Florida
**Concrete Pipe**
Association

# Safety & Cost Improvements

## When Specifying RCP Accordingly

January 11, 2022

# Douglas Holdener, P.E.

- Director
  Florida Concrete Pipe Association
- 25 yrs. Civil Engineering Experience
  - Consultant (7 yrs)
  - Concrete Pipe Producer (12 yrs)
  - Florida Power & Light Contractor (1 yr)
  - Concrete Pipe Association (5 yrs)
- Texas A&M University (M.S. Civ. Eng.)
- Washington University in St. Louis (B.S. Civ. Eng.)
- ASCE
  - FL Report Card (Ports & Energy)
  - Legislative Calls / Support
  - Raised $1,000s for Student Chapters
- Jupiter Farms


COUNTY MATERIALS CORPORATION
countymaterials.com

FORTERRA™
forterrabp.com

Rinker MATERIALS™
rinkerpipe.com

Florida
**Concrete Pipe**
Association


Cheyenne


EVACUATION
ROUTE
30
Florida is impacted by tropical storms more than any other state. The 2020 season yielded 30 named tropical storms. Since 1850, Florida has been hit by over 120 hurricanes.
#5
Ranked 5th highest, since 2002, nearly 35,000 acres have burned from wildfires in Florida. Incredibly, some storm pipe products are prone to melting, but not concrete pipe.
117
YEARS
Precast reinforced concrete pipe was first used in the USA in 1905. With over a century of proven performance, it is the most resilient pipe available.
21.5
MILLION
Population of Florida

# Safety & Cost Improvements
## When Using Concrete Pipe*

- ❑* When Specifying Accordingly and When Supported by Design Basis
- ❑Improving Safety for Men & Women in Trenches
- ❑Reducing Construction / Backfill Schedule
- ❑More Efficient Geotechnical / Density Testing
- ❑More Judicious Use of Soil Materials / Transportation
- ❑F.S 403.9302
  - ❑ Mentioned at Joint Societies Legislative Breakfast (Dec. 2021)
  - ❑ 20-Year Needs Analysis for Stormwater

# 20-Year Needs Analyses

- F.S. 403.9301 – Wastewater
- F.S. 403.9302 – Stormwater
- Originally H.B. 53
  - Sponsor: Rep. DiCeglie (Pinellas)
  - Co-Sponsors: Fischer (Duval); McClain (Marion); Overdorf (St. Lucie, Martin); and Roth (Palm Beach)
  - Initially: Procurement of Construction Services / Public Works
  - Late-April: Needs Analyses
  - June 29, ‘21 – Approved by Governor DeSantis

CHAPTER 2021-194

Committee Substitute for Committee Substitute for
Committee Substitute for House Bill No. 53

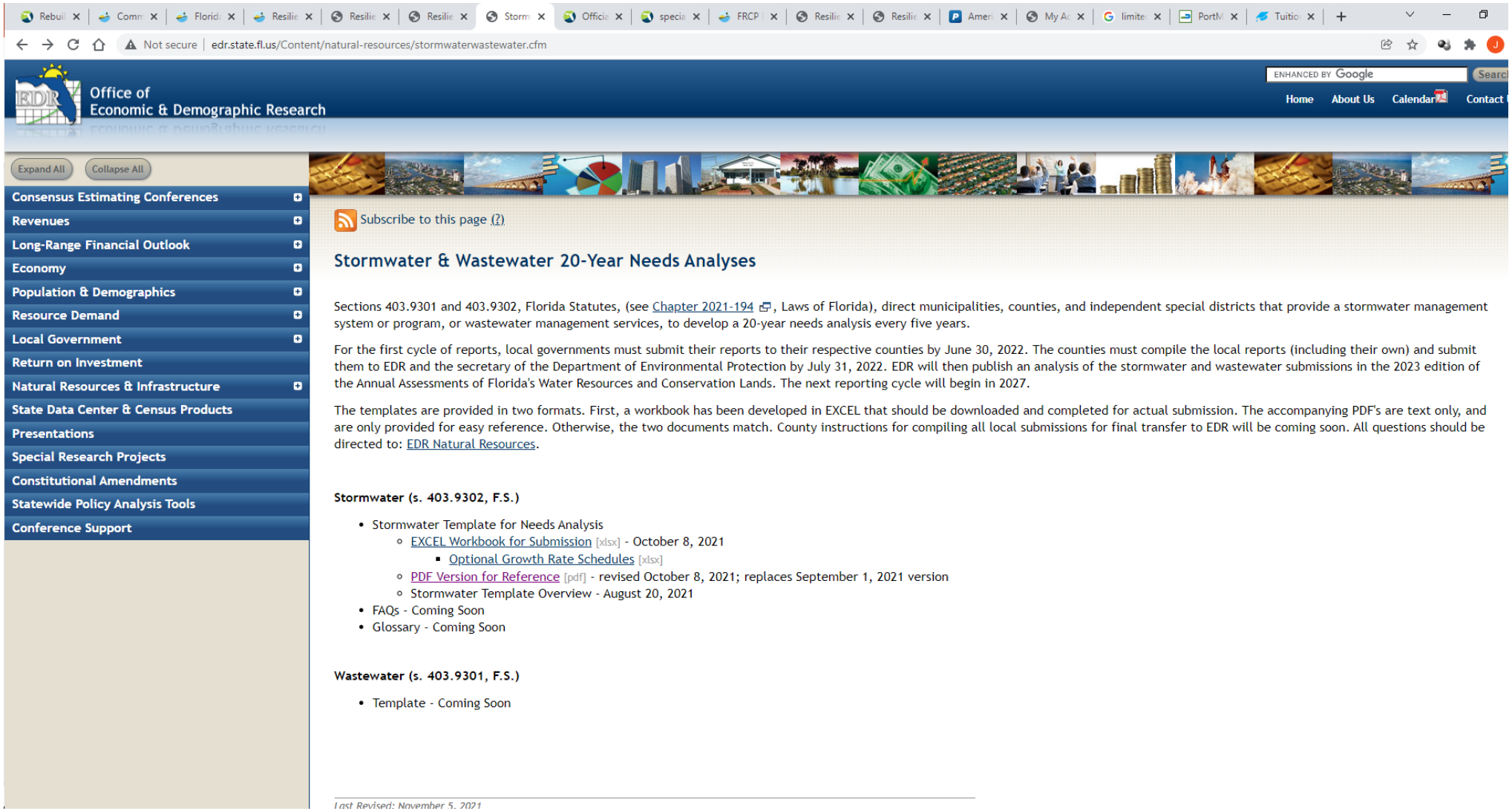
An act relating to public works; amending s. 255.0991, F.S.; revising a prohibition relating to any solicitation for construction services paid for with state appropriated funds; amending s. 255.0992, F.S.; revising the definition of the term "public works project"; prohibiting the state or any political subdivision that contracts for a public works project from taking specified action against certain persons that are engaged in a public works project or have submitted a bid for such a project; providing applicability; amending s. 403.928, F.S.; requiring the Office of Economic and Demographic Research to include an analysis of certain expenditures in its annual assessment; creating s. 403.9301, F.S.; providing definitions; requiring counties, municipalities, and special districts that provide wastewater services to develop a needs analysis that includes certain information by a specified date; requiring municipalities and special districts to submit such analyses to a certain county; requiring the county to file a compiled document with the coordinator of the Office of Economic and Demographic Research by a specified date; requiring the office to evaluate the document and include an analysis in its annual assessment; providing applicability; creating s. 403.9302, F.S.; providing definitions; requiring counties, municipalities, and special districts that provide stormwater management to develop a needs analysis that includes certain information by a specified date; requiring municipalities and special districts to submit such analyses to a certain county; requiring the county to file a compiled document with the Secretary of Environmental Protection and the coordinator of the Office of Economic and Demographic Research by a specified date; requiring the office to evaluate the document and include an analysis in its annual assessment; providing applicability; providing a determination and declaration of important state interest; providing an effective date.

Be It Enacted by the Legislature of the State of Florida:

Section 1. Subsection (2) of section 255.0991, Florida Statutes, is amended to read:

http://laws.flrules.org/2021/194http://laws.flrules.org/2021/194

**Select Chapter 2021 – 194 Public Works.**




http://edr.state.fl.us/Content/natural-resources/stormwaterwastewater.cfm

## Stormwater & Wastewater 20-Year Needs Analyses

Sections 403.9301 and 403.9302, Florida Statutes, (see Chapter 2021-194, Laws of Florida), direct municipalities, counties, and independent special districts that provide a stormwater management system or program, or wastewater management services, to develop a 20-year needs analysis every five years.

For the first cycle of reports, local governments must submit their reports to their respective counties by June 30, 2022. The counties must compile the local reports (including their own) and submit them to EDR and the secretary of the Department of Environmental Protection by July 31, 2022. EDR will then publish an analysis of the stormwater and wastewater submissions in the 2023 edition of the Annual Assessments of Florida's Water Resources and Conservation Lands. The next reporting cycle will begin in 2027.

The templates are provided in two formats. First, a workbook has been developed in EXCEL that should be downloaded and completed for actual submission. The accompanying PDF's are text only, and are only provided for easy reference. Otherwise, the two documents match. County instructions for compiling all local submissions for final transfer to EDR will be coming soon. All questions should be directed to: EDR Natural Resources.

**Note: municipalities and independent special districts report to county within largest portion of service area.**

**Stormwater (s. 403.9302, F.S.)**

- Stormwater Template for Needs Analysis
  - EXCEL Workbook for Submission [xlsx] - October 8, 2021
    - Optional Growth Rate Schedules [xlsx]
  - PDF Version for Reference [pdf] - revised October 8, 2021; replaces September 1, 2021 version
  - Stormwater Template Overview - August 20, 2021
- FAQs - Coming Soon
- Glossary - Coming Soon

**Wastewater (s. 403.9301, F.S.)**

- Template - Coming Soon

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*Last Revised: November 5, 2021*

http://edr.state.fl.us/Content/natural-resources/stormwaterwastewater.cfm

# Template / Worksheets

- ❑ Routine O & M Costs (20-Year Horizon)
- ❑ Future Expansion Projects
  - ❑ Committed Funding Sources
- ❑ Future Expansion Projects
  - ❑ No Funding Source
- ❑ Stormwater Projects / Resiliency Related to Climate Change
  - ❑ Committed Funding
  - ❑ No Identified Funding
- ❑ Est. Remaining Useful Life Projects
  - ❑ Focus on projects needing replacement within 20-Yr Horizon

http://edr.state.fl.us/Content/natural-resources/stormwaterwastewater.cfm

**Part 6.0 The estimated remaining useful life of each facility or its major components (Section 403.9302(3)(e), F.S.)**

Rather than reporting the exact number of useful years remaining for individual components, this section is constructed to focus on infrastructure components that are targeted for replacement and will be major expenses within the 20-year time horizon. Major replacements include culverts and pipe networks, control structures, pump stations, physical/biological filter media, *etc* . Further, the costs of retrofitting when used in lieu of replacement (such as slip lining) should be included in this part. Finally, for the purposes of this document, it is assumed that open storage and conveyance systems are maintained (as opposed to replaced) and have an unlimited service life.

In order to distinguish between routine maintenance projects and the replacement projects to be included in this part, only major expenses are included here. A major expense is defined as any single replacement project greater than 5% of the jurisdiction's total O&M expenditures over the most recent five-year period (such as a project in late 2021 costing more than 5% of the O&M expenditures for fiscal years 2016-2017 to 2020-2021).

**If you have more than 5 projects in a particular category, please use the "Additional Projects" tab. There, you can use dropdown lists to choose the project category and whether there is a committed funding source, then enter the project name and expenditure amounts.**

**End of Useful Life Replacement Projects with a Committed Funding Source**

| | Expenditures (in $thousands) | | | | |
|---|---|---|---|---|---|
| Project Name | LFY 2021-2022 | 2022-23 to 2026-27 | 2027-28 to 2031-32 | 2032-33 to 2036-37 | 2037-38 to 2041-42 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**End of Useful Life Replacement Projects with No Identified Funding Source**

| | Expenditures (in $thousands) | | | | |
|---|---|---|---|---|---|
| Project Name | LFY 2021-2022 | 2022-23 to 2026-27 | 2027-28 to 2031-32 | 2032-33 to 2036-37 | 2037-38 to 2041-42 |
| | | | | | |
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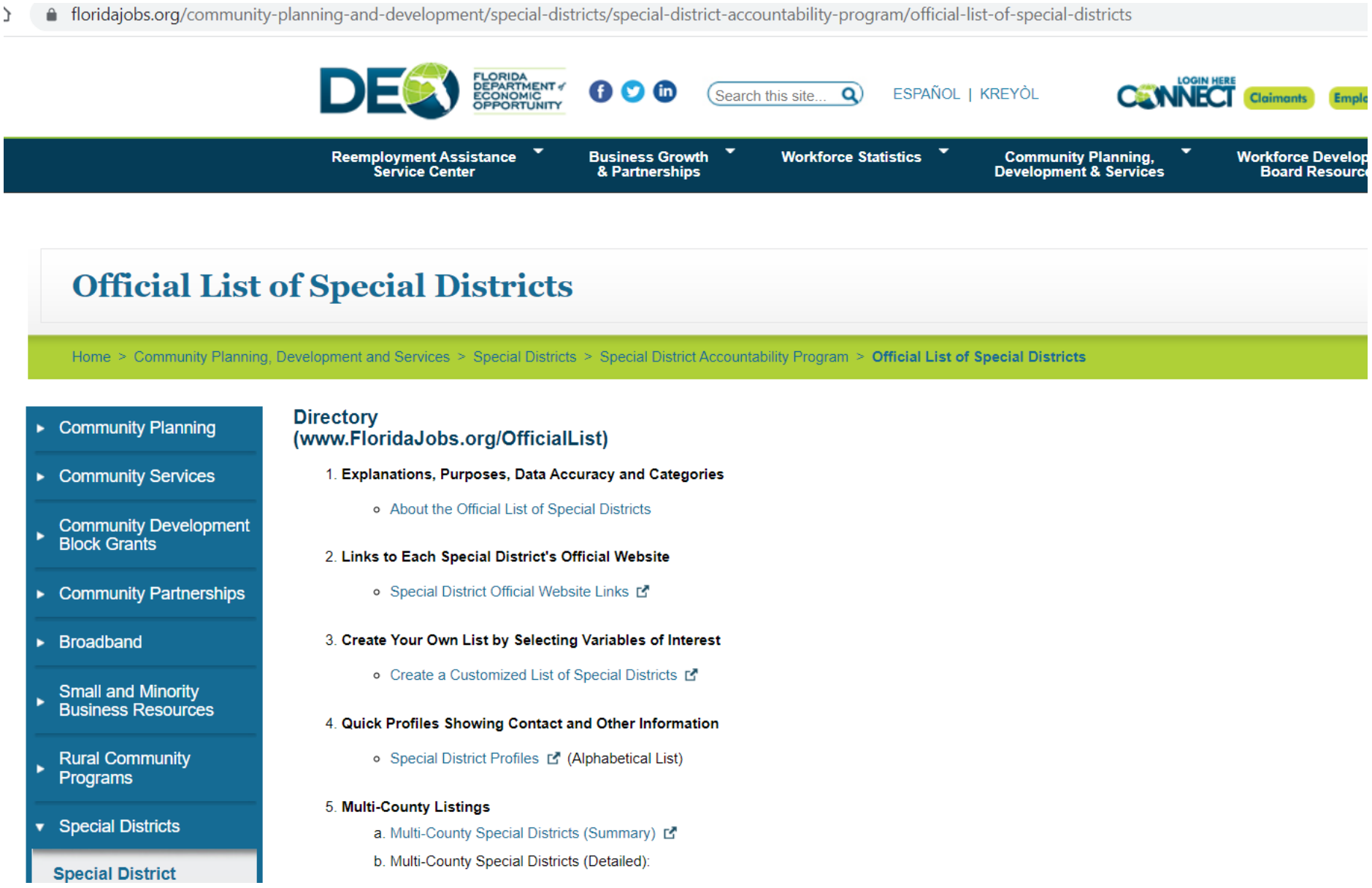
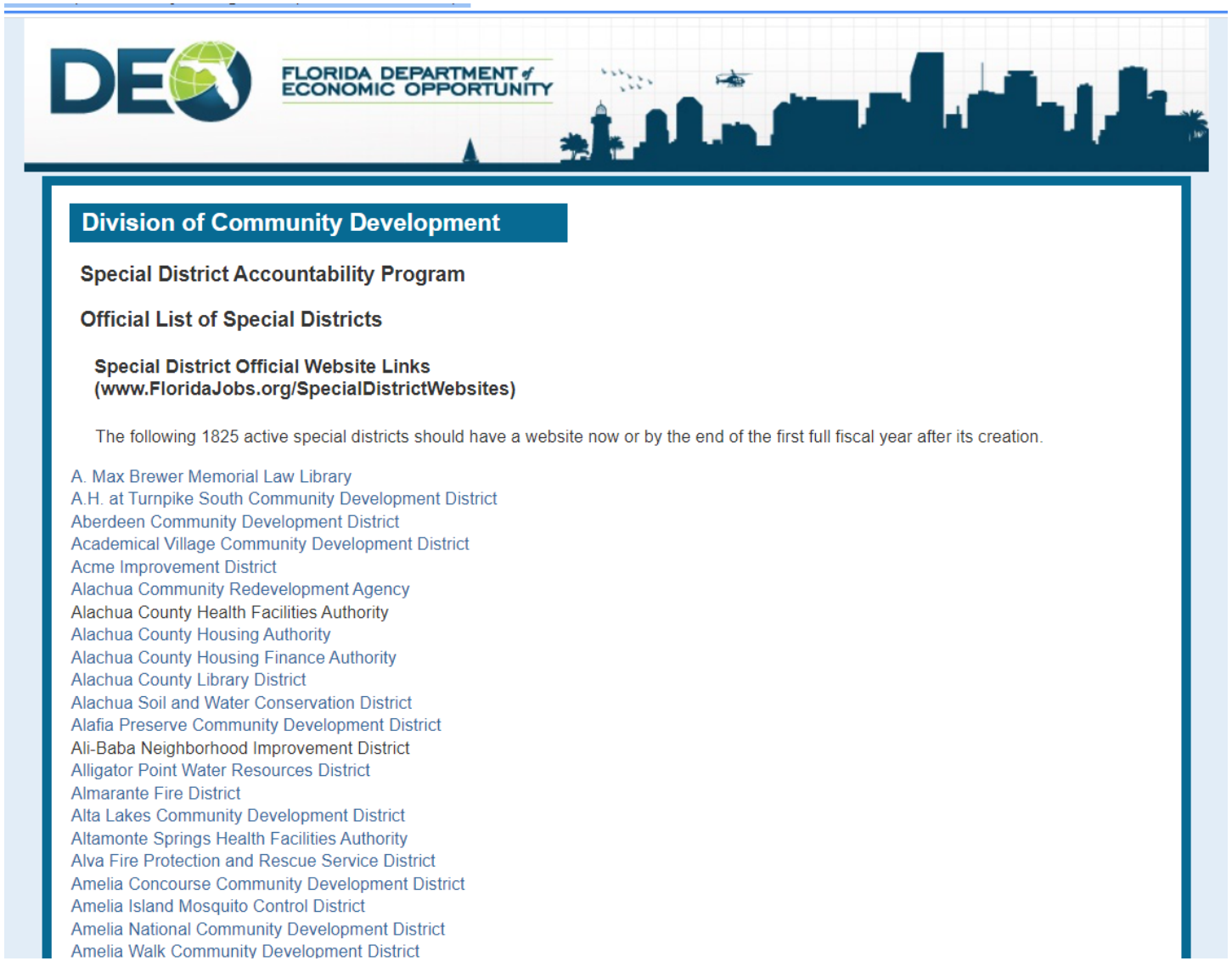
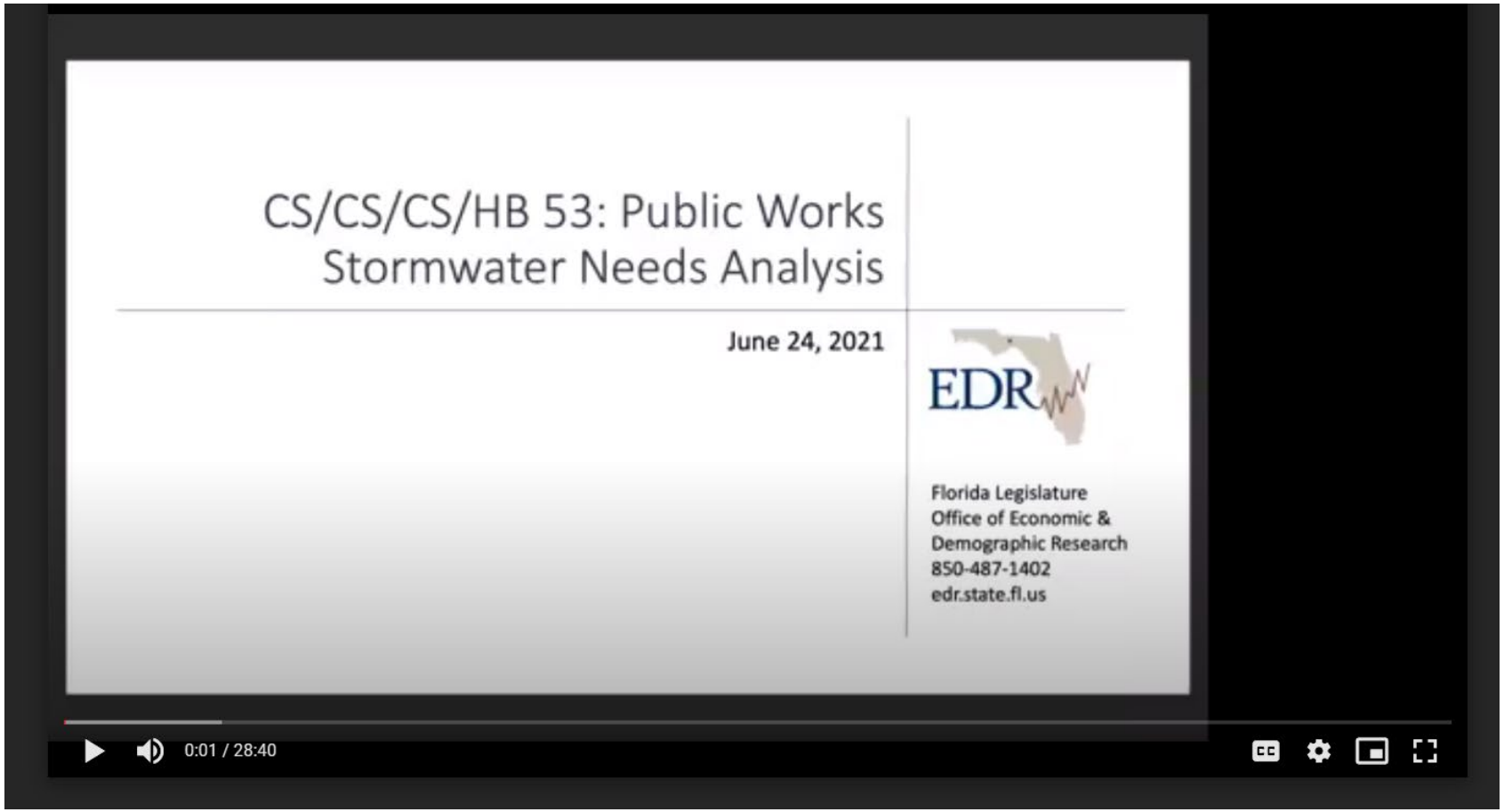



https://floridajobs.org/community-planning-and-development/special-districts/special-district-accountability-program/official-list-of-special-districts




http://specialdistrictreports.floridajobs.org/webreports/websitelist.aspx




https://drive.google.com/file/d/1TMmyBGk-vUZdLEzIGMmyk6ItqvRxbgAm/view

# Safety & Efficiency: How To Accomplish

- ❑ Less Time in Critical Work Zone (Trench)
  - ❑ Laborers, CEIs, Geotechnical
- ❑ Reduce Construction Schedule
  - ❑ Thicker Lifts above RCP Springline
- ❑ Efficient, Safer Use of CEI, Geotechnical Resources
  - ❑ Focus Density Testing Where Most Important
  - ❑ Reduce In-Trench Tests as Appropriate
- ❑ Use More Economical Fill Materials and Reduce Trucking
  - ❑ In-situ Vs. Imported
  - ❑ Alternatives to A-3 soils
  - ❑ Understanding of the role of soils in pipe embedment
  - ❑ Still must have a design basis


# ASCE's Pivotal Role in Concrete Pipe History Plus RCP's Link to Epcot

by Douglas J. Holdener, P.E.
Director, Florida Concrete Pipe Association

The American Society of Civil Engineers (ASCE) was founded in 1852.[1] Ten years prior to the formation of ASCE, in 1842, concrete pipe was installed for the first time in the United States in Mohawk, New York. The 1842 Mohawk concrete pipe was cast in place for a sanitary sewer application and remained in use and in excellent condition for over 140 years. In 1867, Joseph Monier, a French commercial gardener, patented wire reinforcement.[2] Monier showcased wire reinforcing at the Paris Exposition, and subsequently established more patents including production of reinforced concrete pipes in 1868.[3] Precast reinforced concrete pipe (RCP) was first commercially produced in France in 1896 and was introduced in the U.S. in 1905.[4] Since the early 1900s, reinforced concrete pipe (RCP) design, installation, and specifications have evolved, and the ASCE was significant in the development of modern RCP standards.

and it is the basis for the Three-Edge Bearing (3EB) test that is used today for certification of RCP strength class (e.g., III, IV, or V).

The concept of "installation type" originated in the early 1900s. For much of the 20th century, standard installation types for concrete pipe consisted of: (a) concrete cradle (Bedding Factor of 2.8 to 4.8); (b) shaped subgrades (Bedding Factor of 1.5 to 1.9; and (c) flat subgrade (Bedding Factor of 1.1). These early installation types were not the most practical nor economical for construction, however, these older installation details are occasionally still referenced in specifications that have not been updated to modern standards.

In the 1960s, Massachusetts Institute of Technology (MIT) researcher Frank Heger adapted reinforced

ASCE STANDARD

ASCE/CI

15-17

# Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)

ASCE

AMERICAN SOCIETY OF CIVIL ENGINEERS

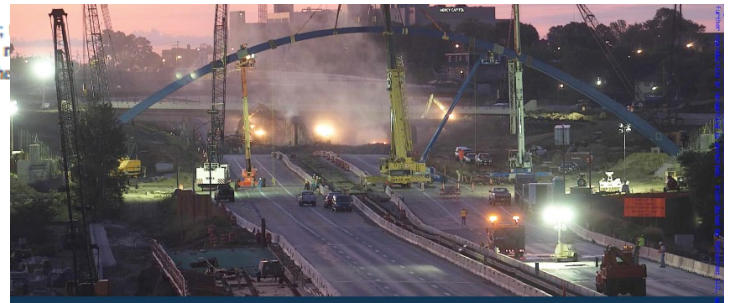
CI ASCE CONSTRUCTION INSTITUTE

ASTM INTERNATIONAL

**Designation: C 1479 – 07a**

## Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations[1]

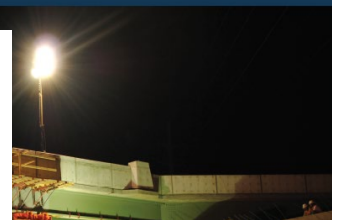
This standard is issued under the fixed designation C 1479; original adoption or, in the case of revision, the year of last r superscript epsilon (ε) indicates an editorial change since the



2017

LRFD Bridge Construction Specifications

4th Edition



Topic No. 625-040-002
Drainage Manual

Effective: January 2021

**Concrete Pipe – Round**

Maximum Cover

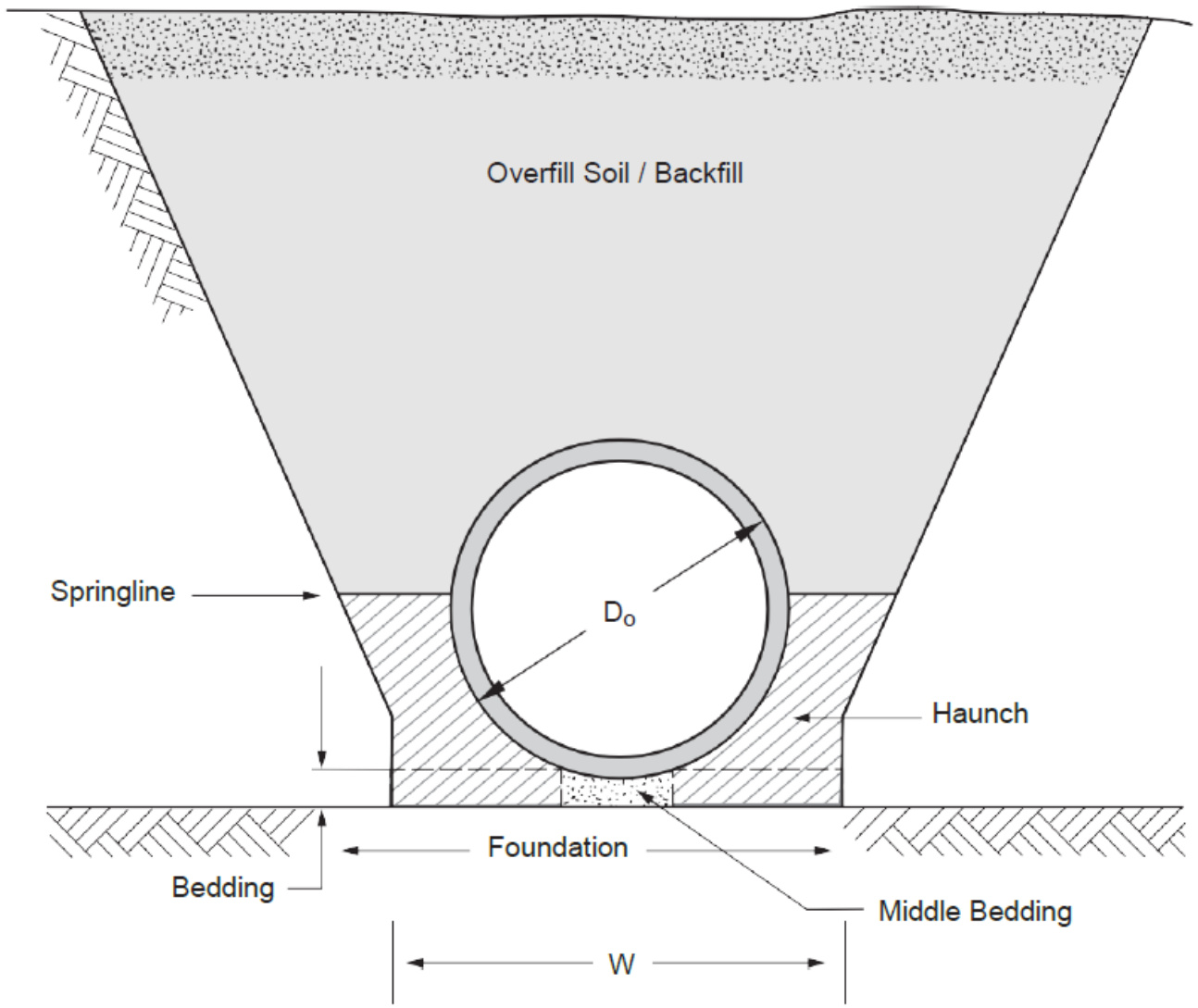
| Round Pipe (B Wall)—Type I Installation | | | | | |
|---|---|---|---|---|---|
| | Maximum Cover (ft) | | | | |
| Pipe Diameter | Class I | Class II | Class III | Class IV | Class V |
| 12" | 11 | 16 | 22 | 34 | 45 |
| 15" | 12 | 16 | 23 | 34 | 45 |
| 18" | 12 | 16 | 23 | 35 | 45 |
| 24" | 11 | 16 | 22 | 34 | 45 |

# Concrete Pipe Structural Fundamentals

"select granular materials with high compaction in zones above the pipe springline does not improve the efficiency of pipe support. Materials in this zone usually may be of the same type and compaction as used for the earth fill over the pipe with no loss of pipe support."

ASCE Pipeline Infrastructure Conference Proceedings, Boston, MA, 1988.

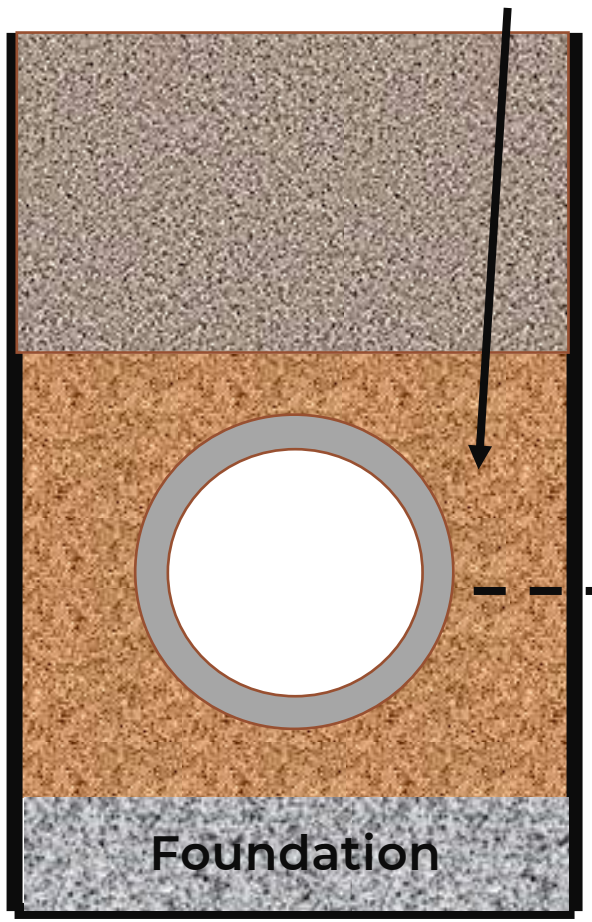
# Concrete Pipe Trench Detail



# Specification Efficiency #1:
# Thick Lifts Above RCP Springline

## Current FDOT Sec. 125

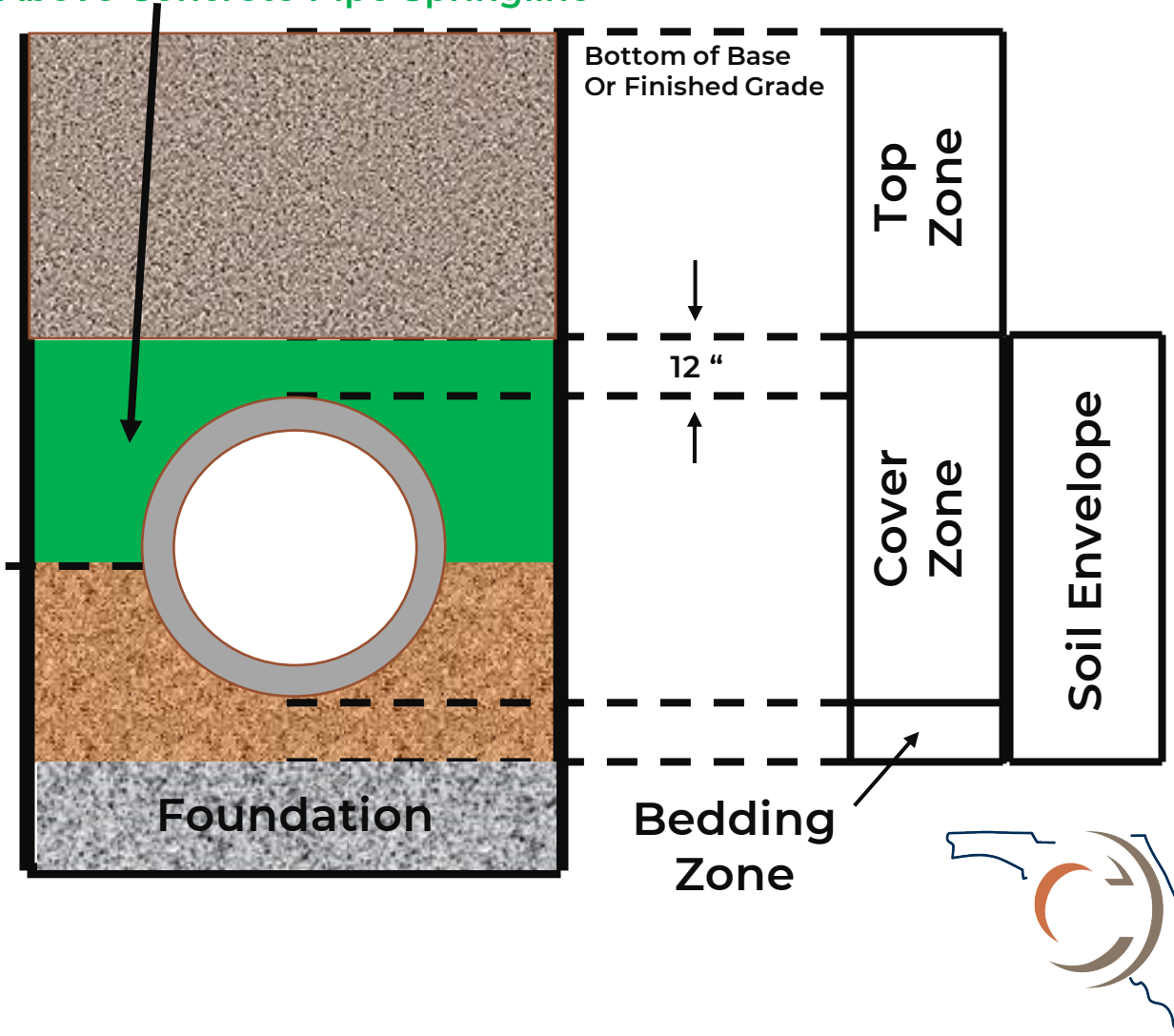
w/ Soil Envelope Compacted to 95% Std. Proctor in 6-Inch Lifts




Springline

## Proposed

w/ Soil Envelope Compacted to 95% Std. Proctor with 12-Inch Lifts Above Concrete Pipe Springline



# Reduce Time Spent in Critical Work Zones by up to 20%

## RCP Embedment Parameters

- 12” backfill lifts above springline of concrete pipe
- Use of current allowed embedment soils
- Compaction 95% std. Proctor

## Expected Benefits

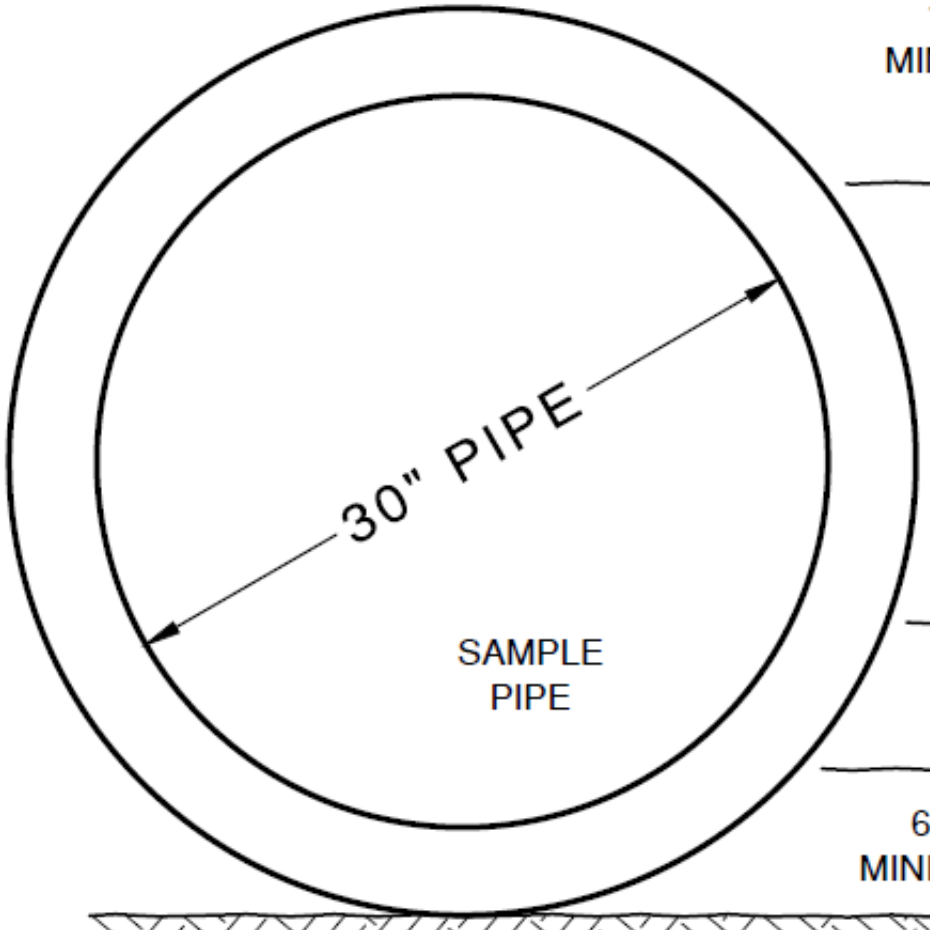
- Safety:  Reduce time in the trench – a Critical Work Zone
- Reduce overall construction schedule, less impact to traffic
- Reduced cost

12.06.01 - Compaction Tests

Compaction tests shall be required for each three hundred (300) linear feet of pipe as a minimum. The [redacted] County Engineer may determine that more compaction tests are required to certify the installation depending on field conditions. The locations of compaction tests within the trench shall be in conformance with the following schedule:

a. One test at the spring line of the pipe
b. One test at an elevation one (1) foot above the pipe crown
c. One test for each two (2) feet of backfill placed above one (1) foot above the pipe crown to subgrade elevation

12" THICK UNIFORM LIFTS COMPACTED TO A MINIMUM DENSITY OF 98% T-180,
FROM TOP OF PIPE TO FINISHED GRADE OR BOTTOM OF BASE MATERIAL




12" COMPACTED MATERIAL.
MINIMUM DENSITY OF 98% T-180

12" COMPACTED MATERIAL.
MINIMUM DENSITY OF 98% T-180

6" COMPACTED MATERIAL.
MINIMUM DENSITY OF 95% T-180

6" COMPACTED MATERIAL.
MINIMUM DENSITY OF 95% T-180

6" COMPACTED MATERIAL.
MINIMUM DENSITY OF 95% T-180

SEE CHART
BELOW FOR
PIPE SIZE
AND
NUMBER OF
6" LIFTS
REQUIRED.

# Thick Lift Above RCP Springline

- FDOT (pilot)
- Lake County (project specifications)
- Putnam County (project specifications)
- City of Tampa (design-build)
- Brevard County (standard)
- City of Tallahassee (standard)

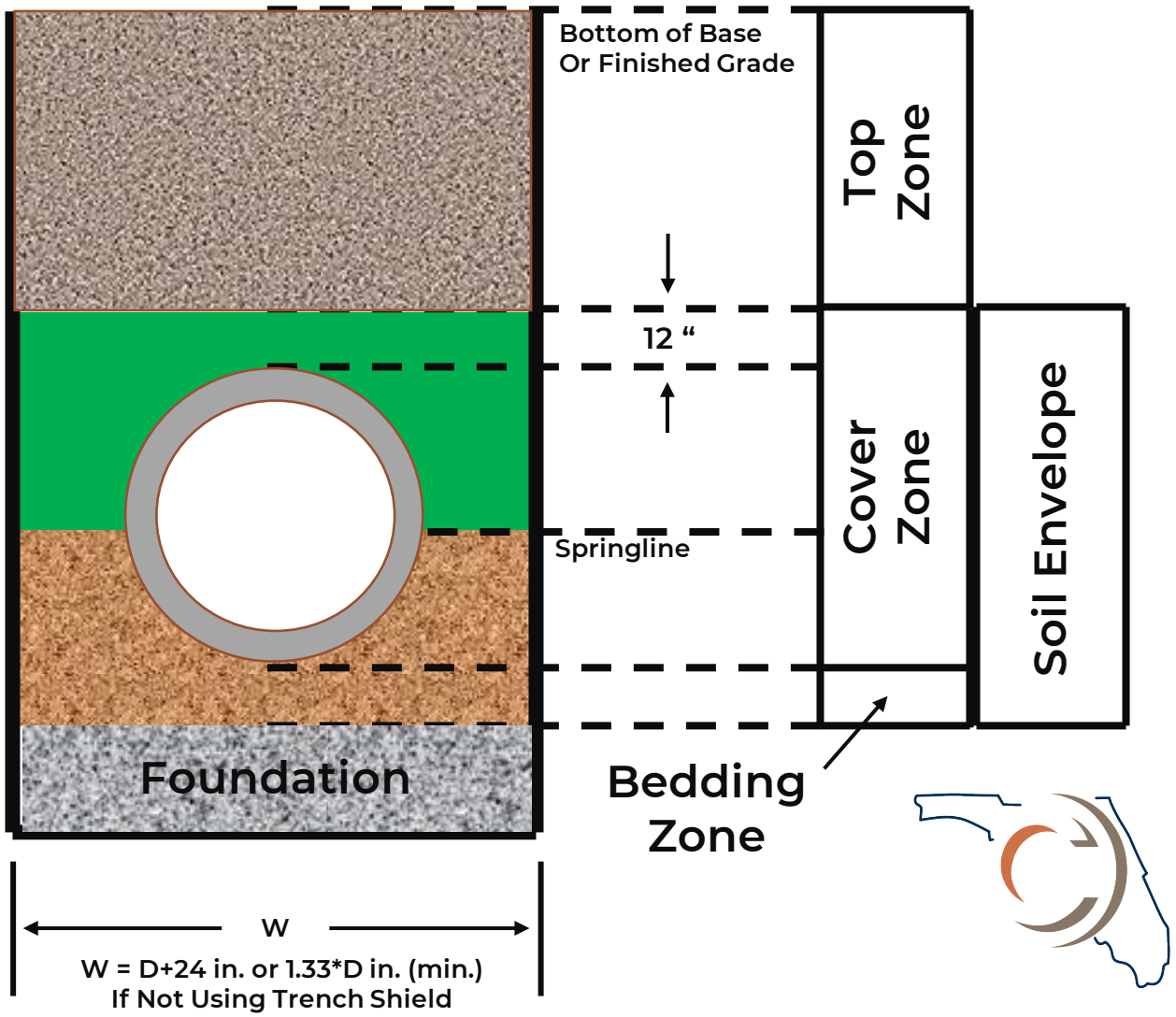
# Safety & Efficiency: How To Accomplish

- ❑ Less Time in Critical Work Zone (Trench)
  - ❑ Laborers, CEIs, Geotechnical
- ❑ Reduce Construction Schedule
  - ❑ Thicker Lifts above RCP Springline
- ❑ Efficient, Safer Use of CEI, Geotechnical Resources
  - ❑ Focus Density Testing Where Most Important
  - ❑ Reduce In-Trench Tests as Appropriate
- ❑ Use More Economical Fill Materials and Reduce Trucking
  - ❑ In-situ Vs. Imported
  - ❑ Alternatives to A-3 soils
  - ❑ Understanding of the role of soils in pipe embedment
  - ❑ Still must have a design basis

# Concrete Pipe Trench Detail

**Concrete Pipe Installation Notes:**

1. RCP shall be ASTM C76 Class III, unless otherwise shown in plans. Installation shall be per ASTM C1479 as modified herein.
2. Foundation shall be stiff to hard in-situ soil, stabilized soil, or compacted fill material.
3. Bedding thickness shall be D/24 inches, not less than 3 inches. Middle bedding directly beneath pipe shall be loosely placed, uncompacted embedment material.
4. Within roadways/traffic areas: Soil Envelope to springline shall be A-1, A-2, A-3, or A-4 material compacted to 95% std. Proctor density.
5. Outside of roadways: Soil Envelope to springline shall be constructed per ASTM C1479 Type 3 at minimum.
6. Above the springline, place concrete pipe embedment material in lifts of no more than 12 inches compacted thickness if using soil types A-3 or A-2-4 (No. 200 sieve ≤ 15%). For all other embedment material, if the contractor chooses to place concrete pipe embedment material in lifts greater than six inches but no more than 12 inches compacted thickness, then the contractor must demonstrate with a successful test section that density can be achieved.
7. Non-shrink grout shall be used at pipe-structure connections. Ensure placement of positive pipe bedding support.
8. Pipe damage or defect observations prior to install. shall be evaluated per AASHTO R73. If final CCTV inspection required, observations shall be reported and evaluated per ASTM C1840.



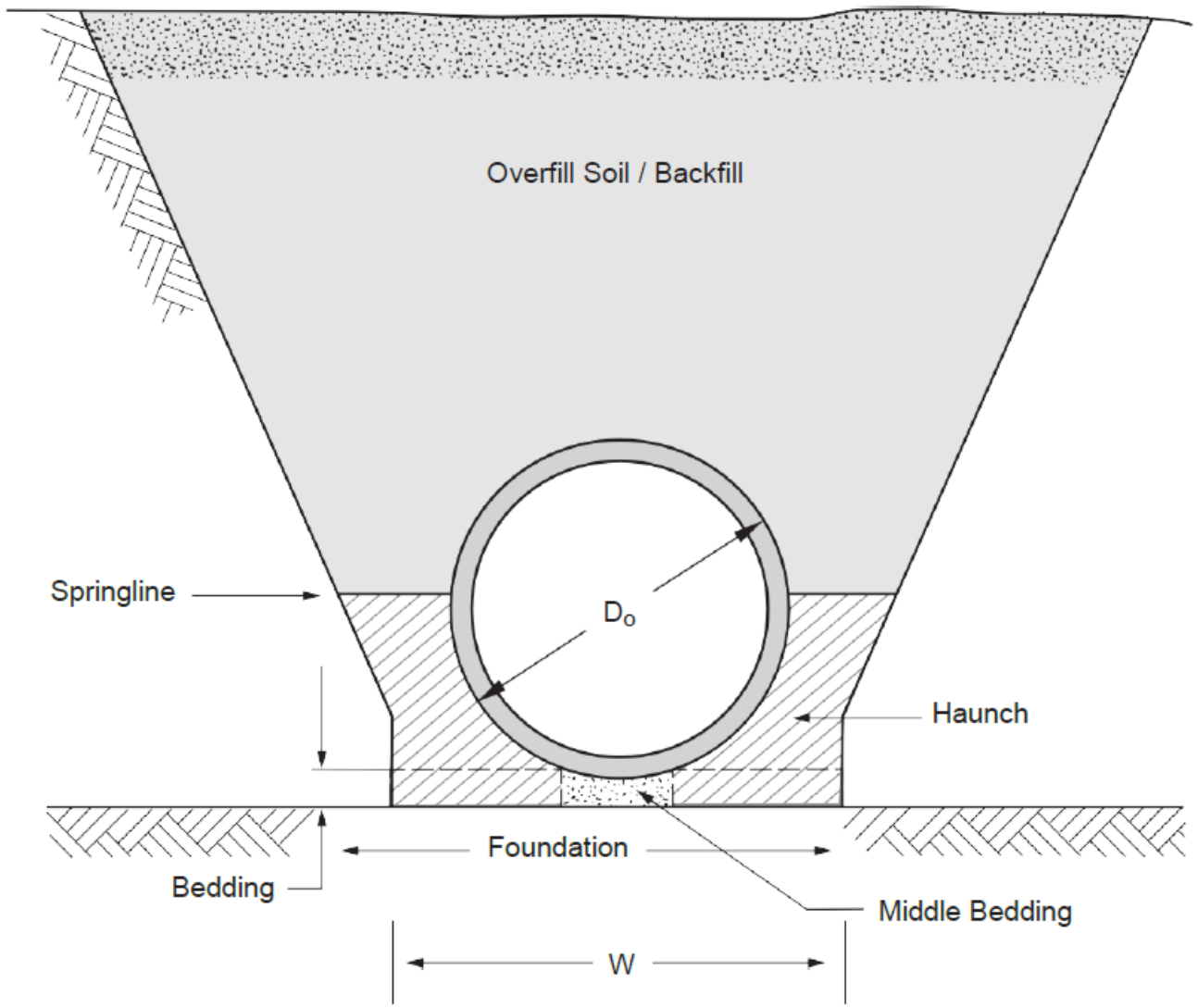
# Specification Efficiency #2: Backfill Material Savings Above RCP Springline

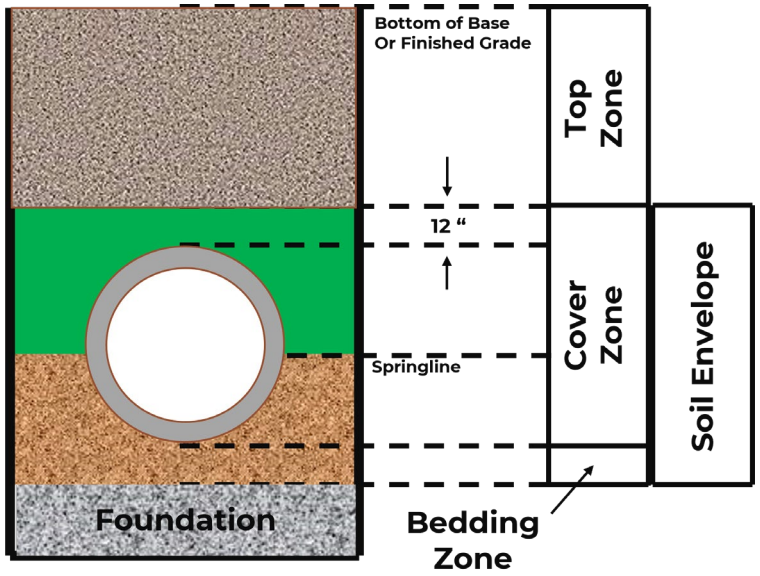
# Concrete Pipe Structural Fundamentals

"select granular materials with high compaction in zones above the pipe springline does not improve the efficiency of pipe support. Materials in this zone usually may be of the same type and compaction as used for the earth fill over the pipe with no loss of pipe support."

ASCE Pipeline Infrastructure Conference Proceedings, Boston, MA, 1988.

# Concrete Pipe Trench Detail






| Illustration of Reduced Backfill when Using Concrete Pipe | | | | |
|---|---|---|---|---|
| RCP Diameter (inch) | Trench Width (ft) [A] | Excess Embedment Above Springline (ft) [B] | Reduced Select Backfill Above Springline per 100 Feet of Trench [C] | Reduced Select Backfill Costs $ per 100 ft [D] |
| 15 | 4 | 1.625 | 650 $ft^3$ | $2,700 / 100 ft |
| 18 | 4 | 1.75 | 700 $ft^3$ | $2,900 / 100 ft |
| 24 | 5 | 2 | 1,000 $ft^3$ | $4,150 / 100 ft |
| 30 | 5 | 2.25 | 1,125 $ft^3$ | $4,670 / 100 ft |
| 36 | 6 | 2.5 | 1,500 $ft^3$ | $6,230 / 100 ft |
| 42 | 7 | 2.75 | 1,925 $ft^3$ | $8,000 / 100 ft |
| 48 | 7 | 3 | 2,100 $ft^3$ | $8,720 / 100 ft |

A. RCP trench width based on AASHTO requirement of D + 24 inches, rounded to the nearest foot.

B. Excess embedment above springline to one foot above pipe crown.

C. Excess structural embedment represents select fill material that contributes negligibly to concrete pipe stresses and could be replaced with more efficient materials.

D. Pay Item Avg. Unit Cost, 04/01/2021 – 09/30/2021, Pay Item 125 3 Select Backfill, $112.57 per CY, Florida Department of Transportation Program Management Office.

# Specification Efficiency #3: Alternative Embedment Installations

14

**Fill Height Tables are based on:**
1. γs = 120 pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -
   this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 4 Bedding**

Class I
Class II
Class III
Class IV
Class V
Special Design

| Pipe Size (in) | Fill Height in Feet | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 12 | 1579 | 1481 | 1111 | 1032 | 1071 | 1154 | 1264 | 1383 | 1372 | 1521 | 1671 | 1820 | 1969 | 2119 |
| 15 | 1519 | 1426 | 1073 | 998 | 1036 | 1116 | 1221 | 1336 | 1326 | 1616 | 1612 | 1756 | 1899 | 2042 |
| 18 | 1443 | 1391 | 1050 | 978 | 1015 | 1093 | 1195 | 1307 | 1297 | 1580 | 1576 | 1715 | 1854 | 1994 |
| 21 | 1306 | 1366 | 1035 | 966 | 1002 | 1079 | 1179 | 1288 | 1279 | 1557 | 1552 | 1688 | 1825 | 1961 |
| 24 | 1288 | 1349 | 1025 | 959 | 994 | 1070 | 1168 | 1276 | 1267 | 1541 | 1535 | 1670 | 1804 | 1938 |
| 27 | 1431 | 1352 | 1025 | 960 | 993 | 1068 | 1165 | 1271 | 1259 | 1531 | 1524 | 1657 | 1790 | 1922 |
| 30 | 1560 | 1360 | 1029 | 965 | 995 | 1070 | 1166 | 1270 | 1254 | 1524 | 1517 | 1648 | 1780 | 1911 |
| 33 | 1437 | 1316 | 1010 | 955 | 988 | 1064 | 1160 | 1264 | 1252 | 1520 | 1512 | 1642 | 1773 | 1903 |
| 36 | 1336 | 1285 | 993 | 947 | 982 | 1060 | 1157 | 1260 | 1251 | 1518 | 1509 | 1639 | 1768 | 1898 |
| 42 | 1181 | 1211 | 966 | 935 | 976 | 1057 | 1153 | 1256 | 1252 | 1518 | 1508 | 1636 | 1764 | 1892 |
| 48 | 1068 | 1090 | 941 | 927 | 973 | 1056 | 1152 | 1255 | 1257 | 1522 | 1511 | 1638 | 1765 | 1892 |

**Note:**
**Type 4 Standard Installation allows the Engineer to design when no field controls (i.e., bedding or compaction) for installation quality and at low fill heights.**

# Concrete Pipe – Round

Maximum Cover

| Round Pipe (B Wall)—Type I Installation | | | | | |
|---|---|---|---|---|---|
| | Maximum Cover (ft) | | | | |
| Pipe Diameter | Class I | Class II | Class III | Class IV | Class V |
| 12" | 11 | 16 | 22 | 34 | 45 |
| 15" | 12 | 16 | 23 | 34 | 45 |
| 18" | 12 | 16 | 23 | 35 | 45 |
| 24" | 11 | 16 | 22 | 34 | 45 |
| 30" | 11 | 15 | 22 | 34 | 45 |
| 36" | 11 | 15 | 21 | 33 | 45 |
| 42" | 10 | 15 | 21 | 33 | 45 |
| 48" | 10 | 14 | 21 | 32 | 45 |

**Fill Height Tables are based on:**
1. γs = 120 pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -
   this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 3 Bedding**

Class I
Class II
Class III
Class IV
Class V
Special Design

| Fill Height in Feet | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipe Size (in) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 12 | 1518 | 1369 | 947 | 817 | 805 | 838 | 896 | 964 | 902 | 1000 | 1098 | 1196 | 1294 | 1392 |
| 15 | 1459 | 1318 | 916 | 794 | 783 | 815 | 872 | 939 | 880 | 975 | 1070 | 1165 | 1260 | 1355 |
| 18 | 1384 | 1285 | 897 | 781 | 772 | 804 | 860 | 926 | 870 | 963 | 1057 | 1150 | 1243 | 1337 |
| 21 | 1247 | 1263 | 886 | 775 | 767 | 799 | 855 | 921 | 867 | 959 | 1051 | 1144 | 1236 | 1329 |
| 24 | 1229 | 1248 | 879 | 772 | 765 | 798 | 854 | 920 | 868 | 960 | 1051 | 1143 | 1235 | 1327 |
| 27 | 1372 | 1251 | 881 | 778 | 770 | 804 | 860 | 925 | 872 | 963 | 1055 | 1147 | 1238 | 1330 |
| 30 | 1500 | 1260 | 887 | 786 | 777 | 812 | 868 | 933 | 878 | 970 | 1061 | 1153 | 1245 | 1337 |
| 33 | 1378 | 1218 | 871 | 780 | 775 | 813 | 871 | 936 | 886 | 978 | 1070 | 1162 | 1254 | 1345 |
| 36 | 1276 | 1189 | 857 | 776 | 774 | 815 | 875 | 941 | 895 | 987 | 1079 | 1172 | 1264 | 1356 |
| 42 | 1119 | 1113 | 829 | 765 | 770 | 815 | 875 | 942 | 903 | 995 | 1087 | 1179 | 1271 | 1363 |
| 48 | 1004 | 992 | 808 | 758 | 770 | 817 | 879 | 946 | 913 | 1005 | 1097 | 1189 | 1281 | 1373 |

**Fill Height Tables are based on:**
1. γs = 120 pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition - this gives conservative results in comparison to trench conditions
4. A Type 1 installation requires greater soil stiffness from the surrounding soils than the Type 2, 3, and 4 installa Therefore, field verification of soil properties and compaction levels should be performed.

**D-Load (lb/ft/ft) for Type 1 Bedding**

| | Fill Height in Feet | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pipe Size (in) | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 12 | 898 | 957 | 1016 | 1075 | 1134 | 1194 | 1253 | 1312 | 1371 |
| 15 | 876 | 933 | 990 | 1048 | 1105 | 1163 | 1220 | 1277 | 1335 |
| 18 | 865 | 921 | 978 | 1034 | 1091 | 1147 | 1203 | 1260 | 1316 |
| 21 | 861 | 917 | 973 | 1029 | 1084 | 1140 | 1196 | 1252 | 1308 |
| 24 | 861 | 917 | 972 | 1028 | 1084 | 1139 | 1195 | 1251 | 1306 |
| 27 | 864 | 920 | 975 | 1031 | 1087 | 1142 | 1198 | 1254 | 1309 |
| 30 | 870 | 925 | 981 | 1037 | 1093 | 1148 | 1204 | 1260 | 1316 |
| 33 | 877 | 933 | 989 | 1045 | 1101 | 1157 | 1213 | 1269 | 1325 |
| 36 | 885 | 941 | 998 | 1054 | 1110 | 1167 | 1223 | 1279 | 1335 |
| 42 | 890 | 946 | 1002 | 1058 | 1115 | 1171 | 1227 | 1283 | 1339 |
| 48 | 897 | 953 | 1010 | 1066 | 1122 | 1178 | 1234 | 1290 | 1346 |

- ❑ Type 1 Install
- ❑ 23 feet max depth
- ❑ Min. 1.5 Safety Factor
- ❑ A-1, A-2, A-3, A-4 (FL) Soils

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**Fill Height Tables are based on:**
1. γs = 120 pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition - this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 2 Bedding**

| | Fill Height in Feet | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pipe Size (in) | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 12 | 1164 | 1240 | 1317 | 1393 | 1470 | 1547 | 1623 | 1700 | 1776 |
| 15 | 1139 | 1214 | 1289 | 1363 | 1438 | 1513 | 1587 | 1662 | 1737 |
| 18 | 1130 | 1204 | 1278 | 1351 | 1425 | 1499 | 1573 | 1647 | 1720 |
| 21 | 1130 | 1203 | 1277 | 1350 | 1424 | 1497 | 1570 | 1644 | 1717 |
| 24 | 1135 | 1209 | 1282 | 1356 | 1429 | 1503 | 1576 | 1650 | 1723 |
| 27 | 1135 | 1208 | 1282 | 1355 | 1428 | 1501 | 1574 | 1648 | 1721 |
| 30 | 1138 | 1211 | 1284 | 1357 | 1430 | 1503 | 1576 | 1649 | 1722 |
| 33 | 1143 | 1216 | 1289 | 1362 | 1435 | 1508 | 1581 | 1654 | 1727 |
| 36 | 1149 | 1222 | 1295 | 1369 | 1442 | 1515 | 1588 | 1662 | 1735 |
| 42 | 1152 | 1225 | 1298 | 1370 | 1443 | 1516 | 1589 | 1662 | 1735 |
| 48 | 1158 | 1231 | 1303 | 1376 | 1449 | 1521 | 1594 | 1667 | 1739 |

- ❑ Type 2 or 3 Install
- ❑ Up to 17 feet max depth
- ❑ Min. 1.5 Safety Factor
- ❑ A-1 thru A-6 Soils

# Benefits of Standard Installations

- Type 1 (e.g., FDOT)
  - Allows deep fills
  - Requires minimal embedment*
- Types 2 & 3
  - Allows max. fills at most applications
  - Allows native soils readily available at most sites
  - Reduced compaction & inspection required
  - Can still design, certify RCP for less costly install

# Safety & Efficiency: How To Accomplish

- ❑ Less Time in Critical Work Zone (Trench)
  - ❑ Laborers, CEIs, Geotechnical
- ❑ Reduce Construction Schedule
  - ❑ Thicker Lifts above RCP Springline
- ❑ Efficient, Safer Use of CEI, Geotechnical Resources
  - ❑ Focus Density Testing Where Most Important
  - ❑ Reduce In-Trench Tests as Appropriate
- ❑ Use More Economical Fill Materials and Reduce Trucking
  - ❑ In-situ Vs. Imported
  - ❑ Economical Soils Above RCP Springline
  - ❑ Use Alternative Standard Installation Types 2 or 3
  - ❑ Understand the design basis of soil-pipe system

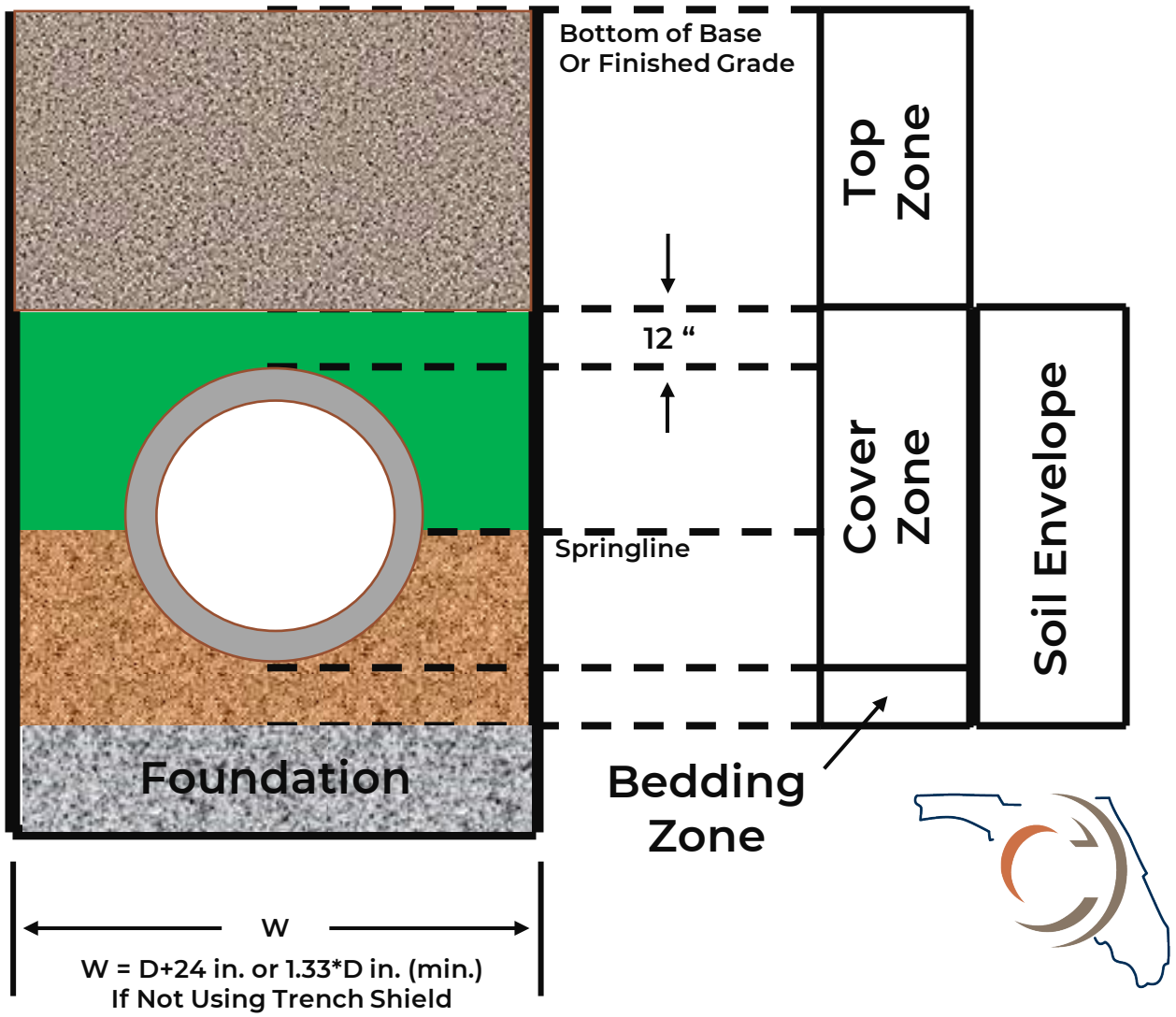
# Safety & Costs Improvements

- RCP Structural Properties, Design, and Standards
- Thick Lifts – 20% Reduction of Time in Critical Work Zones
- More Efficient Geotechnical/Density Testing
  - Test embedment where needed
- Reduce Volume of Select Fill
- Reduce Transportation, Use In-Situ Fill Materials
- Must be justifiable in design and must be stated in specifications

# Concrete Pipe Trench Detail

**Concrete Pipe Installation Notes:**

1. RCP shall be ASTM C76 Class III, unless otherwise shown in plans. Installation shall be per ASTM C1479 as modified herein.
2. Foundation shall be stiff to hard in-situ soil, stabilized soil, or compacted fill material.
3. Bedding thickness shall be D/24 inches, not less than 3 inches. Middle bedding directly beneath pipe shall be loosely placed, uncompacted embedment material.
4. Within roadways/traffic areas: Soil Envelope to springline shall be A-1, A-2, A-3, or A-4 material compacted to 95% std. Proctor density.
5. Outside of roadways: Soil Envelope to springline shall be constructed per ASTM C1479 Type 3 at minimum.
6. Above the springline, place concrete pipe embedment material in lifts of no more than 12 inches compacted thickness if using soil types A-3 or A-2-4 (No. 200 sieve ≤ 15%). For all other embedment material, if the contractor chooses to place concrete pipe embedment material in lifts greater than six inches but no more than 12 inches compacted thickness, then the contractor must demonstrate with a successful test section that density can be achieved.
7. Non-shrink grout shall be used at pipe-structure connections. Ensure placement of positive pipe bedding support.
8. Pipe damage or defect observations prior to install. shall be evaluated per AASHTO R73. If final CCTV inspection required, observations shall be reported and evaluated per ASTM C1840.

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# Thank You

# Specification Development Technical Assistance & Seminars

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