

## Concrete Pipe Backfill Heights<sup>i</sup>

### Round Pipe

| Pipe Size<br>(inches) | Pipe Class   |          |            |          |                    |         |                   |
|-----------------------|--|----------|------------|----------|--------------------|---------|-------------------|
|                       | Class I  | Class II | Class III  | Class IV | Class IV Alternate | Class V | Class V Alternate |
|                       | Round Reinforced Concrete Pipe Backfill Heights (feet) |          |            |          |                    |         |                   |
| 12                    |  |          | 1-16       | 16-24    |                    | 24-35   |                   |
| 15                    |  |          | 1-16       | 16-24    |                    | 24-35   |                   |
| 18                    |  |          | 1-16       | 16-24    |                    | 24-35   |                   |
| 21                    |  |          | 1-16       | 16-24    |                    | 24-35   |                   |
| 24                    |  |          | 1-16       | 16-24    |                    | 24-35   |                   |
| 27                    |  | 3-11     | 1-3, 11-16 | 16-24    |                    | 24-35   |                   |
| 30                    |  | 3-11     | 1-3, 11-16 | 16-24    |                    | 24-35   |                   |
| 33                    |  | 3-11     | 1-3, 11-16 | 16-24    |                    | 24-35   |                   |
| 36                    |  | 3-11     | 1-3, 11-16 | 16-24    |                    | 24-35   |                   |
| 42                    |  | 3-11     | 1-3, 11-16 | 16-24    |                    | 24-35   |                   |
| 48                    |  | 3-11     | 1-3, 11-16 | 16-24    |                    | 24-35   | 24-35             |
| 54                    |  | 3-11     | 1-3, 11-16 | 16-24    |                    | 24-35   | 24-35             |
| 60                    | 6-9  | 3-11     | 1-3, 11-16 | 16-24    | 16-24              | 24-35   | 24-35             |
| 66                    | 6-9  | 3-11     | 1-3, 11-16 | 16-24    | 16-24              | 24-35   | 24-35             |
| 72                    | 6-9  | 3-11     | 1-3, 11-16 | 16-24    | 16-24              | 24-35   | 24-35             |
| 78                    | 6-9  | 3-11     | 1-3, 11-16 | 16-24    | 16-24              |         | 24-35             |
| 84                    | 6-9  | 3-11     | 1-3, 11-16 | 16-24    | 16-24              |         | 24-35             |
| 90                    | 6-9  | 3-11     | 1-3, 11-16 |          | 16-24              |         | 24-35             |
| 96                    | 6-9  | 3-11     | 1-3, 11-16 |          | 16-24              |         | 24-35             |
| 102                   | 6-9  | 3-11     | 1-3, 11-16 |          | 16-24              |         | 24-35             |
| 108                   | 6-9  | 3-11     | 1-3, 11-16 |          | 16-24              |         | 24-35             |

| Backfill heights for Sewer Trench Conditions other than Class I |            |           |          |         |
|---|------------|-----------|----------|---------|
| Pipe Size   | Pipe class |           |          |         |
|   | Class II   | Class III | Class IV | Class V |
|   | FT         |           |          |         |
| 2" thru 54"   | 3-9        | 1-3, 9-13 | 13-23    | 23+     |
| 60" thru 108"   | 1-9        | 9-13      | 13-23    | 23+     |

<sup>i</sup> The Table is based on the following criteria:

1. Minimum cover shall be 12"
2. Minimum cover for unpaved roadways is from the top of gravel surfacing.
3. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Concrete Pipe Backfill Heights<sup>ii</sup>

### Arch Pipe

| Pipe Size   | Pipe Class   |              |                 |              |                 |              |
|-------------|--|--------------|-----------------|--------------|-----------------|--------------|
|             | Class II   |              | Class III       |              | Class IV        |              |
| Span - Rise | Normal Backfill  | Sewer Trench | Normal Backfill | Sewer Trench | Normal Backfill | Sewer Trench |
| (inches)    | Arch Reinforced Concrete Pipe Minimum and Maximum Cover Heights (feet) |              |                 |              |                 |              |
| 22x13       | 3-10   |              | 2-3, 10-14      | 2-13         | 1-2, 14-21      | 1-2, 13-50   |
| 29x18       | 3-10   | 4-6          | 2-3, 10-14      | 2-4, 6-12    | 1-2, 14-22      | 1-2, 12-26   |
| 36x23       | 3-10   | 3-7          | 1-3, 10-14      | 1-3, 7-13    | 14-22           | 13-25        |
| 44x27       | 2-10   | 2-8          | 1-2, 10-14      | 1-2, 8-13    | 14-22           | 13-25        |
| 51x31       | 1-10   | 2-8          | 10-15           | 8-14         | 15-22           | 14-25        |
| 58x36       | 1-10   | 1-8          | 10-15           | 8-14         | 15-22           | 14-25        |
| 65x40       | 1-11   | 1-8          | 11-15           | 8-12         | 15-22           | 12-21        |
| 73x45       | 1-11   | 1-8          | 11-15           | 8-12         | 15-22           | 12-21        |
| 88x54       | 1-12   | 1-9          | 12-15           | 9-13         | 15-23           | 13-22        |
| 102x62      | 1-12   | 1-9          | 12-16           | 9-14         | 16-23           | 14-22        |
| 115x72      | 1-14   | 1-13         | 14-17           | 13-16        | 17-24           | 16-24        |
| 122x78      | 1-14   | 1-13         | 14-17           | 13-16        | 17-24           | 16-24        |
| 138x88      | 1-14   | 1-14         | 14-18           | 14-17        | 18-25           | 17-25        |
| 154x97      | 1-15   | 1-14         | 15-19           | 14-17        | 19-25           | 17-25        |

<sup>ii</sup> The Table is based on the following criteria:

1. Minimum cover shall be 12"
2. Minimum cover for unpaved roadways is from the top of gravel surfacing.
3. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Concrete Pipe Backfill Heights<sup>iii</sup>

### Elliptical Pipe

| Minimum and Maximum Cover for Reinforced Concrete Horizontal Elliptical Culverts |      |                 |              |                 |              |                 |              |                 |              |                 |              |
|--|------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|
| Span   | Rise | Class A         |              | Class I         |              | Class II        |              | Class III       |              | Class IV        |              |
|  |      | Normal Backfill | Sewer Trench |
| inch   | inch | feet            | feet         |
| 91   | 58   | 1-4             | 1-2          | 4-6             | 2-4          | 6-12            | 4-9          | 12-15           | 9-13         | 15-23           | 13-22        |
| 98   | 63   | 1-4             | 1-2          | 4-6             | 2-5          | 6-12            | 5-9          | 12-15           | 9-14         | 15-23           | 14-22        |
| 106  | 68   | 1-4             | 1-3          | 4-7             | 3-5          | 7-12            | 5-9          | 12-16           | 9-14         | 16-23           | 14-22        |
| 113  | 72   | 1-5             | 1-3          | 5-8             | 3-5          | 8-12            | 5-9          | 12-16           | 9-14         | 16-23           | 14-23        |
| 121  | 77   | 1-5             | 1-3          | 5-8             | 3-5          | 8-13            | 5-9          | 13-16           | 9-14         | 16-23           | 14-23        |
| 128  | 82   | 1-5             | 1-3          | 5-8             | 3-6          | 8-13            | 6-10         | 13-17           | 10-14        | 17-23           | 14-23        |
| 136  | 87   | 1-5             | 1-4          | 5-8             | 4-6          | 8-13            | 6-10         | 13-17           | 10-14        | 17-23           | 14-23        |

- Fill heights in Class IV shown for information purposes only.

<sup>iii</sup> The Table is based on the following criteria:

1. Minimum cover shall be 12"
2. Minimum cover for unpaved roadways is from the top of gravel surfacing.
3. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>iv</sup>

### Round Pipe

|   |                              | 2-2/3" x 1/2" Corrugations    |       |       |       |       |
|---|------------------------------|-------------------------------|-------|-------|-------|-------|
| Pipe Size<br>(inches)                         | Minimum<br>cover<br>(inches) | Steel Thickness (gauge)       |       |       |       |       |
|   |                              | 16                            | 14    | 12    | 10    | 8     |
|   |                              | Galvanized Thickness (inches) |       |       |       |       |
|   |                              | 0.064                         | 0.079 | 0.109 | 0.138 | 0.168 |
| Corrugated Steel Pipe Backfill Heights (feet) |                              |                               |       |       |       |       |
| 12  | 12                           | 219                           | 273   |       |       |       |
| 15  | 12                           | 183                           | 228   | 255   |       |       |
| 18  | 12                           | 146                           | 182   | 191   |       |       |
| 24  | 12                           | 109                           | 137   | 191   |       |       |
| 30  | 12                           | 87                            | 108   | 153   |       |       |
| 36  | 12                           | 73                            | 91    | 127   | 164   |       |
| 42  | 12                           | 62                            | 78    | 109   | 141   | 172   |
| 48  | 12                           | 55                            | 68    | 96    | 123   | 150   |
| 54  | 12                           |                               | 61    | 85    | 109   | 134   |
| 60  | 12                           |                               |       | 76    | 98    | 120   |
| 66  | 12                           |                               |       |       | 89    | 109   |
| 72  | 12                           |                               |       |       | 82    | 100   |
| 78  | 12                           |                               |       |       |       | 89    |
| 84  | 12                           |                               |       |       |       | 77    |

<sup>iv</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor = 0.043
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>v</sup>

### Round Pipe

|   |                              | 3" x 1" Corrugations          |       |       |       |       |
|---|------------------------------|-------------------------------|-------|-------|-------|-------|
| Pipe Size<br>(inches)                         | Minimum<br>cover<br>(inches) | Steel Thickness (gauge)       |       |       |       |       |
|   |                              | 16                            | 14    | 12    | 10    | 8     |
|   |                              | Galvanized Thickness (inches) |       |       |       |       |
|   |                              | 0.064                         | 0.079 | 0.109 | 0.138 | 0.168 |
| Corrugated Steel Pipe Backfill Heights (feet) |                              |                               |       |       |       |       |
| 48  | 12                           | 63                            | 78    | 110   | 142   | 173   |
| 54  | 12                           | 56                            | 70    | 98    | 126   | 154   |
| 60  | 12                           | 50                            | 63    | 88    | 113   | 139   |
| 66  | 12                           | 46                            | 57    | 80    | 103   | 126   |
| 72  | 12                           | 42                            | 52    | 73    | 94    | 116   |
| 78  | 12                           | 39                            | 48    | 68    | 87    | 107   |
| 84  | 12                           | 36                            | 45    | 63    | 81    | 99    |
| 90  | 12                           | 33                            | 42    | 59    | 76    | 92    |
| 96  | 12                           |                               | 39    | 55    | 71    | 87    |
| 102   | 24                           |                               | 37    | 52    | 67    | 82    |
| 108   | 24                           |                               |       | 49    | 63    | 77    |
| 114   | 24                           |                               |       | 46    | 60    | 73    |
| 120   | 24                           |                               |       | 44    | 57    | 69    |

<sup>v</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor = 0.033
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>vi</sup>

### Round Pipe

|   |                              | 5" x 1" Corrugations          |       |       |       |       |
|---|------------------------------|-------------------------------|-------|-------|-------|-------|
| Pipe Size<br>(inches)                         | Minimum<br>cover<br>(inches) | Steel Thickness (gauge)       |       |       |       |       |
|   |                              | 16                            | 14    | 12    | 10    | 8     |
|   |                              | Galvanized Thickness (inches) |       |       |       |       |
|   |                              | 0.064                         | 0.079 | 0.109 | 0.138 | 0.168 |
| Corrugated Steel Pipe Backfill Heights (feet) |                              |                               |       |       |       |       |
| 48  | 12                           | 56                            | 70    | 98    | 126   | 154   |
| 54  | 12                           | 50                            | 62    | 87    | 112   | 137   |
| 60  | 12                           | 45                            | 56    | 78    | 101   | 123   |
| 66  | 12                           | 41                            | 51    | 71    | 92    | 112   |
| 72  | 12                           | 37                            | 47    | 65    | 84    | 103   |
| 78  | 12                           | 34                            | 43    | 60    | 78    | 95    |
| 84  | 12                           | 32                            | 40    | 56    | 72    | 88    |
| 90  | 12                           | 30                            | 37    | 52    | 67    | 82    |
| 96  | 12                           |                               | 35    | 49    | 63    | 77    |
| 102   | 24                           |                               | 33    | 46    | 59    | 73    |
| 108   | 24                           |                               |       | 44    | 56    | 69    |
| 114   | 24                           |                               |       | 41    | 53    | 65    |
| 120   | 24                           |                               |       | 39    | 50    | 62    |

<sup>vi</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor = 0.033
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>vii</sup>

### Round Pipe

| 3/4" x 3/4" Rib @ 7-1/2"                      |                              |                               |       |       |       |
|---|------------------------------|-------------------------------|-------|-------|-------|
| Pipe Size<br>(inches)                         | Minimum<br>cover<br>(inches) | Steel thickness (gauge)       |       |       |       |
|   |                              | 16                            | 14    | 12    | 10    |
|   |                              | Galvanized Thickness (inches) |       |       |       |
|   |                              | 0.064                         | 0.079 | 0.109 | 0.138 |
| Corrugated Steel Pipe Backfill Heights (feet) |                              |                               |       |       |       |
| 15  | 12                           | 130                           | 182   | 302   |       |
| 18  | 12                           | 108                           | 151   | 252   |       |
| 24  | 12                           | 72                            | 100   | 167   |       |
| 30  | 12                           | 57                            | 80    | 134   |       |
| 36  | 12                           | 48                            | 67    | 111   |       |
| 42  | 12                           | 41                            | 57    | 95    |       |
| 48  | 12                           | 36                            | 50    | 83    |       |
| 54  | 18                           |                               | 45    | 74    |       |
| 60  | 18                           |                               | 40    | 67    | 97    |
| 66  | 18                           |                               |       | 61    | 88    |
| 72  | 18                           |                               |       | 56    | 81    |
| 78  | 24                           |                               |       | 51    | 75    |

<sup>vii</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor =  $0.0217 I^{1/3}$
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>viii</sup>

### Round Pipe

| 3/4" x 1" Rib @ 11-1/2"                       |                              |                               |       |       |
|---|------------------------------|-------------------------------|-------|-------|
| Pipe Size<br>(inches)                         | Minimum<br>cover<br>(inches) | Steel thickness (gauge)       |       |       |
|   |                              | 16                            | 14    | 12    |
|   |                              | Galvanized Thickness (inches) |       |       |
|   |                              | 0.064                         | 0.079 | 0.109 |
| Corrugated Steel Pipe Backfill Heights (feet) |                              |                               |       |       |
| 15  | 12                           | 95                            | 134   | 225   |
| 18  | 12                           | 79                            | 111   | 188   |
| 24  | 12                           | 53                            | 74    | 125   |
| 30  | 12                           | 42                            | 59    | 100   |
| 36  | 12                           | 35                            | 49    | 83    |
| 42  | 12                           | 30                            | 42    | 71    |
| 48  | 12                           | 26                            | 37    | 62    |
| 54  | 18                           | 23                            | 33    | 55    |
| 60  | 18                           |                               | 30    | 50    |
| 66  | 18                           |                               | 27    | 45    |
| 72  | 18                           |                               |       | 42    |

<sup>viii</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor =  $0.140 I^{1/3}$
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>ix</sup>

### Arch Pipe

| 2 2/3" x 1/2" Corrugations                    |      |      |                              |                               |       |       |       |       |
|---|------|------|------------------------------|-------------------------------|-------|-------|-------|-------|
| Equivalent<br>Pipe<br>Diameter                | Span | Rise | Minimum<br>Cover<br>(inches) | Steel Thickness (gauge)       |       |       |       |       |
|   |      |      |                              | 16                            | 14    | 12    | 10    | 8     |
|   |      |      |                              | Galvanized Thickness (inches) |       |       |       |       |
| Inches  |      |      |                              | 0.064                         | 0.079 | 0.109 | 0.138 | 0.168 |
| Corrugated Steel Pipe Backfill Heights (feet) |      |      |                              |                               |       |       |       |       |
| 15  | 17   | 13   | 18                           | 14                            |       |       |       |       |
| 18  | 21   | 15   | 18                           | 13                            |       |       |       |       |
| 21  | 24   | 18   | 18                           | 14                            |       |       |       |       |
| 24  | 28   | 20   | 18                           | 13                            |       |       |       |       |
| 30  | 35   | 24   | 18                           | 13                            |       |       |       |       |
| 36  | 42   | 29   | 18                           | 13                            |       |       |       |       |
| 42  | 49   | 33   | 18                           |                               | 13    |       |       |       |
| 48  | 57   | 38   | 18                           |                               |       | 13    |       |       |
| 54  | 64   | 43   | 18                           |                               |       | 13    |       |       |
| 60  | 71   | 47   | 18                           |                               |       |       | 13    |       |
| 66  | 77   | 52   | 18                           |                               |       |       |       | 13    |
| 72  | 83   | 57   | 18                           |                               |       |       |       | 13    |

<sup>ix</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor = 0.043
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>x</sup>

### Arch Pipe

| 3" x 1" Corrugations           |      |      |                              |   |       |       |       |
|--------------------------------|------|------|------------------------------|---|-------|-------|-------|
| Equivalent<br>Pipe<br>Diameter | Span | Rise | Minimum<br>Cover<br>(inches) | Steel Thickness (gauge)                       |       |       |       |
|                                |      |      |                              | 14  | 12    | 10    | 8     |
|                                |      |      |                              | Galvanized Thickness (inches)                 |       |       |       |
|                                |      |      |                              | 0.079   | 0.109 | 0.138 | 0.168 |
| Inches                         |      |      |                              | Corrugated Steel Pipe Backfill Heights (feet) |       |       |       |
| 48                             | 53   | 41   |                              | 18  | 21    |       |       |
| 54                             | 60   | 46   | 18                           | 21  |       |       |       |
| 60                             | 66   | 51   | 18                           | 21  |       |       |       |
| 66                             | 73   | 55   | 18                           | 21  |       |       |       |
| 72                             | 81   | 59   | 18                           | 18  |       |       |       |
| 78                             | 87   | 63   | 18                           | 17  |       |       |       |
| 84                             | 95   | 67   | 18                           | 17  |       |       |       |
| 90                             | 103  | 71   | 18                           |   | 17    |       |       |
| 96                             | 112  | 75   | 18                           |   | 17    |       |       |
| 102                            | 117  | 79   | 24                           |   | 17    |       |       |
| 108                            | 128  | 83   | 24                           |   |       | 16    |       |
| 114                            | 137  | 87   | 24                           |   |       | 16    |       |
| 120                            | 142  | 91   | 24                           |   |       |       | 16    |

<sup>x</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor = 0.033
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>xi</sup>

### Arch Pipe

| 5" x 1" Corrugations           |      |      |   |                               |       |       |       |
|--------------------------------|------|------|---|-------------------------------|-------|-------|-------|
| Equivalent<br>Pipe<br>Diameter | Span | Rise | Minimum<br>Cover<br>(inches)                  | Steel Thickness (gauge)       |       |       |       |
|                                |      |      |   | 14                            | 12    | 10    | 8     |
|                                |      |      |   | Galvanized Thickness (inches) |       |       |       |
|                                |      |      |   | 0.079                         | 0.109 | 0.138 | 0.168 |
| Inches                         |      |      | Corrugated Steel Pipe Backfill Heights (feet) |                               |       |       |       |
| 48                             | 53   | 41   | 12  |                               | 21    |       |       |
| 54                             | 60   | 46   | 12  |                               | 21    |       |       |
| 60                             | 66   | 51   | 12  |                               | 21    |       |       |
| 66                             | 73   | 55   | 12  |                               | 21    |       |       |
| 72                             | 81   | 59   | 12  |                               | 18    |       |       |
| 78                             | 87   | 63   | 12  |                               | 17    |       |       |
| 84                             | 95   | 67   | 12  |                               | 17    |       |       |
| 90                             | 103  | 71   | 18  |                               | 17    |       |       |
| 96                             | 112  | 75   | 18  |                               | 17    |       |       |
| 102                            | 117  | 79   | 18  |                               | 17    |       |       |
| 108                            | 128  | 83   | 24  |                               |       | 16    |       |
| 114                            | 137  | 87   | 24  |                               |       | 16    |       |
| 120                            | 142  | 91   | 24  |                               |       |       | 16    |

<sup>xi</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor = 0.033
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>xii</sup>

### Arch Pipe

| 3/4" x 3/4" Rib @ 7-1/2"       |      |      |                              |   |       |       |       |
|--------------------------------|------|------|------------------------------|---|-------|-------|-------|
| Equivalent<br>Pipe<br>Diameter | Span | Rise | Minimum<br>Cover<br>(inches) | Steel Thickness (gauge)                       |       |       |       |
|                                |      |      |                              | 16  | 14    | 12    | 10    |
|                                |      |      |                              | Galvanized Thickness (inches)                 |       |       |       |
|                                |      |      |                              | 0.064   | 0.079 | 0.109 | 0.138 |
| Inches                         |      |      |                              | Corrugated Steel Pipe Backfill Heights (feet) |       |       |       |
| 18                             | 20   | 16   | 12                           | 16  |       |       |       |
| 21                             | 23   | 19   | 12                           | 15  |       |       |       |
| 24                             | 27   | 21   | 12                           | 14  |       |       |       |
| 30                             | 33   | 26   | 12                           | 14  |       |       |       |
| 36                             | 40   | 31   | 12                           | 14  |       |       |       |
| 42                             | 46   | 36   | 12                           | 14  |       |       |       |
| 48                             | 53   | 41   | 18                           |   | 14    |       |       |
| 54                             | 60   | 46   | 18                           |   | 21    |       |       |
| 60                             | 66   | 51   | 18                           |   |       | 21    |       |
| 66                             | 73   | 55   | 18                           |   |       | 21    |       |
| 72                             | 81   | 59   | 20                           |   |       |       | 18    |
| 78                             | 87   | 63   | 22                           |   |       |       | 17    |
| 84                             | 95   | 67   | 24                           |   |       |       | 17    |

<sup>xii</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor =  $0.0217 I^{1/3}$
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Steel Pipe Backfill Heights<sup>xiii</sup>

### Arch Pipe

| 3/4" x 1" Rib @ 11-1/2"        |      |      |                              |   |       |       |
|--------------------------------|------|------|------------------------------|---|-------|-------|
| Equivalent<br>Pipe<br>Diameter | Span | Rise | Minimum<br>Cover<br>(inches) | Steel Thickness (gauge)                       |       |       |
|                                |      |      |                              | 16  | 14    | 12    |
|                                |      |      |                              | Galvanized Thickness (inches)                 |       |       |
|                                |      |      |                              | 0.064   | 0.079 | 0.109 |
| Inches                         |      |      |                              | Corrugated Steel Pipe Backfill Heights (feet) |       |       |
| 18                             | 20   | 16   | 12                           | 16  | 21    |       |
| 21                             | 23   | 19   | 12                           | 15  | 21    |       |
| 24                             | 27   | 21   | 12                           | 14  | 21    |       |
| 30                             | 33   | 26   | 12                           | 14  | 21    |       |
| 36                             | 40   | 31   | 12                           | 14  | 18    |       |
| 42                             | 46   | 36   | 12                           | 14  | 17    |       |
| 48                             | 53   | 41   | 18                           | 14  | 17    |       |
| 54                             | 60   | 46   | 18                           |   | 21    |       |
| 60                             | 66   | 51   | 18                           |   |       | 21    |

<sup>xiii</sup> The Table is based on the following criteria (ASTM/ASSHTO embankment)

1. Pipe Type = Helical
2. Design Method = LRFD
3. Fill Density = 120pcf (prism above pipe)
4. Flexibility factor =  $0.140 I^{1/3}$
5. Safety Factor on Wall Area = 2.00
6. Safety Factor on Buckling = 2.00 based on equations of AASHTO/ASTM
7. Seam Strength check not required for helical pipe
8. Minimum Fill height taken as Span/8 but not less than 12"
9. Minimum cover for unpaved roadways is from the top of gravel surfacing.
10. Minimum cover for paved roadways is:
  - a) To the top of the base for asphalt surfaces
  - b) To the top of the pavement for concrete surfaces

## Corrugated Aluminum Pipe Backfill Heights

### Round Pipe

| 2 2/3" x 1/2" Corrugations                       |                              |                               |       |       |       |       |
|--|------------------------------|-------------------------------|-------|-------|-------|-------|
| Pipe Size<br>(inches)                            | Minimum<br>cover<br>(inches) | Aluminium Thickness (gauge)   |       |       |       |       |
|  |                              | 16                            | 14    | 12    | 10    | 8     |
|  |                              | Galvanized Thickness (inches) |       |       |       |       |
|  |                              | 0.060                         | 0.075 | 0.105 | 0.135 | 0.164 |
| Corrugated Aluminum Pipe Backfill Heights (feet) |                              |                               |       |       |       |       |
| 18   | 12                           | 30                            | 30    | 52    | 54    | 56    |
| 24   | 12                           | 22                            | 22    | 39    | 41    | 42    |
| 30   | 12                           | 18                            | 18    | 31    | 32    | 34    |
| 36   | 12                           | 15                            | 15    | 26    | 27    | 28    |
| 42   | 12                           |                               | 26    | 43    | 43    | 44    |
| 48   | 12                           |                               |       | 40    | 41    | 43    |
| 54   | 12                           |                               |       | 35    | 37    | 38    |
| 60   | 12                           |                               |       |       | 33    | 34    |
| 66   | 12                           |                               |       |       | 30    | 31    |
| 72   | 12                           |                               |       |       |       | 29    |

### Arch Pipe

| 2 2/3" by 1/2" Corrugations                   |                              |                |                |                              |                               |       |       |       |       |  |
|---|------------------------------|----------------|----------------|------------------------------|-------------------------------|-------|-------|-------|-------|--|
| Pipe Size<br>(inches)                         | Minimum<br>cover<br>(inches) | Span<br>Inches | Rise<br>Inches | Minimum<br>cover<br>(inches) | Aluminium Thickness (gauge)   |       |       |       |       |  |
|   |                              |                |                |                              | 16                            | 14    | 12    | 10    | 8     |  |
|   |                              |                |                |                              | Galvanized Thickness (inches) |       |       |       |       |  |
|   |                              |                |                |                              | 0.060                         | 0.075 | 0.105 | 0.135 | 0.164 |  |
| Corrugated Steel Pipe Backfill Heights (feet) |                              |                |                |                              |                               |       |       |       |       |  |
| 18  | 12                           | 18             | 11             | 18                           | 51                            |       |       |       |       |  |
| 24  | 12                           | 22             | 13             | 18                           | 14                            |       |       |       |       |  |
| 30  | 12                           | 25             | 16             | 18                           | 12                            |       |       |       |       |  |
| 36  | 12                           | 29             | 18             | 18                           | 10                            |       |       |       |       |  |
| 42  | 12                           | 36             | 22             | 18                           | 9                             |       |       |       |       |  |
| 48  | 12                           | 43             | 27             | 18                           |                               | 9     |       |       |       |  |
| 54  | 12                           | 50             | 31             | 18                           |                               |       | 8     |       |       |  |
| 60  | 12                           | 58             | 36             | 18                           |                               |       |       | 8     |       |  |

## Polypropylene Pipe Backfill Heights

### Round Pipe – Type S

| Pipe Size<br>(inches) | Minimum<br>cover<br>(inches) | Maximum<br>Fill Height<br>(feet) |
|-----------------------|------------------------------|----------------------------------|
| 12                    | 12                           | 20                               |
| 15                    | 12                           | 20                               |
| 18                    | 12                           | 20                               |
| 21                    | 12                           | 20                               |
| 24                    | 12                           | 20                               |
| 30                    | 12                           | 20                               |
| 36                    | 12                           | 20                               |