH UNION BLVD. RS = 13.431 (x 1000 ft)
.05
.011
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6504
6502
6500
6498
6496
6494
6492
6490
0
50
100
150
200
Station (ft)



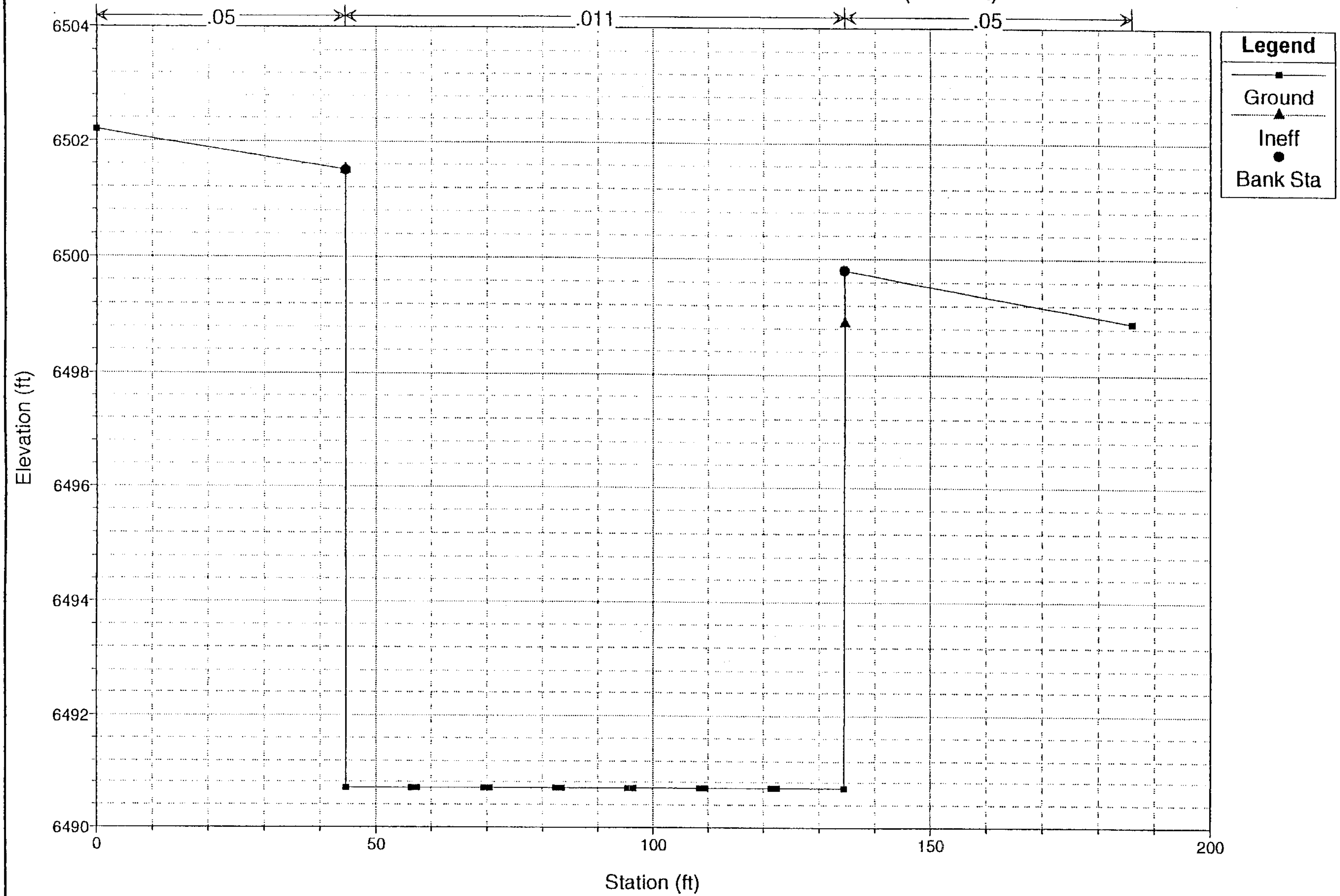
Cottonwood Creek
NORTH UNION BLVD. RS = 13.477 BR D (x 1000 ft)
.05
.011
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6504
6502
6500
6498
6496
6494
6492
6490
0
50
100
150
200
Station (ft)

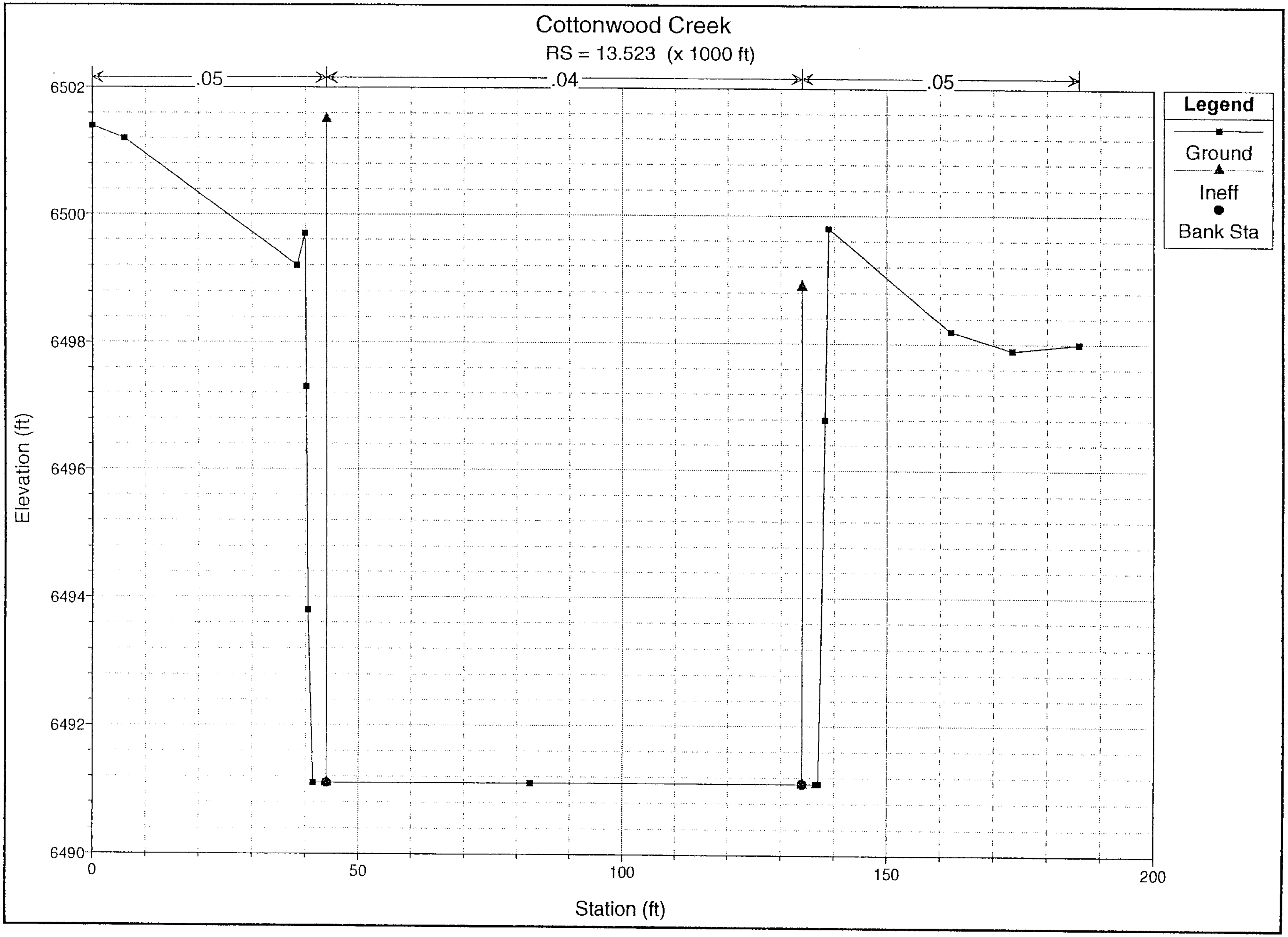


Cottonwood Creek
NORTH UNION BLVD. RS = 13.477 BR U (x 1000 ft)
.05
.011
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6504
6502
6500
6498
6496
6494
6492
6490
0
50
100
150
200
Station (ft)

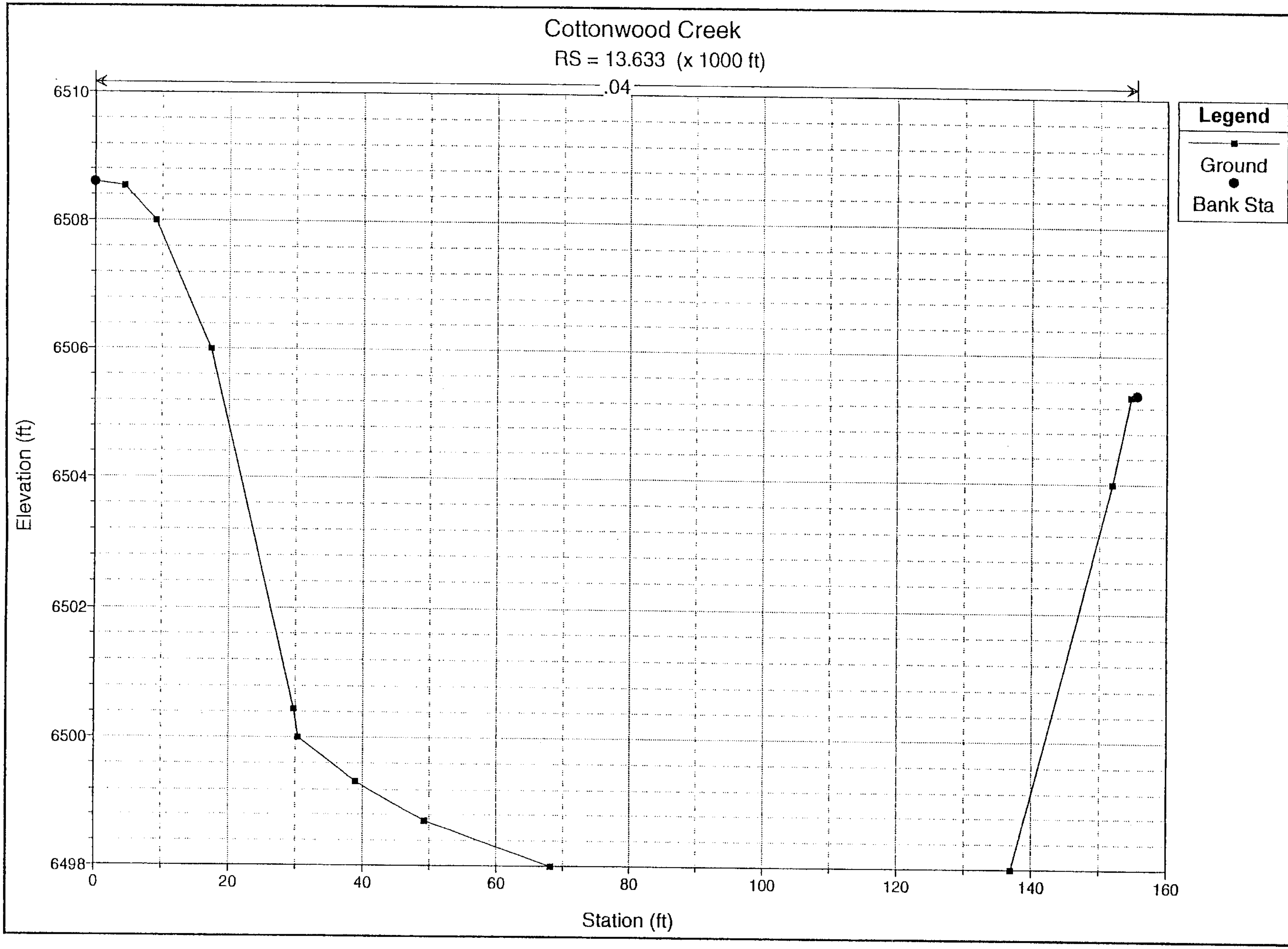
Cottonwood Creek

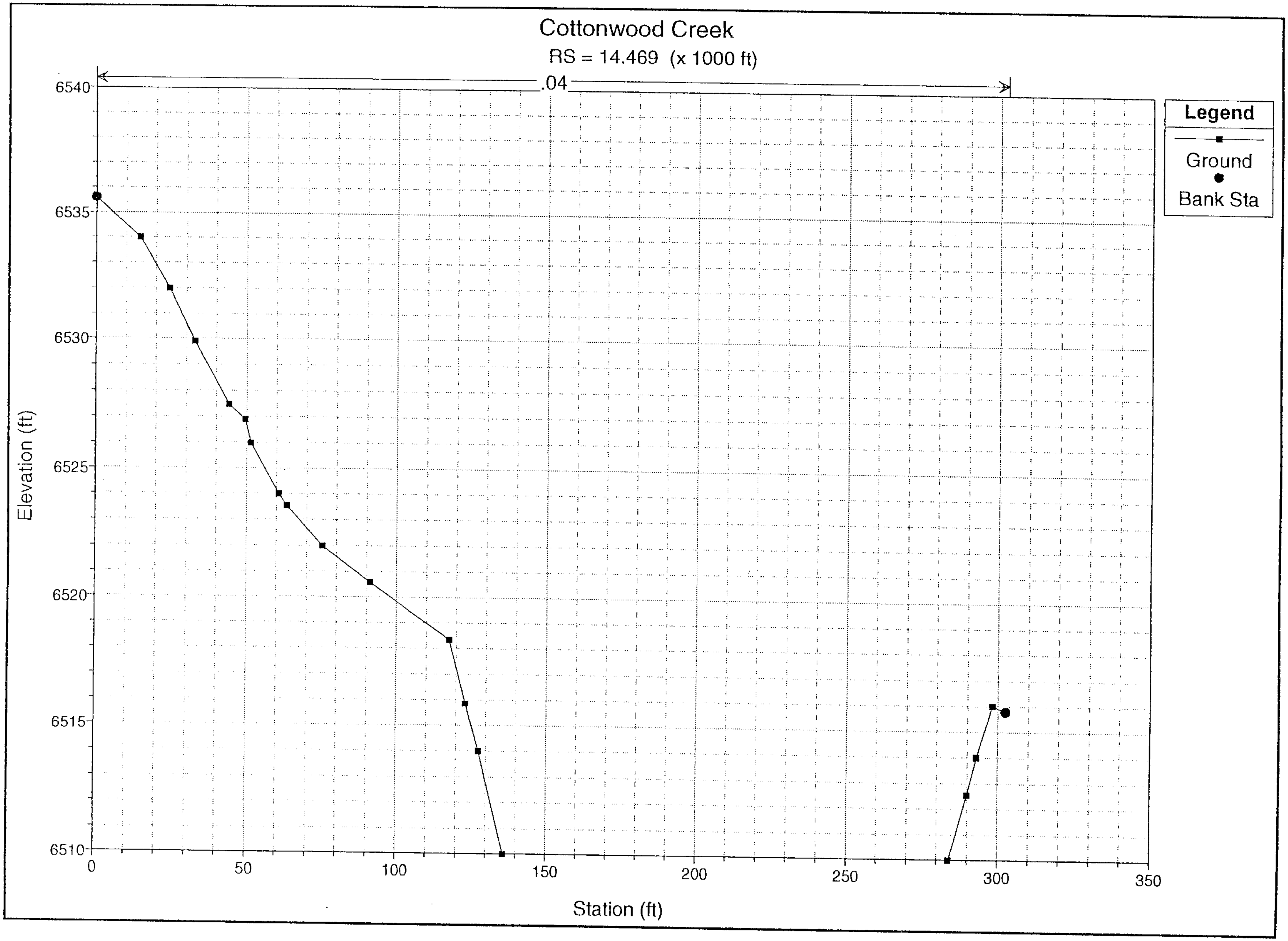
XS @ U/S FACE OF NORTH UNION BLVD. RS = 13.522 (x 1000 ft)



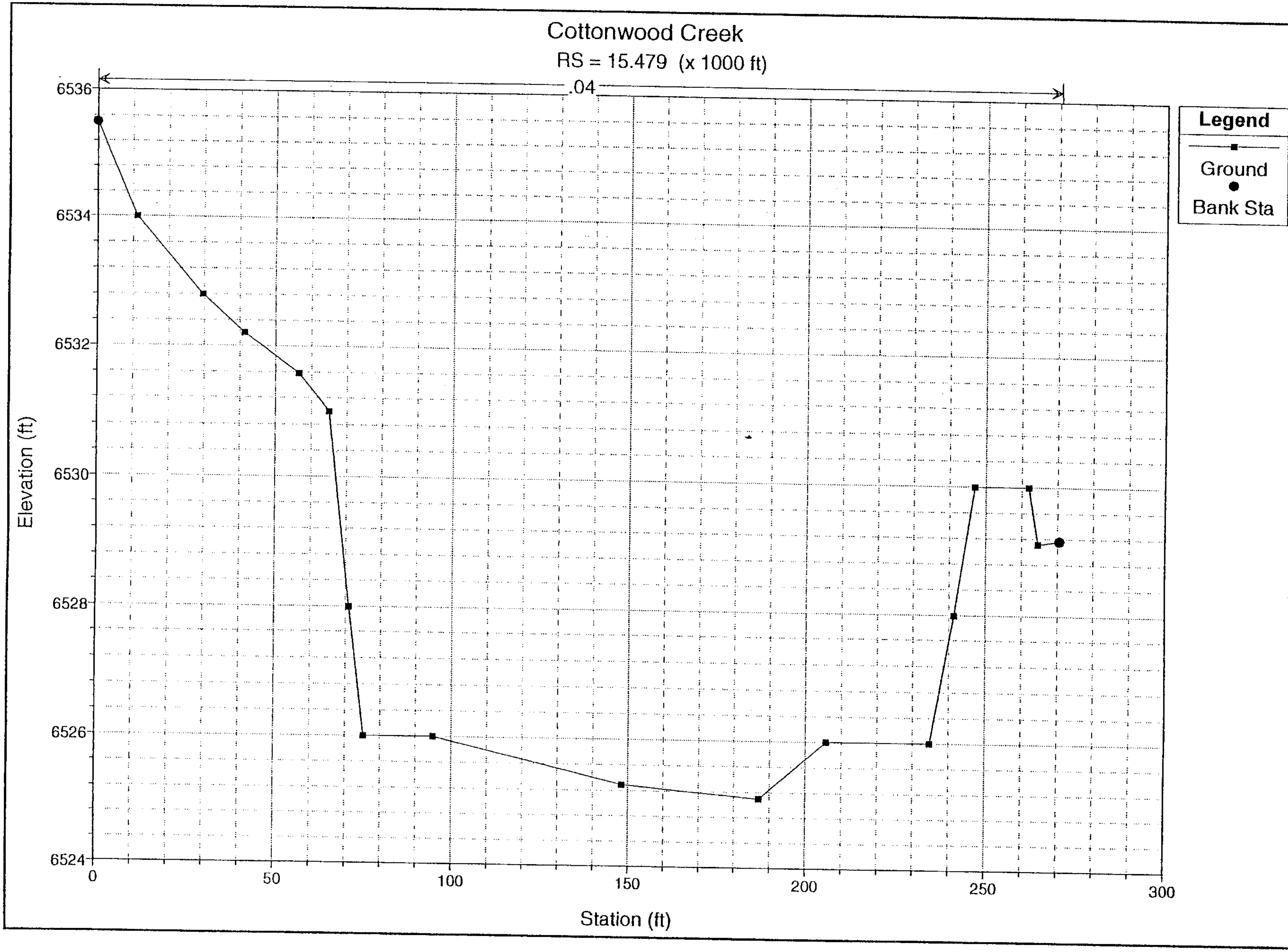


Cottonwood Creek
RS = 13.523 (x 1000 ft)
.05
.04
.05
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
6502
6500
6498
6496
6494
6492
6490
0
50
100
150
200
Station (ft)

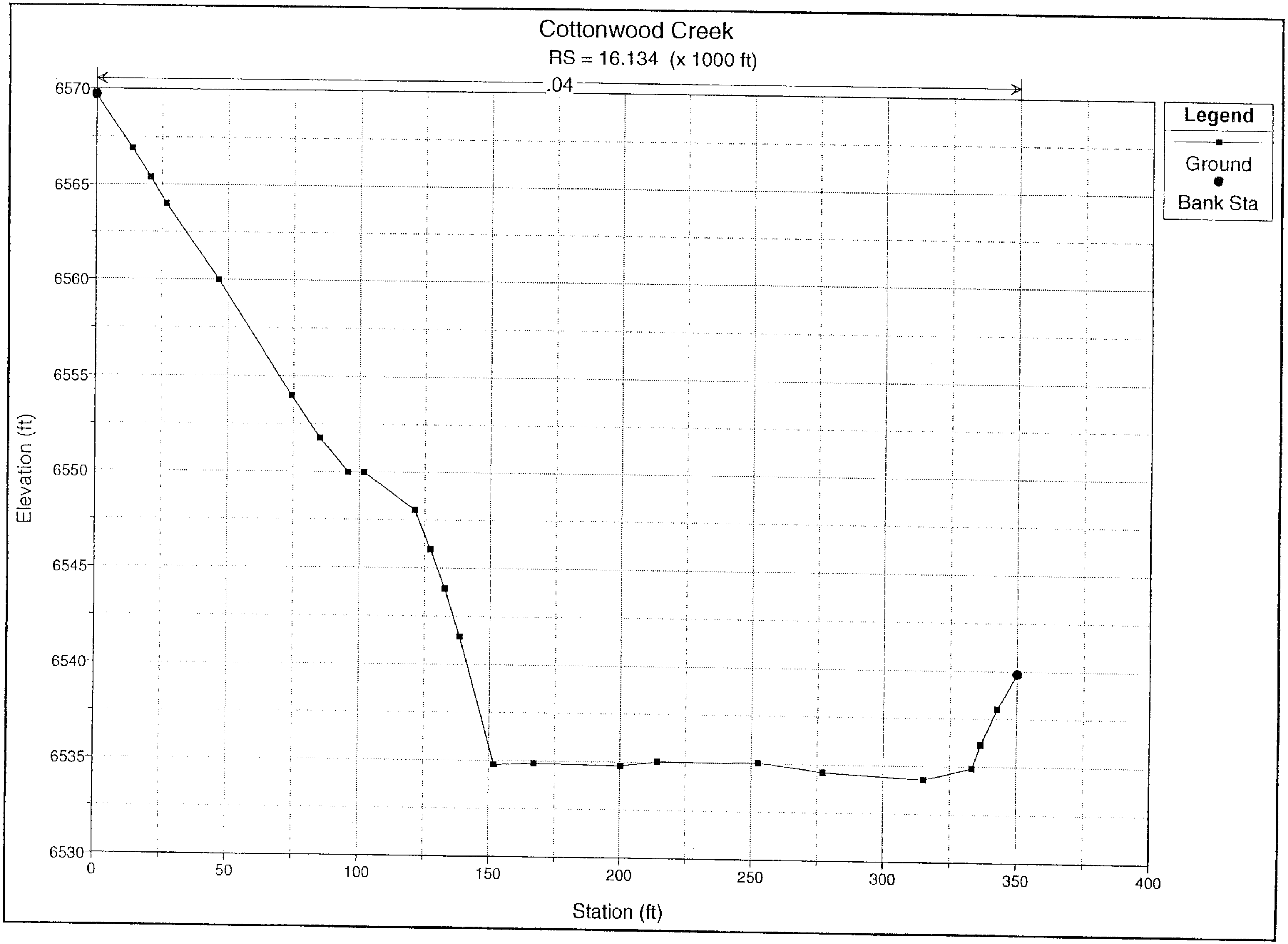

Cottonwood Creek
RS = 13.633 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6510
6508
6506
6504
6502
6500
6498
0
20
40
60
80
100
120
140
160
Station (ft)



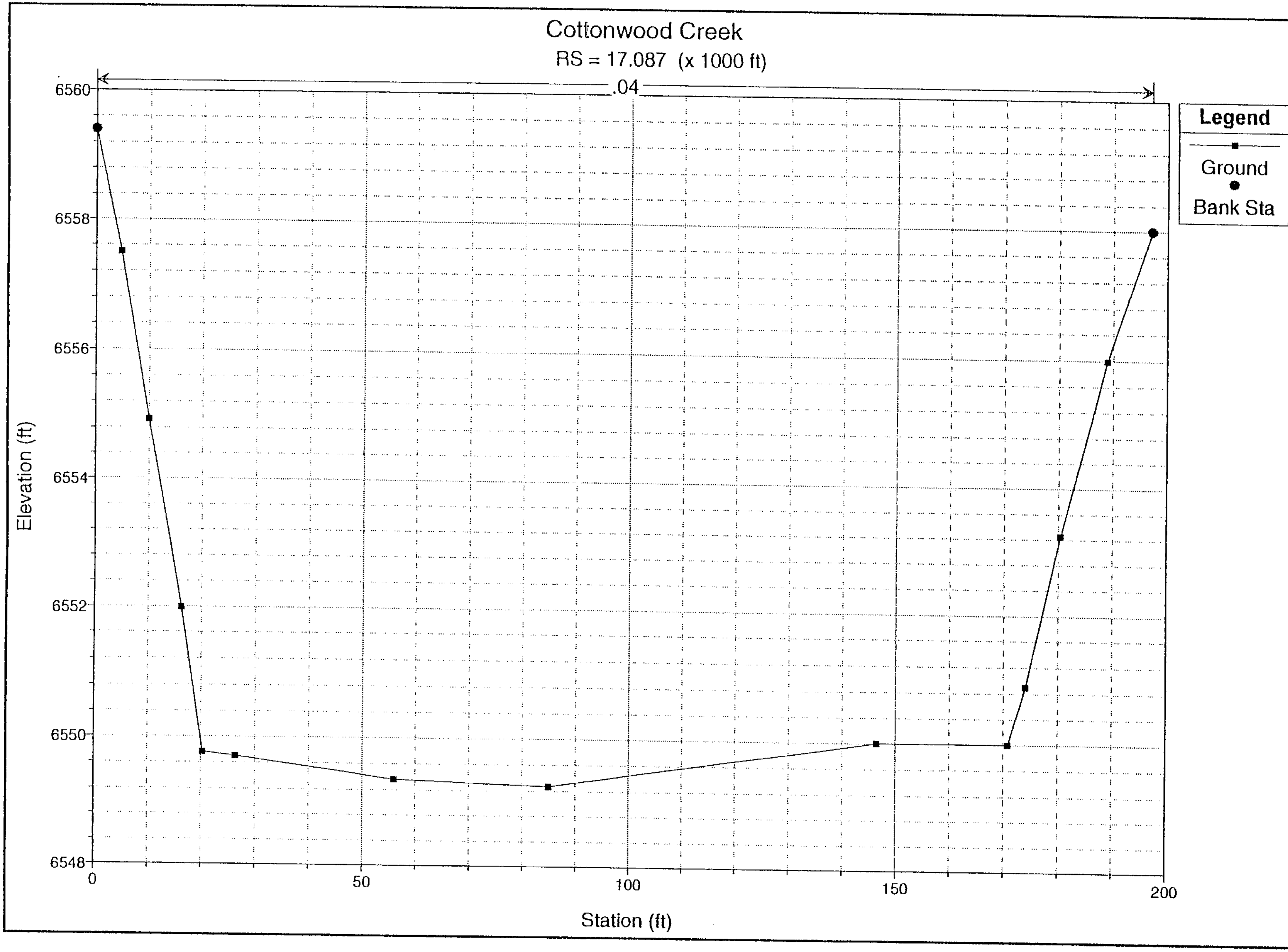
Cottonwood Creek
RS = 14.469 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6540
6535
6530
6525
6520
6515
6510
Station (ft)
0
50
100
150
200
250
300
350



Cottonwood Creek
RS = 15.479 (x 1000 ft)
.04
6536
6534
6532
6530
6528
6526
6524
Elevation (ft)
0
50
100
150
200
250
300
Station (ft)
Legend
Ground
Bank Sta



Cottonwood Creek
RS = 16.134 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6570
6565
6560
6555
6550
6545
6540
6535
6530
0
50
100
150
200
250
300
350
400
Station (ft)


Cottonwood Creek
RS = 17.087 (x 1000 ft)
.04
Legend
Ground
Bank Sta
Elevation (ft)
6560
6558
6556
6554
6552
6550
6548
0
50
100
150
200
Station (ft)