CHARLOTTE.
ENGINEERING & PROPERTY MANAGEMENT

ENGINEERING AND PROPERTY MANAGEMENT ENGINEERS FORUM

Thursday, November 1, 2018

8:30 am Registration

9:00 am - 4:30 pm

1105 Otts St, Charlotte, NC 28205

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Consultant Engineering Forum Content 11/1/2018

1. Agenda
2. Speakers list
3. Resource List
4. Project Schedule Example
5. Planning Phase Report Example
6. Plan Submittal Cover Sheet
7. Engineering Services Guidelines and Plan Development Milestone Checklists
8. Engineering Services Cost Estimating Information
9. Invoice Example
10. PROWAG Design
11. PROWAG Example
12. CDOT Bicycle Facility Design
13. Bicycle Facility Selection
14. Green Pavement Markings for Bicycle Facilities
15. Charlotte-Mecklenburg Storm water Services List of Available Resources
16. Charlotte-Mecklenburg Storm water Services Design Review Guidelines for Engineering Services Projects
17. Storm water Construction Review List
18. Charlotte-Mecklenburg Storm water Services Ten Percent Rule
19. Evaluation and Repair Guidelines for New Drainage Pipe
20. Post Installation Evaluation and Repair of Installed Concrete Pipe
21. City of Charlotte Storm water Services Rigid Pipe Repair Guide for Newly Installed Concrete Pipe
22. Foundation Protection Provision
23. 401/404 Permitting Services for Engineering Services Projects
24. Requirements for Legal Descriptions, Plats and Plans
25. CBI Information Sheet

CHARLOTTE

Engineering & Property Management
Engineers Forum
11/1/18

AGENDA

• Program Overview	9:00 - 9:15
• Welcome	9:15 - 9:25
• Project Expectations and Communications	9:25 - 10:05
• Charlotte Business Inclusion	10:05 – 10:20
• Project Management	10:20 – 10:40
Break – 10 minutes	10:40 – 10:50
• Project Estimating	10:50 – 11:30
• QA/QC	11:30 – 12:00
Discuss breakout session	12:00 -12:05
Breakout session/ lunch	12:05 – 1:00
• Recap from breakout session	1:00 - 1:30
• QA/QC continued	1:30 – 2:30
• PROWAG and Bicycle facility design	2:30 - 3:05
Break – 10 minutes	3:05 – 3:15
• Construction	3:15 - 4:00
• General Q & A session and next steps	4:00 - 4:30

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Engineering & Property Management
Engineers Forum
11/1/18

Speakers

Paul Benton, PE CDOT Engineering Project Manager Paul.Benton@ci.charlotte.nc.us	Dan Leaver, PE Engineering Services Program Manager dleaver@ci.charlotte.nc.us
Skyne Betha Charlotte Business Incl (CBI) Relationship Specialist sbetha@ci.charlotte.nc.us	Samantha Miller, PE CDOT Senior Engineer, PROWAG Samantha.Miller@ci.charlotte.nc.us
Becky Chambers, PE Eng. Services In House P&D Program Manager rchambers@ci.charlotte.nc.us	Chad Nussman Storm Water Services Sr Eng Project Manager cnussman@ci.charlotte.nc.us
Mike Davis, PE Engineering, and Property Management, Director madavis@ci.charlotte.nc.us	Susan Tolan, PE Storm Water Services Construction Manager stolan@ci.charlotte.nc.us
Kruti Desai, PE Storm Water Division Manager kdesai@ci.charlotte.nc.us	Johnella Walker Contract Administrator Coordinator Lead jowalker@ci.charlotte.nc.us
Stewart Edwards, PE Storm Water Services Maint Program Manager stedwards@ci.charlotte.nc.us	Veronica M. Wallace, PE Engineering Services Division Manager vwallace@ci.charlotte.nc.us
Bette Frederick, PE Asst. Engineering Services Division Manager bfrederick@ci.charlotte.nc.us	Theresa Watley Engineering Services Utility Section Manager twatley@ci.charlotte.nc.us
Matt Gustis, PE Storm Water Services Engineering Program Manager mgustis@ci.charlotte.nc.us	Crystal Williams, PE Storm Water Services Senior Engineering Project Manager Crystal.Williams@ci.charlotte.nc.us
Stuart Harborne, Broker Real Estate Acquisition Program Manager Stuart.Harborne@ci.charlotte.nc.us	Tonia Wimberly, PE Engineering Services Construction Program Manager twimberly@ci.charlotte.nc.us
David Wolfe, PE Engineering Services Program Manager dwolfe@ci.charlotte.nc.us	

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ENGINEERING & PROPERTY MANAGEMENT

Engineering Services Important Resources

Reference Material

NCDOT Design Manual
Hard Copy Only
AASHTO Green Book
Hard Copy Only
CDOT Policies
Hard Copy Only
USDG
https://charlottenc.gov/Transportation/PlansProjects/Documents/USDG%20Full%20Document.pdf
CLDSM
https://charlottenc.gov/ld/CLDSM/Pages/default.aspx
NCDOT Standards
https://connect.ncdot.gov/resources/Specifications/Pages/2018-Roadway-Standard-Drawings.aspx
NCDOT Specifications
https://connect.ncdot.gov/resources/Specifications/Pages/2018-Specifications-and-Special-Provisions.aspx
WATCH
https://charlottenc.gov/Transportation/Permits/Documents/2014%20Work%20Area%20Traffic%20Control%20Handbook%20(WATCH).pdf
MUTCD
https://mutcd.fhwa.dot.gov/pdfs/2009/pdf_index.htm
PROWAG
https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/proposed-rights-of-way-guidelines
Storm Water Design Manual
https://charlottenc.gov/StormWater/Regulations/Pages/StormWaterDesignManual.aspx
CATS Bus Stop details
https://charlottenc.gov/ld/CLDSM/Documents/Revised%20CATS%20Details.pdf
City Special Provisions and CIC Spreadsheet
https://charlottenc.gov/Engineering/Bids/Pages/SpecialProvisions.aspx

Website Resources

Consultants.zip (CAD Stds, QA/QC checklist)
http://charlottenc.gov/Engineering/Bids/Pages/CADstandards.aspx
Recent Bid Tab prices
http://charlottenc.gov/Engineering/bids/Pages/BidsContractsArchive.aspx
Charlotte Place Making Hub
https://charlottenc.gov/civicinnovation/placemaking/Pages/default.aspx
Charlotte Explorer
http://cltex/

October 30, 2018

Engineering Services Typical Project Schedule (Standard/Non-Federal)

Date Prepared: 9/25/2018

Phase	Duration Months
Initiation	2
Planning	9
Design	12
Real Estate	6
Bid Preparation	2
Construction Preparation/ Utility Relocation	7
Construction Bid	5
Construction	12
Warranty	12
Landscaping	4
Closeout	3

Notes

Color Key

- Council Policy /Process
- E&PM Policy /Process
- Production Time (consultants, engineers, contractors, etc.)
- Private Utility
- General Statute
- Summary

Tasks	Duration (Working Days)
INITIATION PHASE	
Initiation	20
PLANNING PHASE	180
IPDS Project Planning	45
Consultant Fee Negotiation	15
Survey & Mapping	35
Planning Utility Coordination	165
1st Public Meeting	45
Concept Preparation	45
Concept Plan Submittal/Review	20
Planning Rpt	90
2nd Public Meeting	30
(Design fee Negotiation to occur during Planning Phase)	
Design Phase	260
Design Utility Coordination	200
Permitting	40
Preliminary Design Plan Preparation	60
Preliminary Design Plan Submittal/ Review	25
3rd Public Meeting	30
Real Estate Plan Preparation	20
Real Estate Plan Submittal/ Review	20
Design Revisions from Real Estate	82
100% Design Document Submittal	35
Real Estate Preparation Phase	60
Plat Preparation	30
Consultant / Real Estate Plat Review	20
Real Estate Request Processing	10
Real Estate Phase	150
Real Estate	120
File Condemnations / End of Real Estate	30
Bid Preparation Phase	30
Stakeholder Reviews for SP's, Est. & CBI	20
Const Bid Request on Loop	10
Const Bid Package Assigned to Specialist	10
Construction Preparation/Utility Relocation Phase	60
Sign Relocation	10
Tree Clearing	10
Utility Staking	30
Utility Relocation	100
Construction Bid Phase	70
Const - Bid	70
Const-Contract Execution	30
Construction Phase	260
Const - Survey Staking	280
Const-.NTP - Final Acceptance	260
Record Drawings	30
Warranty Phase	260
Warranty	260
Landscape Phase	100
Lndscp - Design	
Lndscp - Installation	
CLOSE-OUT	60
IPDS Closing	60

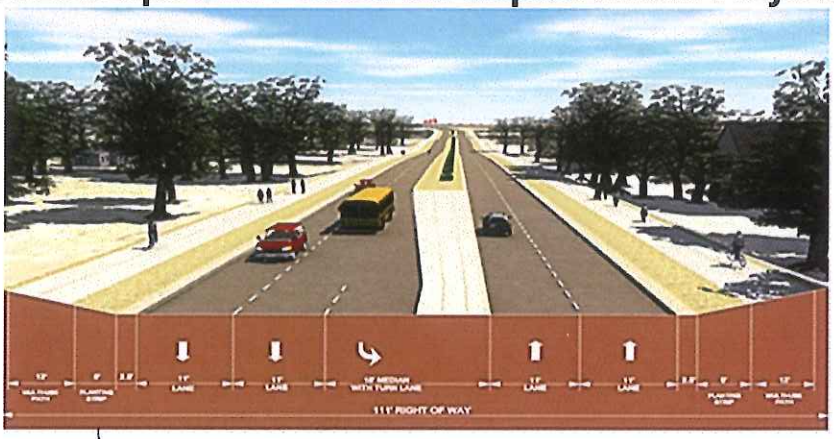
NOTES:

1. Assumed a one year construction schedule
2. Assumed minimal Utility Relocation

EXAMPLE

Planning Phase Report

Example Road
Streetscape and Pedestrian Improvement Project



Conceptual rendering of section of Brown-Grier Road

City Project # 512-XX-XXX

Prepared for:
City of Charlotte
Engineering & Property Management

Prepared by:
Engineering Firm

Date

PE Seal

Table of Contents

3.4.2 Unified Development Ordinance (UDO) / Area Plan / Charlotte WALKS / Charlotte BIKES / Comprehensive Transportation Plan (CTP) Plan Objectives
3.4.3 Public Input Process
3.4.4 Design Criteria and Assumptions

3.5 USDG Step 5 – Recommend Street Classification and Initial Cross-Section

3.5.1 Recommended USDG Street Classification
3.5.1.1 Initial Cross-Section

3.6 USDG Step 6 – Describe Tradeoffs and Select Cross-Section

3.6.1 Alternatives Analysis
3.6.1.1 Initial Alternatives
3.6.1.2 Preferred Alternative

4.0 Conceptual Plans (15% Line and Grade)
- 4.1 Base Map; Exhibit maps; Proposed vertical and horizontal alignments; Transit, bicycle facilities; Sidewalk, curb and gutter, and medians; Pavement Marking; Right-of-way and easement lines; Storm drainage Improvements; Landscaping; Lighting; Signalization; Hardscape Features; Traffic Control
- 4.2 Plan Sheets with Horizontal Design
- 4.3 Profile Sheets with Vertical Design

5.0 Permits and Encroachments
- 5.1 Wetland and Stream Delineation and Mitigation
  - 5.1.1 401/404 Permits
- 5.2 Natural Resources
  - 5.2.1 Threatened and Endangered Species
  - 5.2.2 Archaeologic and Cultural Resources
  - 5.2.3 Historic Architecture
- 5.3 Post-Construction Controls Ordinance
- 5.4 Sedimentation and Erosion Control
- 5.5 City/County Floodway Special Use Permit
- 5.6 NCDOT Encroachment
- 5.7 RailRoad Encroachment

6.0 Agency Identification and Coordination
- 6.1 Utilities Coordination
- 6.2 NCDOT

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List of Figures and/or Exhibits

List of Appendices

CHARLOTTE.
ENGINEERING & PROPERTY MANAGEMENT

Engineering Services

PLAN SUBMITTAL COVER SHEET

DATE _____

PROJECT NAME _____

PROJECT LOCATION _____

% PLAN COMPLETION _____

SUBMITTAL INCLUDES:

_____ **COMPLETE PLANS PACKAGE**

_____ **MILESTONE CHECKLIST**

_____ **CURRENT COST ESTIMATE**

CONSULTANT _____

CONSULTANT PM _____

CONSULTANT QA/QC ENGINEER _____

Project Name:	Consultant:
Project Number:	Project Manager:

ENGINEERING SERVICES GUIDELINES AND PLAN DEVELOPMENT MILESTONE CHECKLISTS

The following guidelines have been established to aid the Engineer/Designer/Manager in understanding the design process as it relates to Engineering Services work. These guidelines are meant to be used as the minimum criteria by which design activities occur while realizing that each project is unique and may require special considerations.

Design Plan Milestone Checklists

Projects are recommended to the following Plan Development Milestones:

I. 25% Plans Review (Client Department Review for "Large" Projects)
II. 50% Plans Review (Preliminary Plans – Core & Support Team Review)
III. 75% Plans Review (Preliminary Plans – Core & Support Team Review)
IV. 90% Plans Review (Preliminary Plans – Core & Support Team Review)
V. Final Plans (Core & Support Team Review)

Following are Outlines of each Milestone with:

A. General Overview
B. Required Submittals
C. Plan Checklist

I. **25% Plans Review** Submittal Date:_____Designer: _____

Review Date:_____Reviewer: _____

Note: Survey should be field verified prior to beginning 25% plans to assure it is correct and no improvements have been installed since survey was received. All review plans submitted must be 24" X 36" Black-Line (Originals or PDFs). Each sheet should have a "Plans Prepared By:" block and have the stamping "Preliminary Plans – Do Not Use for Construction," until the final plan set is issued.

____ Field visit to verify survey

A. General Overview

This milestone has been set to ensure the Project Design is proceeding according to IPDS Project Plan, preset design criteria, and sound engineering judgment. At this milestone, conceptual designs should have evaluated multiple alternatives (if applicable) to determine the most cost-effective Preliminary Horizontal and Vertical Alignments based on the client's initial scope of work, design criteria and approved design exceptions. If not, the design should not proceed with plan production with cutting sheets. With the conceptual design approved, proceed with preparing plans. The 25% Plans Review should include the following:

B. Required Submittals (Place a Check Mark, or N/A)

____ Design Assumptions or Design Criteria

____ Listing of Required Permits or Special Reviews

(i.e. Phase I Environmental Site Assessment, Historical Agency Review, NCDOT Encroachment Agreement, Water Quality Permit, Erosion Control Permit, etc.

____ Verification of Correspondence with Pertinent Utility Companies

_____ Control Point Calculations for Projects with a Resurfacing Grade

_____ Vertical Clearance Calculations

____ Preliminary Pavement Design

____ Engineer's Estimate

____ Project Construction Plans (Approx. 25% Completion)

C. 25% Plans Checklist (Place a Check Mark, or N/A)

Note: All plans submitted must be 24" X 36" Black-Line (Originals or PDFs). Each sheet should have a "Plans Prepared By:" block and have the stamping "Preliminary Plans – Do Not Use for Construction".

1. Title Sheet (Use City of Charlotte Standard Cover Sheet)

____ Vicinity Map is "complete" and "accurate"
(Includes at least two major streets and an intersection)
(Show North Arrow inside vicinity map)

____ Legend of Conventional Symbols Used
(Make sure Lines and Symbols are "accurately" shown)

____ Index of Sheets (Varies per Project)
Suggested Layout:

-- Sheet 1	Title Sheet
-- Sheet 2, 2A, 2B, etc (2 Series)	General Notes, Standard Abbreviations & Various Details (including ramp details)
-- Sheet 3, 3A, 3B, etc (3 Series)	Typical Sections, Drainage Summary
-- Sheets 4 thru XX	Plan & Profile Sheets
-- Sheets TCP1 thru TCPxx	Traffic Control Plans
-- Sheets PM1 Thru PMxx	Pavement Marking & Signing Plans
-- Sheets EC1 thru ECxx	Erosion Control Plans
-- Sheets SP1 thru SPxx	Construction Staking Plans
-- Sheets SIG1 thru SIGxx	Signal Plans
-- Sheets UC1 thru UCxx	Utility Construction Plans
-- Sheets UBO1 thru UOxx	Utilities By Others Plans
-- Sheets X1 thru Xxx	Cross-Sections Sheets

_____ Project Name & Project Number (Place in two locations)
_____ As a heading under the City logo (centered at the top of the sheet)
_____ Vertically along the Right-Hand Border

____ Project Features
(Type of work such as: Grading, Storm Drainage, Concrete Curb & Gutter, Paving, etc. Place under Project Name & Number in heading.

____ Standard Specification Date (Most current publication) (NCDOT Standard Specifications for Roads & Structures)

____ Signature Block entitled "Recommended for Construction" with signature space for project stakeholders (unsigned at this point)

____ Signature Block containing City Engineer's approval signature & date
(unsigned at this point)

____ Location Map
Shows Project Layout on numbered superimposed sheets to include the following:
_____ Project Alignment for all Proposed Construction
(include Stations for -L- lines, -Y- lines, detours, etc.)
_____ Existing Roads and Streets affected by construction
(both those that are part of the project and those not part of project)
_____ Show Major Proposed Work with Shading
(do not show any associated text or other details)
_____ Street Names, Route Numbers, Survey Line Names & Numbers
_____ Alignment Equality Stations
_____ Streams and Rivers
_____ Railroads
_____ City Limits
_____ Beginning and Ending Stations for the Project
_____ North Arrow

____ List of Graphical Scales used for the Project

____ Design designation is shown

2. Typical Sections (to be shown in the "2 Series" of sheets)

____ Provide Typical Roadway Section(s). Include road name, construction alignment reference identification and stations. Label pavement types, curb & gutter, sidewalk, etc.... to match items listed in the Preliminary Material Schedule.

3. Plan Sheets
In general, show Existing Features with dashed and/or "screened" lines and proposed features with heavier solid lines and/or shading. **Use City of Charlotte layering standards.**

_____ Sheets are ½ Plan (at the bottom of sheet) and ½ Profile (at the top of the sheet) unless project lends itself to separate plan and profile sheets. The Horizontal Scale should be 1" = 20' and the Vertical Scale should be 1" = 4'. Any variance from these scales should be approved by the Program Manager.

_____ Existing Planimetric Features relative to project (field verified by designer)
_____ Streets, roads, driveways, sidewalks (names, labels, etc.)
_____ Houses, buildings, garages, sheds (names, labels, etc.)
_____ Fences, walls (labels)
_____ Trees, shrubs, woods lines, etc. (type and size if pertinent)
_____ Utilities (above and below ground) (type, size & mat'l if known)
_____ Storm Drainage Facilities (size, type, and invert elevations)
_____ Property Lines, Exist. R/W Lines, Exist. Permanent Easement Lines
(Show Monumentation found with label – ex. ½" EIP)
_____ Property Owner Information (use City of Charlotte standard parcel block info.)
_____ Railroads (show tracks to scale)(label ownership)
_____ Bodies of water (rivers, creeks, streams, lakes, ponds, etc.)
(give name, width, direction of flow, etc.)
_____ Any other existing features relative to project

_____ Survey Information (shown at the correct location on the plansheet)
- _____ Survey Control Points (symbol, point name, material, N,E, Elev.) (ex. TP-2 (60d Nail) with N, E, and Elev.)
- _____ Survey Benchmarks (symbol, name, alignment reference, and Elev.) (ex. BM-2 (-L- Sta 10+53 34' Rt.) (Elev. = 750.56')
- _____ North Arrow (related to specific survey datum – i.e. NAD83 etc.)
- _____ Datum Description (Place Block on Plansheet #4)

_____ Proposed Features
- _____ Horizontal Alignment(s)
  Proposed Design/Construction Alignment(s) to include:
- _____ Heavy solid line(s) showing Proposed Alignment (Designate with -L-, -Y- or multiple with –L1-, -Y1-, etc.)
- _____ Beginning and Ending Stations (with Coordinates) (ex. -L- POT Sta. 10+00.00) (N = , E =)
- _____ Equality Stations (with Coordinates) (ex. -L- POC Sta. 13+26.54 = -Y- POT Sta. 10+85.63) (N = , E =)
- _____ Event Point Stations (i.e. PC, PT, PCC, PRC, PINC, etc.)
- _____ Bearings and Distances on Tangents

_____ Horizontal Curve Data (Show in Curve Info. Box)
(Number each curve and provide delta angle, radius, length of curve, and tangent length)(Optional: chord distance, chord bearing)

_____ Proposed Improvements such as curb and gutter, sidewalk, driveways, etc. (show with appropriate line weight and shading). Labeling is not necessary at this milestone. Drainage improvements should not be shown – these are not detailed enough at this milestone)

_____ Match Lines (reference station number and sheet number)

4. Profile Sheets

In general, show Existing Features with dashed and/or "screened" lines and Proposed Features with heavier solid lines and/or shading. **Use City of Charlotte layering standards.**

_____ Sheets are ½ Plan (at the bottom of sheet) and ½ Profile (at the top of the sheet) unless project lends itself to separate plan and profile sheets. The Horizontal Scale should be 1" = 20' and the Vertical Scale should be 1" = 4'. Any variance from these scales should be approved by the Program Manager.

_____ Existing Features
- _____ Dashed Line(s) labeled Existing Grade along -L-, -Y-, etc. (show existing centerline elevations every 25')
- _____ Existing Drainage or Utility Structures and Pipes (show to scale) (label size, type, material, and top/rim and invert elevations)

_____ Survey Information (shown at the correct location on the sheet)
(show benchmarks with name, setting, alignment reference, and elevation)
(ex. BM-2 (Railroad Spike set in the base of 32" Oak)
-L- Sta. 10+53 34' Rt.
Elev. = 750.56' (NAVD88)

_____ Proposed Features

_____ Vertical Alignment(s) (Show on a project by project basis)
Proposed Design/Construction Alignments to include:

_____ Heavy solid line(s) labeled "Proposed Grade"
(designate with -L-, -Y- or multiple with –L1-, -Y1-, etc.)

_____ Label proposed grades along grade line, PVC, PVT, and PVI Stations and Elevations

_____ Vertical Curves – label PVI station/elevation, K value, algebraic difference in grade, length of curve, low/high point station/elevation

_____ Proposed Elevations every 25'

5. Cross-Sections Sheets

In general, show Existing Features with dashed and/or "screened" lines and Proposed Features with heavier solid lines and/or shading. **Use City of Charlotte layering standards.**

_____ Scale should be 1" = 5' (Horizontal and Vertical) (Any variance from this scale should be approved by the Program Manager)

_____ Show Existing Ground Line (give existing elevation at construction alignment location(s))

_____ Show critical cross sections as identified by the Project Manager (locations with large obstacles such as trees, signs, retaining walls, or locations with high cut/fill lines)

6. General

_____ "Preliminary Plans- Do Not Use for Construction" is noted on all sheets.

_____ Same project number is shown on all sheets.

_____ Date plans printed shown in the title block.

II. 50% Plans Review Submittal Date:_____Designer: _____

Review Date:_____Reviewer: _____

A. General Overview

Note: A cursory review of previous milestone reviews should be completed prior to proceeding with the next milestone review to ensure changes and additions have been updated or corrected.

At this point, the design should be checked for constructability, utility conflicts and compliance with Storm Water Services design requirements. To meet this milestone requirement, a concept drainage (plan view only) should be completed with preliminary spread calculations and inlet locations with pipe layout and slopes. In addition, a written phasing for traffic control should be reviewed by CDOT to ensure the project can be constructed without temporary widening or overnight lane closures. Utility conflicts, above ground and underground, should be highlighted and discussed with the Utility Coordinator. Throughout the project limits, cut and fill lines should be imported to identify tree and environmental impacts as well as potential retaining wall or guardrail locations.

B. Required Submittals (Place a Check Mark, or N/A)

_____ Geotechnical Report (if applicable)

_____ Summary of concerns noted in the Phase I ESA document (if applicable)

_____ Storm Drainage Topo Map for proposed inlet locations and inlet calculation spreadsheet

_____ 50% Engineer's estimate

_____ Project Construction Plans (approximately 50% complete)

C. 50% Plans Checklist (Place a Check Mark, or N/A)

1. Title Sheet (Use City of Charlotte Standard Cover Sheet) (complete per 25% Plans)

   _____ Design designation data is shown.

2. Details (to be shown in the "2 Series" of sheets)

   _____ Provide Details for retaining walls and non-standard catch basins or culvert improvements.

   _____ Provide Details for other non-standard items not covered under NCDOT Specifications.

3. Plan Sheets

   _____ Label proposed Improvements such as curb and gutter, sidewalk, driveways, etc. (show with appropriate line weight and shading)

_____ Label pavement widths and taper/transitions.

_____ Label utility poles to be relocated "by others."

_____ Highlight above ground and underground utilities that are in conflict with the proposed improvements.

_____ Label proposed concept drainage system with material, length, slope and class of pipe.

_____ Import cut/fill lines and show retaining wall limits if determined necessary.

_____ Label tree removal and required tree protection.

_____ Show pavement removal with appropriate hatching

_____ Show accessible ramp locations with crossings

_____ Show superelevation at correct plan location(s) (if applicable)

_____ Show guard rail and retaining wall location(s) (if applicable)

4. Profile Sheets (No Change from the 25% review.)

5. Traffic Control (Written Phasing Scheme only)

_____ List by phase the proposed approach to accommodating the traffic control during the life of the project. Phases should be consistent with general construction guidelines and practices.

_____ Show proposed detours if required.

6. Cross-Sections Sheets

_____ Show Proposed Ground Line (templates with no labeling at this point).

_____ Add daylight lines for Cut/Fill slopes.

_____ Provide proposed elevation at construction alignment location(s).

_____ Show proposed retaining wall or guardrail locations.

_____ Sections should be shown at min. 50' increments (25' increment are required for projects < 1 mile and all sidewalk projects along the construction alignment(s) (i.e. 10+00, 10+50, 11+00, etc.). Label alignment designation and station.

_____ Check to ensure sight distance requirements have been met per the design criteria at intersections and major entrances with large traffic volumes.

75% Plans Review Submittal Date:_____Designer: _____

Review Date:_____Reviewer: _____

A. General Overview

Note: Survey should be field verified again prior to beginning 75% plans to assure no improvements have been installed since survey was received and last field visit occurred. A cursory review of previous milestone reviews should be completed prior to proceeding with the next milestone review to ensure changes and additions have been updated or corrected.

For this review, mark-ups/comments from utility companies as well as Storm Water Services should be incorporated into the project design. The project design at this milestone should include storm drainage (horizontal and vertical) with identified pipe sizes and minimum slopes. In addition, a traffic control plan (both written phasing and associated diagrams), and a pavement marking plan. In addition to the detailed plans, an updated engineer's estimate should be prepared. Any required permits should be identified at this milestone and plans should be prepared for appropriate submittals (NCDEQ, NCDOT, Water Quality, Etc.). Project grading limits should be checked for area disturbed. If the area exceeds one acre, an erosion control permit is required. If there are changes in the approved budget or schedule, a Change Control Document should be prepared to inform the Client and Project Team.

____ Field visit to verify survey

B. Required Submittals (Place a Check Mark, or N/A)

_____ Updated 75% engineer's estimate

_____ Storm Drainage Topo Map for proposed pipe system and pipe calculation spreadsheet

_____ ROW/easement quantities (spreadsheet)

_____ Project Construction Plans (approximately 75% complete)

C. 75% Plans Checklist (Place a Check Mark, or N/A)

1. Title Sheet

_____ Design designation data is shown.

2. Typical Sections & Details (to be shown in the "2 and 3 Series" of sheets)

_____ All necessary dimensions shown on pavement, subgrade, shoulders, slopes, centerline, medians, sidewalks, utility strips, curb & gutter, etc.

_____ Milling limits shown (if applicable)

_____ All slopes shown on pavement, shoulders, subgrade, hinge point grading, ditches, cut & fills.

_____ All grade points shown.

_____ All variable limits shown.

_____ Provide Details for retaining walls, non-standard catch basins, and culvert improvements. (update from previous milestone reviews).

_____ Provide Details for special ditches (lateral and berm ditches). Provide alignment, station, offset, and quantities such as drainage ditch excavation, rip rap, and filter fabric. (Note: Project Manager may choose to show this information on the plan sheets.)

_____ Provide Details for other non-standard items not covered under NCDOT Specifications. Some that may be considered are sidewalk taper, pipe trench detail for storm drainage pipe, and pavement overlay or wedging.

3. Plan Sheets

_____ Show the limits of construction by placing slope-stake lines on the plans. (lines should be designated as cut or fill by linetype)

_____ Show berm and lateral ditches if required. Insert corresponding ditch details.

_____ Proposed drainage. (cross-pipes, storm sewer systems, and driveway pipes) Label all pipes with size and material. Show and label pipe inlet and outlet devices such as headwalls, endwalls, flared-end sections, false sumps, rip rap and filter fabric requirements and quantities. Label drainage structure numbers.

_____ Label radii measured to face of curb.

_____ Label proposed utility poles to be relocated "by others" at the specified locations indicated by utility companies.

_____ Guardrail shown & labeled

_____ Show and label signal items to be installed by roadway contractor (ped bases, pull boxes, conduit, etc.)

_____ Retaining walls shown & labeled

_____ Ramps shown accurately on plan sheet with station labels (details not yet created)

4. Profile Sheets

_____ Show curb line grades if different from proposed design-line grade line.

_____ Label proposed edge of pavement elevations for left and right lip lines.

_____ Show proposed lateral ditches with beginning, ending, and PVI stations and elevations. Label proposed lateral ditch grades.

_____ Update proposed drainage. Make sure drainage structure number corresponds with that shown in plan view.

5. Erosion Control Plans

_____ Preferred scale 1"=40'.

_____ Erosion Control Notes & Legend Key.
(Use symbology consistent with the Erosion & Sediment Control Planning & Design Manual: https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual)

_____ Erosion Control measures shown on plan view. Erosion control plan must be sufficient to obtain plan approval and required erosion permits from NCDEQ.

_____ Erosion Control Details - if standard, refer to standard number.

_____ Temporary Wattle Check Dam/Inlet Protection
_____ Temporary Silt Fence
_____ Temporary and Permanent Seeding Specifications
_____ Other

6. Traffic Control/ Pavement Marking Plan

_____ Standard Traffic Control General Notes & Project Notes modified per project.

_____ Traffic control phasing is consistent with general construction practices.

_____ Traffic control custom phase drawings and/or CDOT WATCH diagrams correctly referenced per written phasing.

_____ Pavement Marking Plan preferred scale 1"=40'.

_____ Legend matches NCDOT pavement marking schedule.

_____ Legend matches plan view symbology.

7. Cross-Sections Sheets

_____ Label cut & fill slopes and varying pavement cross slopes.

_____ Label pertinent proposed elevations such as lip elevations and grade break point elevations.

_____ Show berm and lateral ditches.

_____ Show additional critical cross-sections at driveways and other critical areas such as drainage inlets.

_____ Label any non-typical existing or proposed features such as retaining walls, buildings, headwalls, channel changes, etc.

8. Utility Construction Plans

_____ Include in the construction set as separate plans if needed due to plan sheet clutter

90% Plans Review Submittal Date:_____Designer: _____

Review Date:_____Reviewer: _____

A. General Overview

Note: A cursory review of previous milestone reviews should be completed prior to proceeding with the next milestone review to ensure changes and additions have been updated or corrected.

This review milestone precedes preparing plats and easement exhibits for real estate acquisition. For this review, final mark-ups/comments from utility companies as well as Storm Water Services should be incorporated into the project design. The project design at this milestone should include updated drainage (horizontal and vertical), traffic control, and pavement marking plans. In addition to the detailed plans, an updated engineer's estimate should be prepared with an updated real estate cost. All required permit applications should be prepared at this point along with any required fees with check requests submitted.

B. Required Submittals (Place a Check Mark, or N/A)

_____ Final Pavement Design Calculation and typical sections modified.

_____ Final drainage map with spreadsheets and calculations for pipe system and inlet design

_____ Updated 90% engineer's estimate

_____ Permit Applications along with check requests (May include NCDEQ Erosion Control, NCDOT encroachment, Municipal Agreement, Water Quality Permit)

_____ Ramp Calculations

_____ Project Construction Plans (approximately 90% complete).

C. 90% Plans Checklist (Place a Check Mark, or N/A)

1. Title Sheet

_____ Design designation data is shown.

2. Typical Sections& Details (to be shown in the "2 and 3 Series" of sheets)

_____ Update the pavement/material schedule to incorporate the final pavement design.

_____ Ramp & curb return details

_____ Drainage structure table

3. Quantities Summary Sheet(s) (if applicable)

_____ Drainage Summary (Standard NCDOT or City formats)

4. Plan Sheets

_____ Show curb return elevations (if necessary). Label elevation on plan at 10' increments along lip of curb or shown on a curb return profile on a separate sheet

_____ Check to ensure all proposed work is clearly indicated. Such items overlooked to this point might include: fence relocations/additions, tree removal/protection & trimming needs, sign relocations/removal/additions, pipes to be removed/plugged/extended/, sealing abandoned wells, driveway reconnections, driveway pipes, etc.

_____ Show final storm drainage and labeled.

_____ Right-of-way & Easement lines, and Parcel numbers shown with standard parcel block information (check to make sure this matches plats/exhibits)

_____ Check to ensure no property has been landlocked with proposed improvements

_____ Areas to remain undisturbed with the right-of-way clearly marked

5. Profile Sheets

_____ Finalize proposed drainage. Label all pipes (parallel and cross-pipes) with size, material, length, slope, and class of pipe. Provide top/rim and invert elevations for all drainage structures. Label NCDOT or LDSM standards required (i.e. NCDOT Std. 840.01).

_____ Curb return profiles (if necessary)

6. Erosion Control Plans

_____ Narrative (if necessary)

_____ Construction Sequence (if necessary)

_____ Check to ensure all erosion control measures are contained within existing or proposed right-of-way and easements

7. Traffic Control/ Pavement Marking Plan

_____ Update plan sheets per comments from 75% review

8. Cross-Sections Sheets

_____ Show volumes for embankments, unclassified excavation, and known undercut excavation on each cross-section.

_____ Provide dimensions as needed (required on NCDOT streets).

9. Utility Construction Plans

_____ Check to ensure only work to be performed by the contractor is indicated with heavy lines and text

_____ Show other pertinent plan information with background or gray-scale symbology

10. Utilities By Others Plans

_____ Include in the construction set as separate plans if needed due to plan sheet clutter

_____ Check to ensure only work to be performed by others (not the contractor) is indicated with heavy lines and text

_____ Show other pertinent plan information with background or gray-scale symbology

Final Plans Review Submittal Date:_____Designer: _____

Review Date:_____Reviewer: _____

A. General Overview

This milestone review has as its purpose to finalize construction plans, engineer's estimate, project special provisions, and any other items necessary to submit to Bid Phase. It incorporates review comments from the 90% plans review and external reviews such as NCDOT Encroachment Agreement. Prior to this review, right-of-way and easement needs have been determined and incorporated into the plans, plats and exhibits have been prepared, and Real Estate Phase is well underway. Coordination has occurred for landscaping needs, traffic signal work, and utility relocations. The project budget and schedule have been updated to reflect any IPDS Change Controls. This review should present a clear picture of the project design with all necessary details for successful construction.

B. Required Submittals (Place a Check Mark, or N/A)

_____ Submit Permit Applications (May include Erosion Control, NCDOT encroachment, Municipal Agreement, Water Quality Permit).

_____ Final Engineer's Estimate (all computations included)

_____ Written Project Special Provisions

_____ Listing of Right-of-Way and Easement Areas (via Spreadsheet)

_____ Final Project Construction Plans with signed/sealed mylar cover sheet and final review stamp on remaining sheets

C. Final Plans Checklist (Place a Check Mark, or N/A)

1. Title Sheet

_____ Updated Index of Sheets

_____ Project Stakeholder signatures under the "Recommended for Construction" block

_____ City Engineer's approval signature

2. Details (to be shown in the "2 and 3 Series" of sheets)

_____ Standard General Notes shown on Sheet 2 & updated to show project specific Sheet references

_____ List of Standard Drawings pertinent to project (NCDOT or CMLD)

3. Plan Sheets

_____ All cross-reference notes are correct

_____ All utility relocations/adjustments labeled and clearly identified as work the contractor is to perform or as work to be done by others

4. Profile Sheets

_____ All cross-reference notes are correct if separate plan & profile sheets

5. Traffic Control Plans

_____ Update to reflect any changes from 90% review or to address any access issues

6. Pavement Marking Plans

_____ Clearly denote markings to be removed (include line item(s) & quantities in engineer's estimate)

_____ Check for any temporary markings needed (include line item(s) & quantities in engineer's estimate)

_____ Check for the need of permanent pavement markers (raised or snowplowable)

_____ Reference Standard Drawings (if applicable)

_____ Clearly identify signs to be installed by the contractor & signs to be installed by others

7. Construction Staking Plans

_____ Provide all necessary information for staking not contained elsewhere in the construction plans (Note: This information may be provided at a later date if required and not be included at this milestone.)

8. Signal Plans

_____ Include in the construction plans if the contractor is to perform any of this work

Consultant Forum

Nov 1, 2018

Cost Estimating Information

1. Website resources
    a. CIC list and Special Provisions: http://charlottenc.gov/Engineering/Bids/Pages/SpecialProvisions.aspx
    b. Bid Tab prices: http://charlottenc.gov/Engineering/bids/Pages/BidsContractsArchive.aspx
2. Cost Estimating spreadsheet
    a. Provided by project manager – make sure it is latest updated spreadsheet
    b. \\CHARLOTTE\CoCDFS\Engineering\Shared Data\Shared_Engineering Proj Templates\Cost PROJECT NAME XX% DATE.xlsx
    c. Date updated for each submittal
        i. Twice a year – March/Sept plus milestone reviews (25/50/75/90/100)
    d. Must be reviewed internally prior to submittal to City (2 names on estimate)
    e. Update type of cost estimate in pull down
    f. Line items are used from the CIC list provided in the spreadsheet (unless specialty item)
    g. Check NCDOT specs or City SPs to make sure pay items are understood
        i. Example –ramps recently revised to include vertical curb in pay item (used to be separate)
    h. Required tabs
        i. Construction
        ii. Comp grading - calculate actual comp grading cost (no longer a %)
            1. Suggest not to use anything below 20% as a check
        iii. RE cost (RE to provide unit price)
        iv. Utilities
        v. Signals (planning/25% plans, provided by CDOT implementation 50% and later)
        vi. Pipe Video – for all projects with new storm drainage pipe
    i. Other tabs available for earthwork/asphalt/stone/pavement markings/signs are optional
        i. If you have internal spreadsheets for these items, feel free to use them but they must be submitted with your cost estimates.
    j. Cover Sheet – ensure items you are responsible for in h. above are correctly represented on the cover sheet. Complete survey, geotech, and other applicable items on the cover sheet in coordination with the City's project manager. The City's project manager is ultimately responsible for ensuring the cover sheet is completed.

Invoice

Reference Invoice Number with Payment

Invoice No.	00433051-H
Invoice Date	January 13, 2015
Invoice Amount Due	$9,449.43
Payment Terms	Net 30

City of Charlotte
Accounts Payable
PO Box 37979
Charlotte, NC 28237-7979

Project name
Purchase Order No: 2015000662

Professional Services
From: November 30, 2014 To: December 27, 2014

Professional Services Summarization	Hours	Amount
Administration	1.00	amounts
Project Manager	44.50	
Public Involvement Coordinator	2.00	
Senior Planner	1.00	
Sr Public Involvement Coord	4.50	
Staff Engineer	5.00	
Sust Trans Planner (Expert)	4.00	
	62.00	**$9,202.00**
	Total Professional Services	**$9,202.00**

Expenses Summarization	Quantity	Amount
Long Distance Travel		17.00
Standard Printing/Plotting		230.43
		$247.43
	Total Expenses	**$247.43**

Amount Due This Invoice	**$9,449.43**

Fee Amount	$374,954.00
Fee Invoiced to Date	$77,457.83
Fee Remaining	$297,496.17

Project name
Contract #

INVOICE SUMMARY

00433051-H
Project Invoice No. 3
Invoice Period End Date 12/27/2014

PHASE 1 - TASK SUMMARY

Task	Description	Contract Amt	Previously Earned Fee	Current Invoice	Earned Fee To Date	Contract Balance	Total %
1	Community Engagement	$ 82,214.00	$ 16,732.50	$ 5,225.00	$ 21,957.50	$ 60,256.50	26.71%
	consultant	$ 76,714.00	$ 16,732.50	$ 5,225.00	$ 21,957.50	$ 54,756.50	28.62%
		$ 5,500.00	$ -	$ -	$ -	$ 5,500.00	0.00%
2	Market Analysis	$ 78,600.00	$ 31,700.00	$ -	$ 31,700.00	$ 46,900.00	40.33%
	consultant	$ 3,960.00	$ 3,000.00	$ -	$ 3,000.00	$ 960.00	75.76%
		$ 66,640.00	$ 28,700.00	$ -	$ 28,700.00	$ 37,940.00	43.07%
		$ 8,000.00	$ -	$ -	$ -	$ 8,000.00	0.00%
3	Project Identification	$ 27,968.00	$ 11,465.00	$ 1,205.00	$ 12,670.00	$ 15,298.00	45.30%
4	Project Prioritization	$ 13,590.00	$ -	$ -	$ -	$ 13,590.00	0.00%
7	Administrative	$ 11,328.00	$ 5,130.00	$ 2,772.00	$ 7,902.00	$ 3,426.00	69.76%
	TOTAL	$ 213,700.00	$ 65,027.50	$ 9,202.00	$ 74,229.50	$ 139,470.50	34.74%

PHASE 2 - TASK SUMMARY

Task	Description	Contract Amt	Previously Earned Fee	Current Invoice	Earned Fee To Date	Contract Balance	Total %
1	Community Engagement	OPTIONAL					
3	Project Concept Development	$ 84,010.00	$ -	$ -	$ -	$ 84,010.00	0.00%
	consultant	$ 45,810.00	$ -	$ -	$ -	$ 45,810.00	0.00%
		$ 6,600.00	$ -	$ -	$ -	$ 6,600.00	0.00%
		$ 21,000.00	$ -	$ -	$ -	$ 21,000.00	0.00%
		$ 10,600.00	$ -	$ -	$ -	$ 10,600.00	0.00%
4	Project Prioritization & Ranking	OPTIONAL					
5	CIS Summary Report	$ 32,016.00	$ -	$ -	$ -	$ 32,016.00	0.00%
	consultant	$ 30,016.00	$ -	$ -	$ -	$ 30,016.00	0.00%
		$ 2,000.00	$ -	$ -	$ -	$ 2,000.00	0.00%
6	Presentation of CIS Summary Report	OPTIONAL					
7	Administrative	$ 8,928.00	$ -	$ -	$ -	$ 8,928.00	0.00%
	TOTAL	$ 124,954.00	$ -	$ -	$ -	$ 124,954.00	0.00%

DIRECT EXPENSES SUMMARY

	Contract Amt	Previously Billed	Current Invoice	Total Billed To Date	Contract Balance	Total %
consultant	$ 24,000.00	$ 1,559.31	$ 247.43	$ 1,806.74	$ 22,193.26	7.53%
	$ -	$ -	$ -	$ -	$ -	
	$ 10,800.00	$ 965.32	$ -	$ 965.32	$ 9,834.68	8.94%
	$ 500.00	$ -	$ -	$ -	$ 500.00	0.00%
	$ 500.00	$ -	$ -	$ -	$ 500.00	0.00%
	$ 500.00	$ -	$ -	$ -	$ 500.00	0.00%
TOTAL	$ 36,300.00	$ 2,524.63	$ 247.43	$ 2,772.06	$ 33,527.94	7.64%

TASK 1 - COMMUNITY ENGAGEMENT

Project name

00433051-H

Project Invoice No. 3
Invoice Period End Date 12/27/2014

TASK 1-

	Previous Hours Billed	Hours Billed to Date	Current Hours	Hourly Rate	Total Labor Current Invoice
Project Manager	24	49	25	Rates	$ Rates
Senior Planner					$
Sustain. Trans. Planner					$
Planner					$
Sr. Professional Engr.					$
Staff Engineer		5	5		$
Sr. PI Coord.	41.25	45.75	4.5		$
PI Coord.	76.25	78.25	2		$
Graphic Artist					$
Web Specialist	0.25	0.25			$
Administration					$
				TASK 1 TOTAL -	**$ 5,225.00**

TASK 1 -

Contract Amount	Previously Billed	Current Invoice	Total Current Invoice
$ 5,500.00	$ -	$ -	$ -

TASK 1 TOTAL EARNED - CURRENT INVOICE	**$ 5,225.00**
TASK 1 PREVIOUSLY EARNED	$ 16,732.50
TASK 1 TOTAL EARNED TO DATE	$ 21,957.50
TASK 1 TOTAL CONTRACT AMOUNT	$ 82,214.00
TASK 1 CONTRACT BALANCE	**$ 60,256.50**

TASK 2 - MARKET ANALYSIS

TASK 2 -

	Previous Hours Billed	Hours Billed to Date	Current Hours	Hourly Rate	Total Labor Current Invoice
Project Manager	20	20		Rates	$ -
Senior Planner					$ -
Sustain. Trans. Planner					$ -
Planner					$ -
Sr. Professional Engr.					$ -
Staff Engineer					$ -
Sr. PI Coord.					$ -
PI Coord.					$ -
Graphic Artist					$ -
Web Specialist					$ -
Administration					$ -
				TASK 2 TOTAL -	**$ -**

TASK 2

Contract Amount	Previously Billed	Current Invoice	Total Current Invoice
$ 66,640.00	$ 28,700.00	$ -	$ -

TASK 2

Contract Amount	Previously Billed	Current Invoice	Total Current Invoice
$ 8,000.00	$ -	$ -	$ -

TASK 2 TOTAL EARNED - CURRENT INVOICE	**$ -**
TASK 2 PREVIOUSLY EARNED	$ 31,700.00
TASK 2 TOTAL EARNED TO DATE	$ 31,700.00
TASK 2 TOTAL CONTRACT AMOUNT	$ 78,600.00
TASK 2 CONTRACT BALANCE	**$ 46,900.00**

CHARLOTTE.

CITY OF CHARLOTTE
DEPARTMENT OF TRANSPORTATION

Charlotte Department of Transportation **November 2018**

Engineers Forum
PROWAG Design

Where sidewalks and pedestrian routes within street crossings (including marked and unmarked crosswalks) are provided, they must be constructed so they are accessible to all users, including those with disabilities.

The July 26, 2011 "Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right - of - Way" was written by the US Access Board, a federal agency that is part of the Department of Justice. The Guidelines are also known as the Public Right - of - Way Accessibility Guidelines, or PROWAG. PROWAG provides more specific information than the existing Americans with disabilities Act Accessibilities Guidelines (ADAAG) for transportation facilities within the right - of - way including pedestrian access routes, signals, and parking facilities. The PROWAG requirements are currently in the development and adoption process and have not yet been officially adopted by the Department of Justice; however, the Federal Highway Administration has issued guidance that the draft version of the PROWAG "are currently recommended best practices, and can be considered the state of the practice that could be followed for areas not fully addressed" in the existing ADAAG requirements.

Designers are encouraged to reference the complete PROWAG document for additional information (https://www.access-board.gov/). Buildings and other structures not covered by PROWAG must comply with the applicable requirements of the ADAAG.

Due to the importance of ensuring that all facilities are built according to PROWAG, it is the expectation that the designer provide details that aid in the construction of curb ramps including slopes and dimensions (see attached curb ramp details for examples).

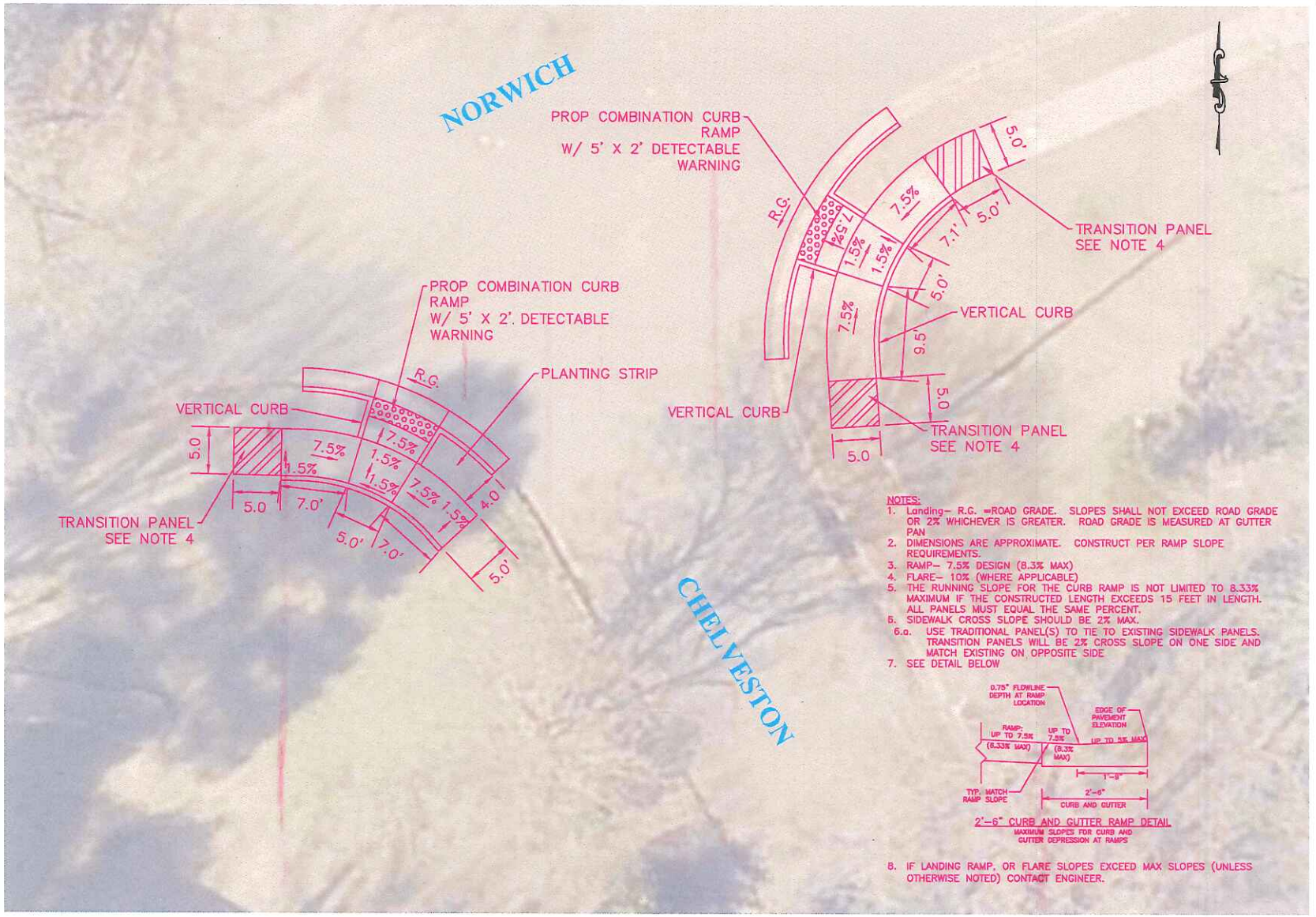
The following documents should be frequent tools of any project team working in Charlotte:

- Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way
  https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way

- Special Report: Accessible Public Rights-of-Way Planning and Design for Alterations
  https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/guidance-and-research/accessible-public-rights-of-way-planning-and-design-for-alterations

- Charlotte Land Development Standards
  https://charlottenc.gov/ld/CLDSM/Pages/default.aspx?NotFoundURL=https://charlottenc.gov/cldsm&Referrer=

- NCDOT Alternative Curb Ramp Designs
  https://connect.ncdot.gov/resources/Specifications/Pages/2018-Roadway-Standard-Drawings.aspx



NOTES:

1. Landing– R.G. =ROAD GRADE. SLOPES SHALL NOT EXCEED ROAD GRADE OR 2% WHICHEVER IS GREATER. ROAD GRADE IS MEASURED AT GUTTER PAN
2. DIMENSIONS ARE APPROXIMATE. CONSTRUCT PER RAMP SLOPE REQUIREMENTS.
3. RAMP– 7.5% DESIGN (8.3% MAX)
4. FLARE– 10% (WHERE APPLICABLE)
5. THE RUNNING SLOPE FOR THE CURB RAMP IS NOT LIMITED TO 8.33% MAXIMUM IF THE CONSTRUCTED LENGTH EXCEEDS 15 FEET IN LENGTH. ALL PANELS MUST EQUAL THE SAME PERCENT.
6. SIDEWALK CROSS SLOPE SHOULD BE 2% MAX.
   6.a. USE TRADITIONAL PANEL(S) TO TIE TO EXISTING SIDEWALK PANELS. TRANSITION PANELS WILL BE 2% CROSS SLOPE ON ONE SIDE AND MATCH EXISTING ON OPPOSITE SIDE
7. SEE DETAIL BELOW

2'–6" CURB AND GUTTER RAMP DETAIL
MAXIMUM SLOPES FOR CURB AND GUTTER DEPRESSION AT RAMPS

8. IF LANDING RAMP, OR FLARE SLOPES EXCEED MAX SLOPES (UNLESS OTHERWISE NOTED) CONTACT ENGINEER.

CHARLOTTE.

Plans Prepared By:
BUILDING DEPARTMENT
CITY OF CHARLOTTE
STORMWATER SERVICES
PLANNING & ZONING GROUP

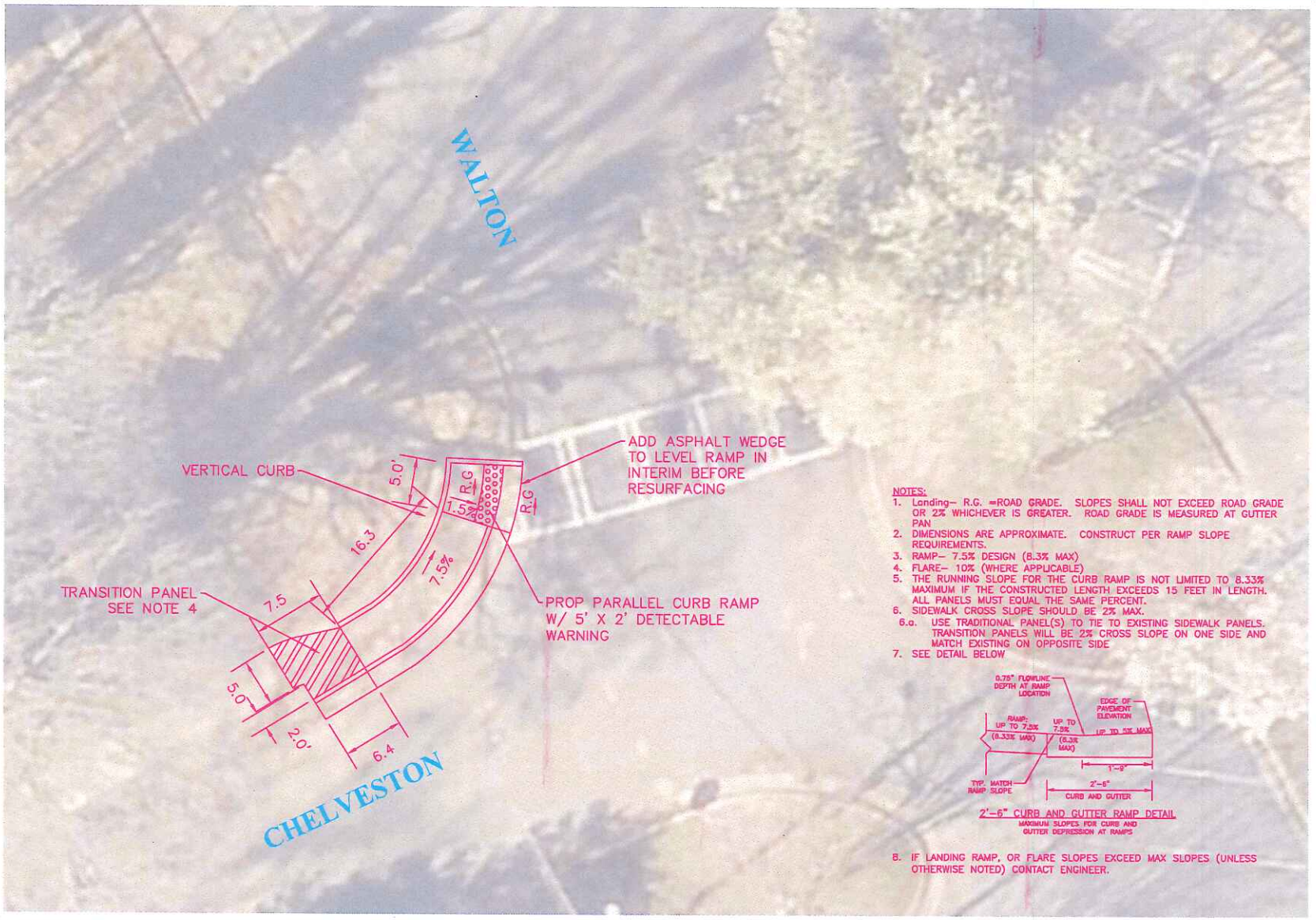
H1"=10'	ESM	ESM	09/18/17
DRAWN BY	CHECKED BY	REVISED BY	REVISED DATE

CURB RAMP DETAIL

CHELVESTON AND NORWICH (AREA 14)

SHEET 1 OF 1

Wednesday, August 30, 2017 2:57:00 PM



NOTES:

1. Landing– R.G. =ROAD GRADE. SLOPES SHALL NOT EXCEED ROAD GRADE OR 2% WHICHEVER IS GREATER. ROAD GRADE IS MEASURED AT GUTTER PAN
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5. THE RUNNING SLOPE FOR THE CURB RAMP IS NOT LIMITED TO 8.33% MAXIMUM IF THE CONSTRUCTED LENGTH EXCEEDS 15 FEET IN LENGTH. ALL PANELS MUST EQUAL THE SAME PERCENT.
6. SIDEWALK CROSS SLOPE SHOULD BE 2% MAX.
   6.a. USE TRADITIONAL PANEL(S) TO TIE TO EXISTING SIDEWALK PANELS. TRANSITION PANELS WILL BE 2% CROSS SLOPE ON ONE SIDE AND MATCH EXISTING ON OPPOSITE SIDE
7. SEE DETAIL BELOW

2'-6" CURB AND GUTTER RAMP DETAIL
MAXIMUM SLOPES FOR CURB AND GUTTER DEPRESSION AT RAMPS

8. IF LANDING RAMP, OR FLARE SLOPES EXCEED MAX SLOPES (UNLESS OTHERWISE NOTED) CONTACT ENGINEER.

CHARLOTTE.

Plans Prepared By:

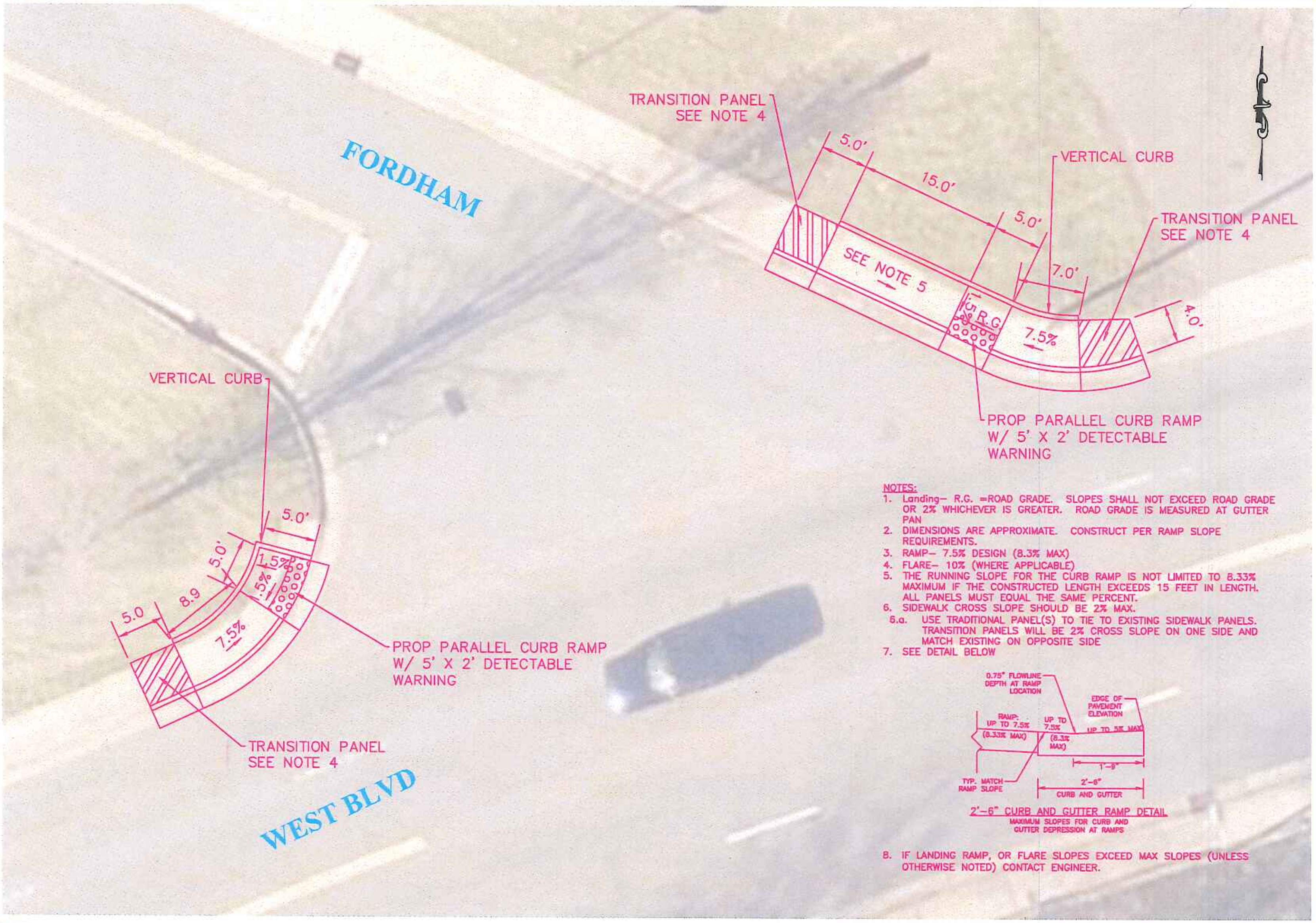
BUILDING Inspection

CURB RAMP DETAIL

CHELVESTON AND WALTON (AREA 14)

SHEET 1 OF 1

Wednesday, August 30, 2017 2:58:01 PM



NOTES:
1. Landing– R.G. =ROAD GRADE. SLOPES SHALL NOT EXCEED ROAD GRADE OR 2% WHICHEVER IS GREATER. ROAD GRADE IS MEASURED AT GUTTER PAN
2. DIMENSIONS ARE APPROXIMATE. CONSTRUCT PER RAMP SLOPE REQUIREMENTS.
3. RAMP– 7.5% DESIGN (8.3% MAX)
4. FLARE– 10% (WHERE APPLICABLE)
5. THE RUNNING SLOPE FOR THE CURB RAMP IS NOT LIMITED TO 8.33% MAXIMUM IF THE CONSTRUCTED LENGTH EXCEEDS 15 FEET IN LENGTH. ALL PANELS MUST EQUAL THE SAME PERCENT.
6. SIDEWALK CROSS SLOPE SHOULD BE 2% MAX.
6.a. USE TRADITIONAL PANEL(S) TO TIE TO EXISTING SIDEWALK PANELS. TRANSITION PANELS WILL BE 2% CROSS SLOPE ON ONE SIDE AND MATCH EXISTING ON OPPOSITE SIDE
7. SEE DETAIL BELOW

0.75" FLOWLINE DEPTH AT RAMP LOCATION
EDGE OF PAVEMENT ELEVATION
RAMP: UP TO 7.5% (8.33% MAX)
UP TO 7.5% (8.3% MAX)
UP TO 5% MAX
1'-9"
2'-6"
CURB AND GUTTER
TYP. MATCH RAMP SLOPE

2'-6" CURB AND GUTTER RAMP DETAIL
MAXIMUM SLOPES FOR CURB AND GUTTER DEPRESSION AT RAMPS

8. IF LANDING RAMP, OR FLARE SLOPES EXCEED MAX SLOPES (UNLESS OTHERWISE NOTED) CONTACT ENGINEER.

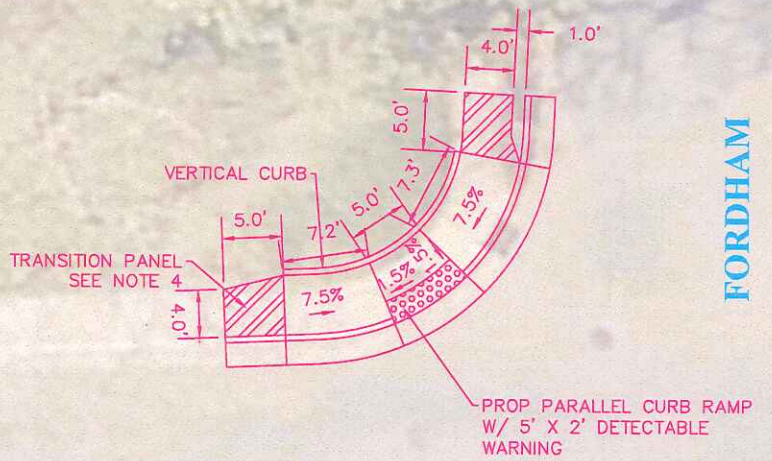
CHARLOTTE.

Plans Prepared By:
BUILDING
FOR CHARLOTTE
CITY OF CHARLOTTE
ENGINEERING & PROPERTY MANAGEMENT
PLANNING & DESIGN GROUP
600 East Fourth Street
Charlotte, North Carolina 28202
Phone: (704) 336-2291
Fax: (704) 336-6586

H=1"=10'
SEM
SEM
08/18/17

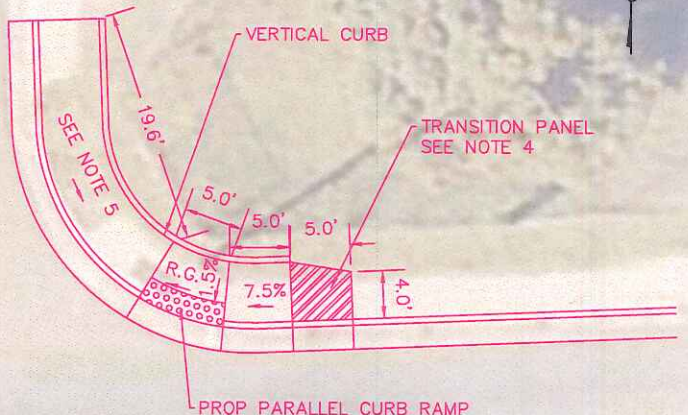
CURB RAMP DETAIL
FORDHAM AND WEST (AREA 14)
1
1

Wednesday, August 30, 2017 2:59:10 PM



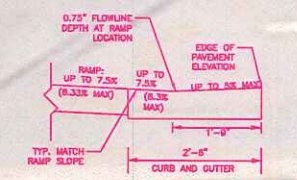
FORDHAM

WEST BLVD



NOTES:

1. Landing– R.G. =ROAD GRADE. SLOPES SHALL NOT EXCEED ROAD GRADE OR 2% WHICHEVER IS GREATER. ROAD GRADE IS MEASURED AT GUTTER PAN
2. DIMENSIONS ARE APPROXIMATE. CONSTRUCT PER RAMP SLOPE REQUIREMENTS.
3. RAMP– 7.5% DESIGN (8.3% MAX)
4. FLARE– 10% (WHERE APPLICABLE)
5. THE RUNNING SLOPE FOR THE CURB RAMP IS NOT LIMITED TO 8.33% MAXIMUM IF THE CONSTRUCTED LENGTH EXCEEDS 15 FEET IN LENGTH. ALL PANELS MUST EQUAL THE SAME PERCENT.
6. SIDEWALK CROSS SLOPE SHOULD BE 2% MAX.
   - 6.a. USE TRADITIONAL PANEL(S) TO TIE TO EXISTING SIDEWALK PANELS. TRANSITION PANELS WILL BE 2% CROSS SLOPE ON ONE SIDE AND MATCH EXISTING ON OPPOSITE SIDE
7. SEE DETAIL BELOW



2'–6" CURB AND GUTTER RAMP DETAIL
MAXIMUM SLOPES FOR CURB AND GUTTER DEPRESSION AT RAMPS

8. IF LANDING RAMP, OR FLARE SLOPES EXCEED MAX SLOPES (UNLESS OTHERWISE NOTED) CONTACT ENGINEER.

CHARLOTTE.

Plans Prepared By:

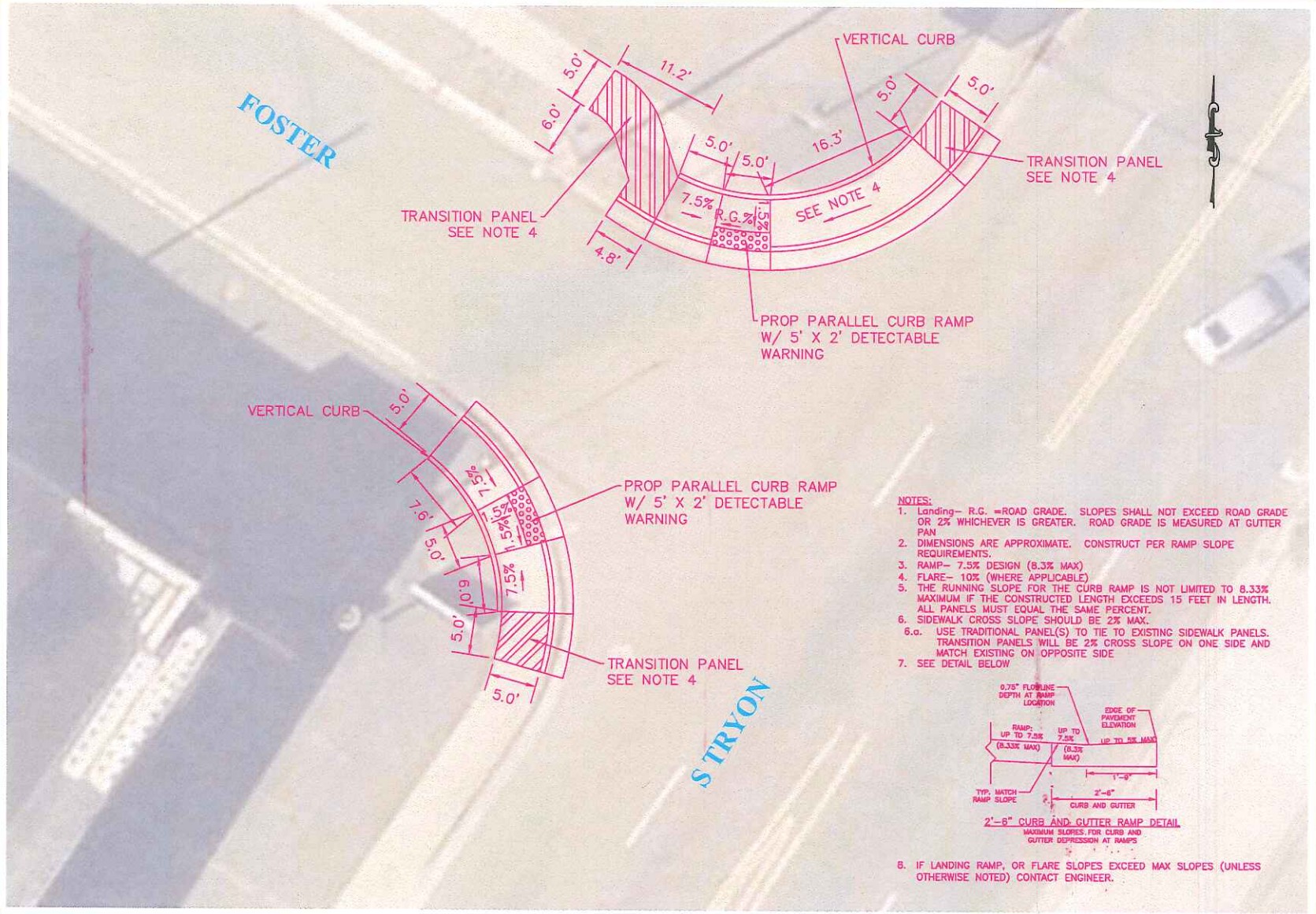
BUILDING

CURB RAMP DETAIL

FORDHAM AND WEST (AREA 14)

SHEET 1 OF 1

Wednesday, August 30, 2017 2:59:58 PM



NOTES:

1. Landing– R.G. =ROAD GRADE. SLOPES SHALL NOT EXCEED ROAD GRADE OR 2% WHICHEVER IS GREATER. ROAD GRADE IS MEASURED AT GUTTER PAN
2. DIMENSIONS ARE APPROXIMATE. CONSTRUCT PER RAMP SLOPE REQUIREMENTS.
3. RAMP– 7.5% DESIGN (8.3% MAX)
4. FLARE– 10% (WHERE APPLICABLE)
5. THE RUNNING SLOPE FOR THE CURB RAMP IS NOT LIMITED TO 8.33% MAXIMUM IF THE CONSTRUCTED LENGTH EXCEEDS 15 FEET IN LENGTH. ALL PANELS MUST EQUAL THE SAME PERCENT.
6. SIDEWALK CROSS SLOPE SHOULD BE 2% MAX.
   - 6.a. USE TRADITIONAL PANEL(S) TO TIE TO EXISTING SIDEWALK PANELS. TRANSITION PANELS WILL BE 2% CROSS SLOPE ON ONE SIDE AND MATCH EXISTING ON OPPOSITE SIDE
7. SEE DETAIL BELOW

2'–6" CURB AND GUTTER RAMP DETAIL
MAXIMUM SLOPES FOR CURB AND GUTTER DEPRESSION AT RAMPS

8. IF LANDING RAMP, OR FLARE SLOPES EXCEED MAX SLOPES (UNLESS OTHERWISE NOTED) CONTACT ENGINEER.

CHARLOTTE.

Plans Prepared By:

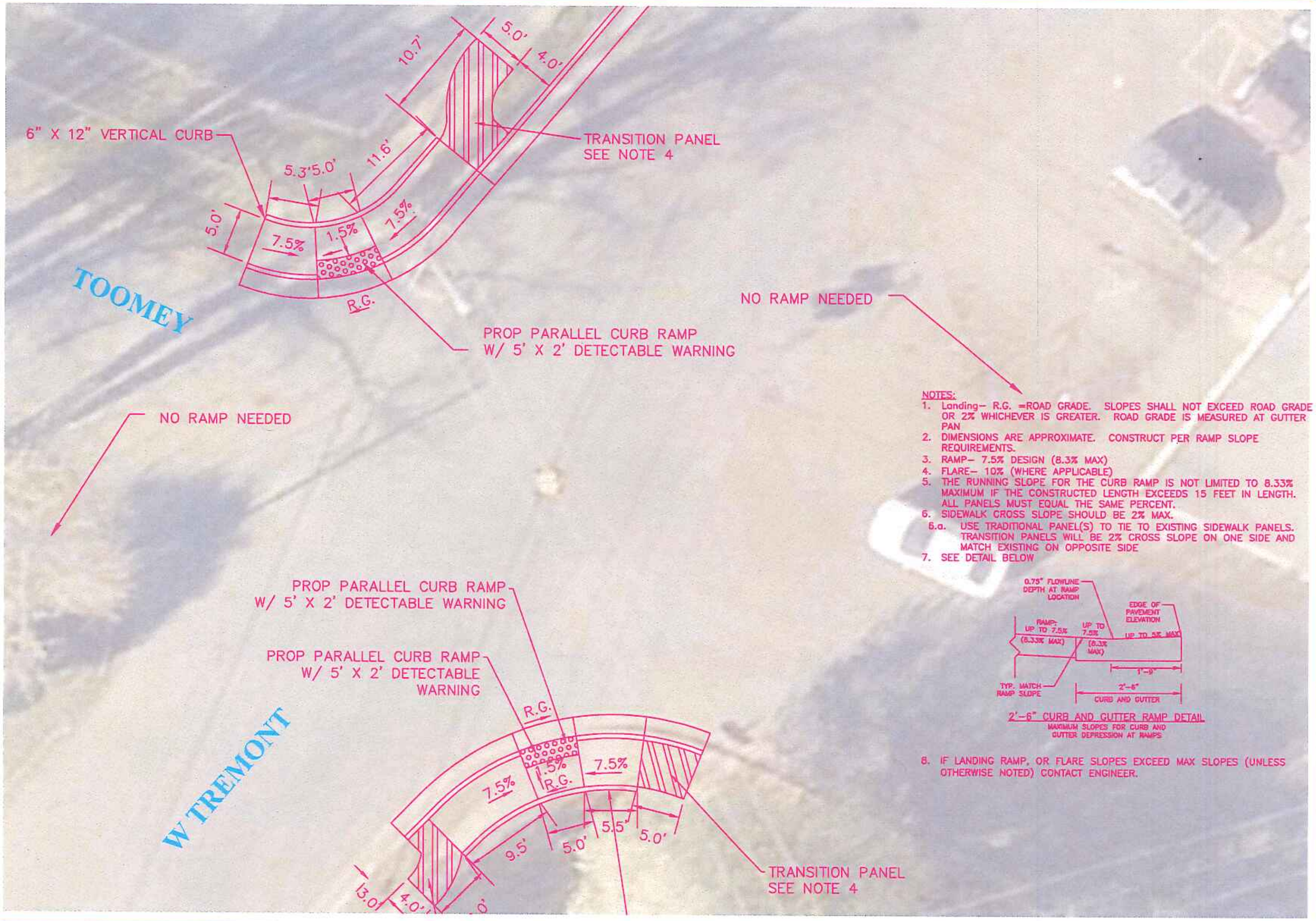
BUILDING INNOVATIONS

CURB RAMP DETAIL

FOSTER AND SOUTH TRYON (AREA 14)

SHEET 1 OF 1

Wednesday, August 30, 2017 3:00:19 PM



CHARLOTTE.

Plans Prepared By:

BUILDING FOR CHARLOTTE

CURB RAMP DETAIL

W. TREMONT AND TOOMEY (AREA 14)

1 of 1

H:1"=10'

08/18/17

Wednesday, August 30, 2017 2:58:44 PM

Charlotte Department of Transportation **1 November 2018**

Engineers Forum
Bicycle Facility Design

The City of Charlotte seeks to plan, design, construct, operate and maintain the City's transportation network in a way that promotes safe travel, economic development, and transportation choices. In accordance with adopted City Policy such as the Urban Streets Design Guide (USDG) and the Transportation Action Plan (TAP), Charlotte is committed to enhancing the connectivity, safety, and prevalence of its bicycle network throughout the City. Charlotte is becoming a more bicycle-friendly community everyday as bike lanes and separated bike lanes are added where roads are widened or built; projects are constructed through the implementation of bicycle and greenway plans, and as greenfield areas develop in a more connected fashion.

Through the City's 2016 phone survey on transportation, the City learned that, while most residents do not find it easy to travel by bicycle in Charlotte, a majority of residents would like to bike more.

The United States is undergoing rapid advances in bicycle facility design practices. Separated Bike Lanes and other innovative facilities are becoming more prevalent in cities across the United States. The result is new and evolving design guidance at the federal, state, and local levels of which all engineers and planners working in the field of transportation must be aware.

As projects advance, there are many planning and design details to be determined, including: location within network, safety benefits, existing and potential users, choosing the location of bicycle facility, additional contextual considerations, installation opportunities, funding, maintenance and outreach, and project evaluation.

***Charlotte Bikes*, adopted in May 2017, includes a Bicycle Facility Implementation Guide. This portion of the Plan serves as a starting point for selection of the preferred bikeway facility type for a given roadway based on traffic speeds and volumes. However, many other factors must be considered, so the results of this tool must be calibrated to project demands.**

The following documents should be frequent tools of any project team working in Charlotte:

- Federal Highway Administration (FHWA)
  - Bicycle and Pedestrian Facility Design Flexibility
    https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_flexibility.cfm
    - "...DOT encourages transportation agencies to go beyond the minimum requirements, and proactively provide convenient, safe, and context-sensitive

facilities that foster increased use by bicyclists and pedestrians of all ages and abilities, and utilize universal design characteristics when appropriate."
    - Specifically endorses NACTO, ITE guidance, outlines pilot/experimentation process
  - Separated Bike Lane Planning & Design Guide https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page00.cfm
- American Association of State Highway and Transportation Officials (AASHTO)
  - Guide for the Development of Bicycle Facilities (2012, Fourth Edition) https://store.transportation.org/Item/CollectionDetail?ID=116&gclid=Cj0KCQjwsMDeBRDMARIsAKrOP7HRFGC4R3DRkzBlJgD0uimFgG_btSmcY4Kftz-K3K0pNYcoh1YDTG0aAmBrEALw_wcB
  - AASHTO is currently working through the approval process for a new edition of the Bicycle Guide, anticipated to be released in 2019. The AASHTO Guide has been rewritten to support inclusive bicycling for All Ages and Abilities serving the widest spectrum of bicyclists.
- National Association of City Transportation Officials (NACTO)
  - Urban Street Design Guide https://nacto.org/publication/urban-street-design-guide/
  - Urban Bikeway Design Guide https://nacto.org/publication/urban-bikeway-design-guide/
- North Carolina Department of Transportation (NCDOT)
  - Complete Streets Planning and Design Guidelines https://connect.ncdot.gov/projects/BikePed/Pages/Complete-Streets.aspx
- Charlotte
  - *Charlotte Bikes* (Adopted May 2017) https://charlottenc.gov/Transportation/Programs/Pages/Bicycle.aspx
  - CDOT Technical Memorandum No. 17-01: Green Pavement Markings for Bicycle Facilities (2017)
  - Urban Street Design Guidelines (USDG, 2007) https://charlottenc.gov/Transportation/PlansProjects/Documents/USDG%20Full%20Document.pdf

APPENDIX A: BIKEWAY FACILITY SELECTION

Bikeway Facility Selection in the Charlotte Context

In some cases the selection of an appropriate bikeway must balance traffic conditions, land use context, and implementation cost.

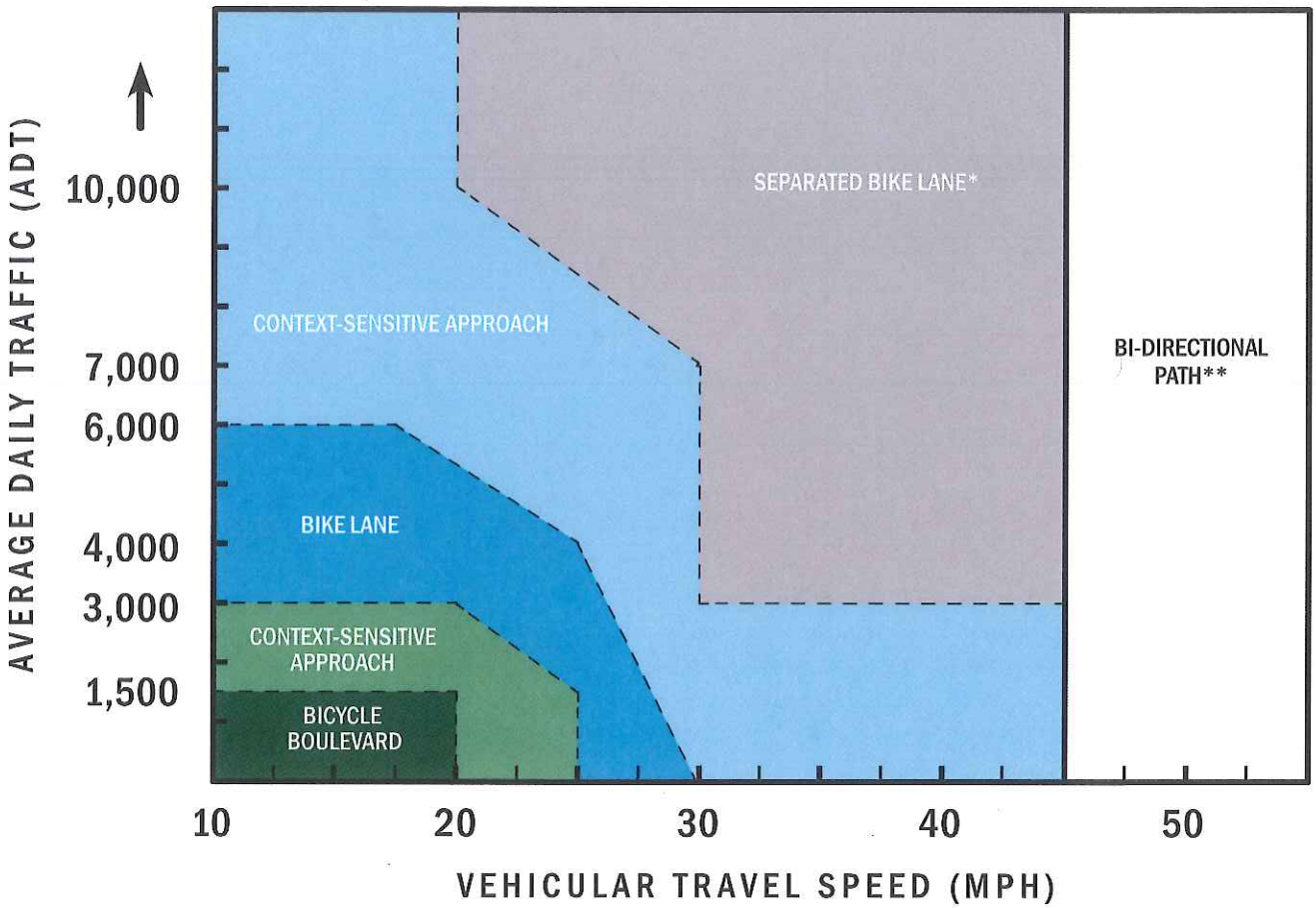
As a starting point to selecting the preferred bikeway facility type for a given roadway, *Figure 1* (on the following page) can be used to determine the recommended type of bikeway to be provided in particular roadway speed and volume situations. To use this chart, identify the appropriate daily traffic volume and travel speed on the existing or proposed roadway, and locate the facility type(s) indicated by those key variables.

Other factors beyond speed and volume which may alter the preferred facility selection include:

- traffic mix of automobiles and heavy vehicles,
- the presence of on-street parking,
- available roadway or roadside space,
- intersection and driveway density, and
- surrounding land uses and expected pedestrian volumes.

Once the preferred facility type is identified, the reference tables on the following pages provide high- level summary information regarding the design, implementation and design considerations related to each facility type.

Figure 1: Bicycle Facility Implementation Guide



These speeds are generally inappropriate in an urban setting, and a path may be a viable facility type.

A separated bike lane facility is appropriate in this speed and volume range

A bike lane may function here, but additional separation is preferred. Consider providing additional width in the form of a painted buffer or physical separation.

A bike lane facility is appropriate in this speed and volume range

A bicycle boulevard may function here, but consider additional traffic calming and access management in order to improve conditions.

A bicycle boulevard may function here, but consider additional traffic calming and access management in order to improve conditions.

* SEPARATED BIKE LANE

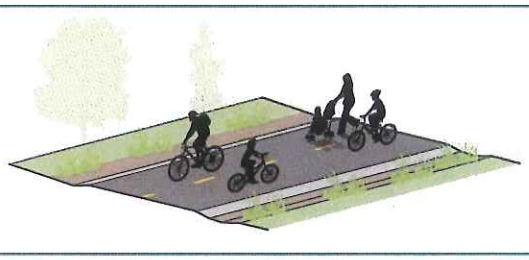
One-way directional separated bicycle facilities are preferred over two-way cycletracks under most circumstances.

Bidirectional (two-way) separated bike lanes may be considered on one-way streets, where operational challenges can most easily be addressed. On two-way streets, bidirectional separated bike lanes are generally inappropriate, but may be considered for short segments to fill a gap or complete a critical connection. Long segments of bidirectional separated bike lanes may be appropriate on streets with few intersections or driveways, such as along rivers or parks.

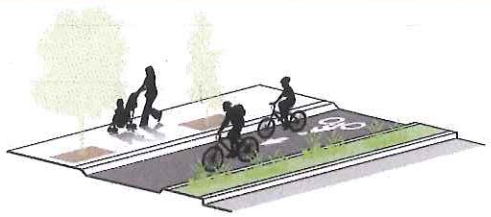
** BI-DIRECTIONAL PATH

Shared-use paths adjacent to a road ("sidepaths") are generally only appropriate in limited-access types of road corridors.

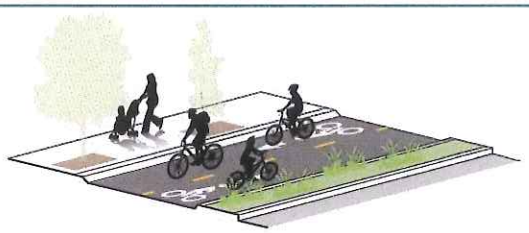
Shared-use paths are generally inappropriate in an environment with expectation for high pedestrian volumes or in an environment with frequent street and driveway spacing. The preferred access spacing to safely accommodate shared-use paths is recommended at 880' or greater for street intersections and 440' or greater for driveways.



BI-DIRECTIONAL PATH
Non-motorized pathway in an independent right of way or parallel to a roadway.



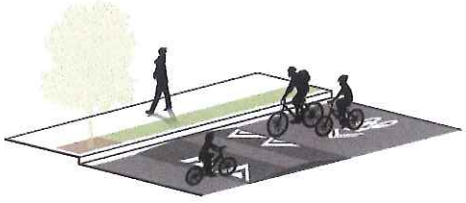
ONE-WAY SEPARATED BIKE LANE
Physically separated bike lanes. Also known as a cycle track or protected bike lane.



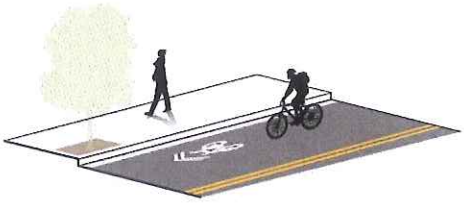
TWO-WAY SEPARATED BIKE LANE
Physically separated bike lanes designed for bi-directional use.

BUFFERED BIKE LANE
On-street bike lanes paired with a designated buffer space.

ON-STREET BIKE LANE
On-street bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage.



BICYCLE BOULEVARD
Bicycle boulevards are low-volume, low-speed streets designed to prioritize bicyclist travel and discourage motor vehicle travel along the route and across intersections. Also known as "neighborhood greenways," "quiet streets," etc.



SHARED ROADWAY
Shared roadways (which may be designated bike routes) are roadways without dedicated bicycle facilities. Shared Lane Markings (SLM) may be included.

Sources

The AASHTO Bike Guide states that bicycle boulevard volumes should be "generally less than 3,000 vehicles per day." (p. 2-19) Guidance for volumes on shared roadways are even stricter, and should be "generally less than 1,000 vehicles per day" (p. 2-17).

In shared roadway conditions, the AASHTO Bike Guide states that vehicle speeds should be set "where the speed differential between motorists and bicyclists is typically 15 mph or less." (p. 2-19). Casual bicyclists may travel as slow as 8 mph (AASHTO Bike Guide p. 2-5), resulting in a maximum motor vehicle speed of 23 mph and an appropriate speed limit of 20 mph.

As speeds and volumes increase, so does the desire for user separation. The AASHTO Bike Guide states that bicycle lanes are appropriate on "any road where the design speed is more than 25 mph" (p. 2-19). Between 3,000 and 6,000 ADT, the MUTCD encourages lane delineation in the form of center lines and edge lines (Sec. 3B.01). Delineation of bicycle lanes is also appropriate in this volume range.

The AASHTO Bike Guide recommends physical separation such as paths on roadways with "very high motor vehicle volumes such that bicyclists might be discouraged from riding on the roadway." (p. 2-20). Beyond 10,000 ADT, roadways become congested and stressful. AASHTO Green Book defines high-speed as greater than 45 mph, and also states that "Reconstructed urban arterial highways should generally be designed for an operating speed of at least 50 km/h [30 mph]." p2-58. At these arterial roadway volumes and speeds, physical separation is desired.

NCHRP Report 766: Recommended Bicycle Lane Widths for Various Roadway Characteristics (2014) describes characteristics which impact bicycle positioning, and where buffers may be beneficial for influencing safety.

Bicycle Facility Selection: A Comparison of Approaches (2002) by Michael King, Andy Clarke, and Charles Zegeer, evaluates bicycle facility selection guidelines from a variety of published national, state, and local design manuals, in order to determine whether global consensus exists that could lead toward establishing minimum standards.

Connecting Charlotte

Charlotte Department of Transportation
Memorandum

Date: September 13, 2017

To: All CDOT Divisions

From: Liz Babson, PE
Acting Director

Subject: Green Pavement Markings for Bicycle Facilities

Charlotte Department of Transportation
Engineering and Operations Division
Technical Memorandum No. 17-01

Expiration
This Technical Memorandum expires January 30, 2022, unless superseded or extended prior to that date.

Purpose
The purpose of the Technical Memorandum is to establish consistent use of green pavement markings for bicycle facilities throughout the City of Charlotte. This document includes definitions, criteria for use, and guidelines for color, taper lengths, and signage. Example layouts are attached.

This Technical Memorandum does not apply to the multi-use trails such as Cross-Charlotte Trail, Little Sugar Creek Greenway, and the Rail Trail between Old Pineville Road and 12th Street. These trails have their own design guidance for street crossings. Refer to Technical Memorandum No. 17-02 for the use of green pavement marking along multi-use trails.

Background
The Federal Highway Administration (FHWA) authorized interim approval (designated as IA-14) for green pavement markings. Interim approval allows use of this traffic control device, pending official rulemaking for inclusion in the Manual on Uniform Traffic Control Devices (MUTCD). A number of experiments were conducted in the US and other countries to determine the value of designating a specific color to indicate a portion of the roadway reserved for use by bicyclists. Based on those studies, green was selected as the preferred color.

The Charlotte Department of Transportation (CDOT) supports green pavement markings for bicyclists and received approval from FHWA for its use. The National Association of City Transportation Officials (NACTO) developed the Urban Bikeway Design Guide which states that the green pavement marking within a bicycle lane increases the visibility of the facility, identifies potential areas of conflict, and reinforces priority to bicyclists in conflict areas. Green pavement markings can be used as a message for both motorists and bicyclists of a potential conflict in the street. NACTO and FHWA guidance were the basis for many of the sections outlined below.

Definitions
The following are accepted definitions of bicycle facilities:

Bicycle Lane – a portion of the roadway that has been designated by striping, signage, and pavement markings for the exclusive use of bicyclists. It is separated from the adjacent travel lane by a white lane line.

Buffered Bicycle Lane – a bicycle lane paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane by means of pavement markings. The buffer may contain tubular markers or a similar flexible vertical element.

Protected Bicycle Lane – a bicycle lane that is physically separated from the motor vehicle travel lane and/or parking lane. The separation is achieved by a vertical element that is more substantial than tubular markers and similar devices. Some examples include curbs, monolithic medians, jersey barriers, and planters.

Two-Way Separated Bicycle Lane – an exclusive, two-way bicycle facility that combines the user experience of a separated path with the in-street infrastructure of a conventional bicycle lane. These facilities are generally protected from motor vehicle traffic similarly to protected bicycle lanes.

Criteria
Bicycle facilities located in Uptown or on major or minor thoroughfares, as designated by the Thoroughfare Plan are eligible for green pavement markings if at least one criterion below is satisfied. Other streets (non-thoroughfares) may be considered on a case by case basis.

The criteria below are divided into two primary categories – Conflict Zones and Wayfinding.

I. Conflict Zones

Conflict zones are locations where larger volumes of motor vehicles and bicyclists are expected to cross paths. Examples include:

A. Bicycle facility crossing an exclusive right turn lane in the same direction:

1. Unsignalized intersection (**Figure 1**)
2. Signalized intersection (**Figure 2**) with single or dual right turn lanes
3. Interchange entrance/exit ramps
4. Driveways with exclusive right turn lanes
5. Through lanes that drop as exclusive right turn lane (**Figure 3**).

B. Two-way separated bicycle lanes crossing at a public street or a driveway (**Figure 4**)
C. Bicycle facilities crossing a driveway with inadequate sight distance that may prohibit drivers from seeing any approaching bicyclist.
D. Unique conditions not identified above may be considered for green pavement markings on a case-by-case basis in consultation with the Engineering & Operations Division.

II. Wayfinding

Wayfinding is used with signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes. Typically, green pavement markings should not be used to transition between an in-street bicycle facility and a bicycle ramp at a roundabout. Examples where green markings may be used include the following:

A. Direct bicyclists around conflict zones, such as guiding bicyclists around designated streetcar stations (**Figure 5**)

B. Direct bicyclists at transitions between bicycle facilities (**Figure 6**)

C. Direct bicyclists into entries or exits of Bicycle Boxes and Two Stage Bicycle Turn Boxes (**Figures 7-9**)

Guidelines

If the bicycle facility meets at least one of the criteria listed for green pavement marking, then the markings must follow the guideline listed below.

I. Material and Color of Pavement Marking

CDOT conducted field experiments with green marking materials ranging from paint to thermoplastic. The thermoplastic performed best with respect to skid resistance and durability. CDOT prefers the use of a thermoplastic product that meets the color criteria based on FHWA's requirement outlined below:

A. Daytime chromaticity coordinates for the color used for green colored pavement shall be as follows:

1		2		3		4	
x	y	x	y	x	y	x	y
0.230	0.754	0.266	0.500	0.367	0.500	0.444	0.555

The daytime luminance factor (Y) shall be at least 7, but no more than 35.

B. The nighttime chromaticity coordinates for the color used for green colored pavement shall be as follows:

1		2		3		4	
x	y	x	y	x	y	x	y
0.230	0.754	0.366	0.540	0.450	0.500	0.479	0.520

C. Green colored pavement should be retroreflective.

D. If approved by CDOT, green marking materials other than thermoplastic shall minimize loss of traction for bicyclists (see Paragraph 4 of Section 3A.04 of the 2009 MUTCD).

II. Pavement Marking Lengths

Green pavement marking must fill between two white lines that mark the bicycle facilities. The green pavement markings will not be filled in gaps between skip marks, except at driveways. Green pavement markings shall extend the length of the conflict/wayfinding zone and shall have an approach distance. For signalized intersections, green pavement markings should also have a departure distance that extends beyond the conflict/wayfinding zone. The approach and departure distance should be equal in length. The length of the solid green pavement marking is determined by the posted speed limit of the roadway. Table 1 specifies the length by speed limit (this does not apply at driveways and shared use paths).

Table 1. Length of Green Pavement Marking

Posted Speed Limit	**Length of Solid Green Pavement Marking Approach & Departure Conflict Area***
25 mph	25 ft
30 mph	30 ft
35 mph	35 ft
40 mph	40 ft
45 mph	45 ft
Interchange Ramps	50 ft

**CDOT Engineer may allow minor adjustments on a case by case basis*

***Based on table from Washington Department of Transportation Roadway Bicycle Facilities*

Cycle tracks crossing at a public street/driveway or shared use paths that cross at a driveway must have a solid green continuous through the width of the public street/driveway, even between white skip mark gaps. This is to elevate motorist's attention of potential bicyclist crossings. Green markings are not typically needed on driveway approaches and departures.

III. Taper Length

The taper length of the bicycle facilities should follow AASHTO's Geometric Design of Highways and Streets. Table 2 shows the minimum and desirable taper rate based on roadway design speed. The taper rate is the ratio of L:W where L is the taper length in feet and W is the width of offset in feet.

Table 2. Taper Rates for Bay Tapers

Minimum and Desirable Taper Rates for Bay Tapers		
Design Speed	**Minimum Taper Rate**	**Desirable Taper Rate**
≥ 50 mph	10:1	15:1
31 – 49 mph	10:1	12:1
≤ 30 mph	8:1	12:1

IV. Signage

If motor vehicles entering an exclusive right turn lane must cross a bicycle facility, the BEGIN RIGHT TURN LANE YIELD TO BIKES (R4-4) sign should be used. The R4-4 sign should not be used when bicyclists need to move left because of a right turn lane drop situation.

Refer to **Figures 1-9** for reference to additional signage and placements.

Questions
For information on the technical contents of this memorandum, please contact Angela Berry at 704-432-5259 in the Traffic Safety, ITS & Special Projects Section of CDOT.

Attachments
Figures 1-9

CITY OF CHARLOTTE

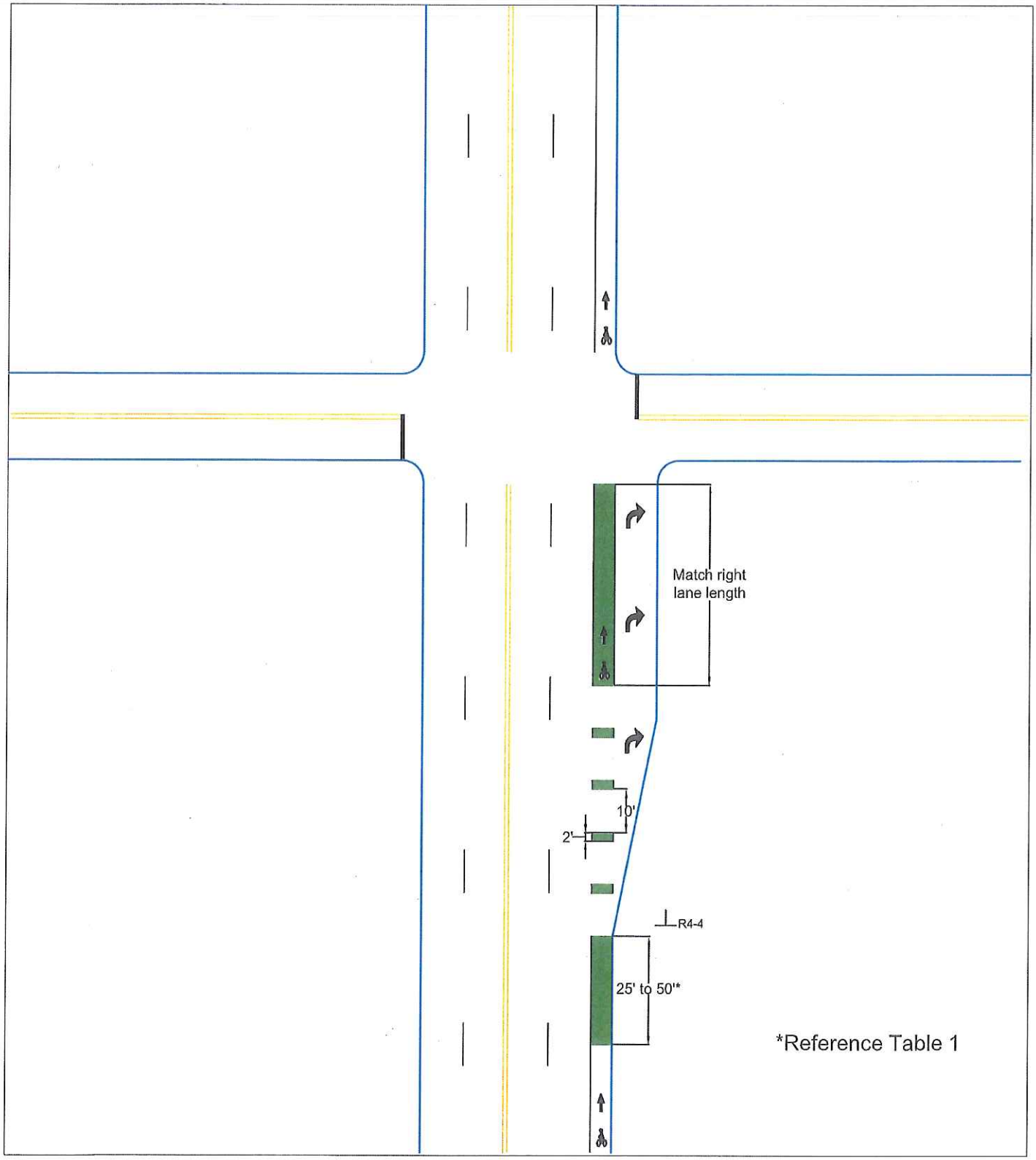
DEPARTMENT OF TRANSPORTATION

ENGINEERING & OPERATIONS DIVISION

Technical Memorandum No. 17-01

Green Pavement Markings

Figure 1. Unsignalized Exclusive Right Turn Lane Example Layout



CITY OF CHARLOTTE

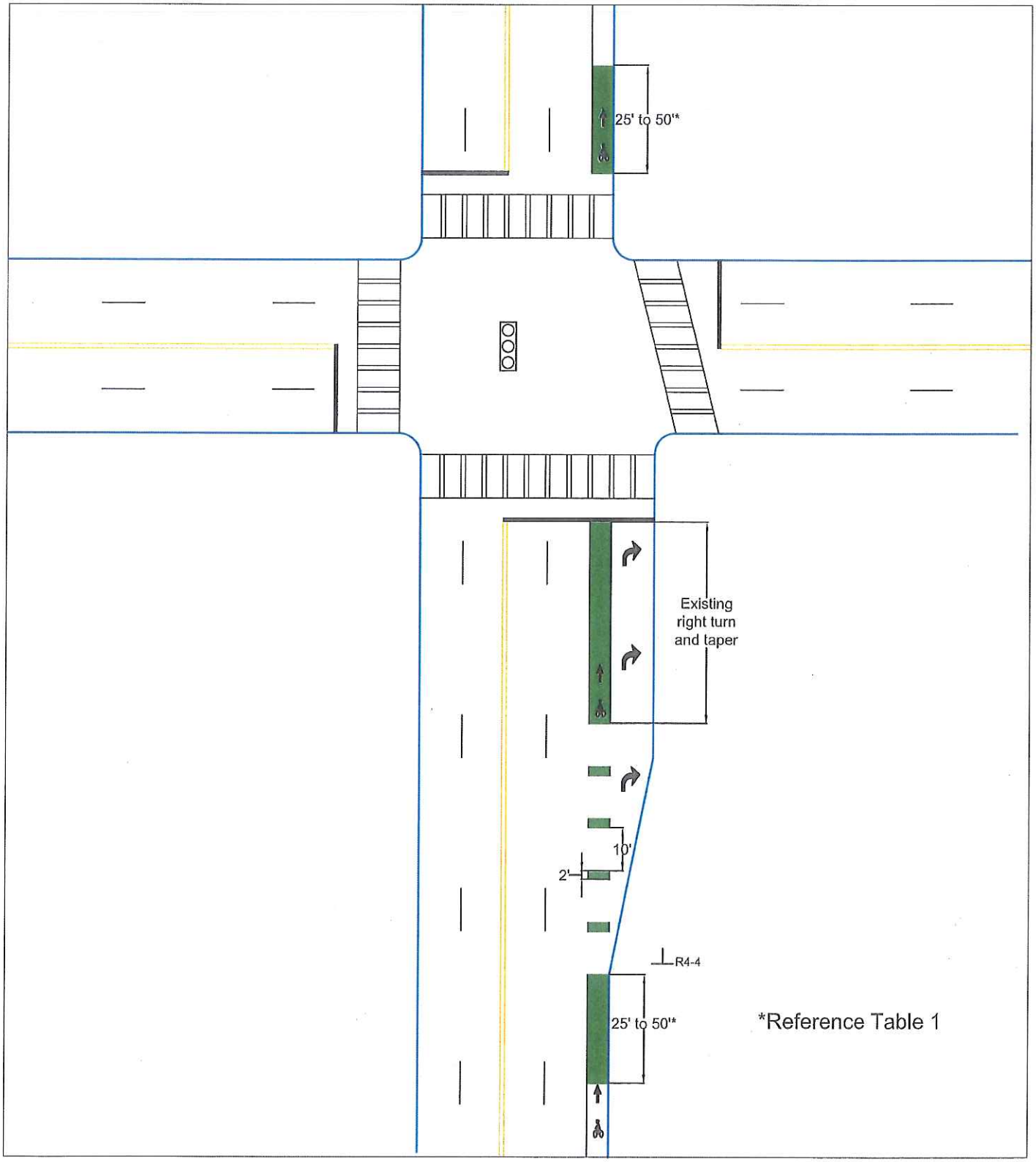
DEPARTMENT OF TRANSPORTATION

ENGINEERING & OPERATIONS DIVISION

Technical Memorandum No. 17-01

Green Pavement Markings

Figure 2. Signalized Exclusive Right Turn Lane Example Layout



CITY OF CHARLOTTE

DEPARTMENT OF TRANSPORTATION

ENGINEERING & OPERATIONS DIVISION

Technical Memorandum No. 17-01

Green Pavement Markings

Figure 3. Through Lane Drops as an Exclusive Right Turn Lane Example Layout

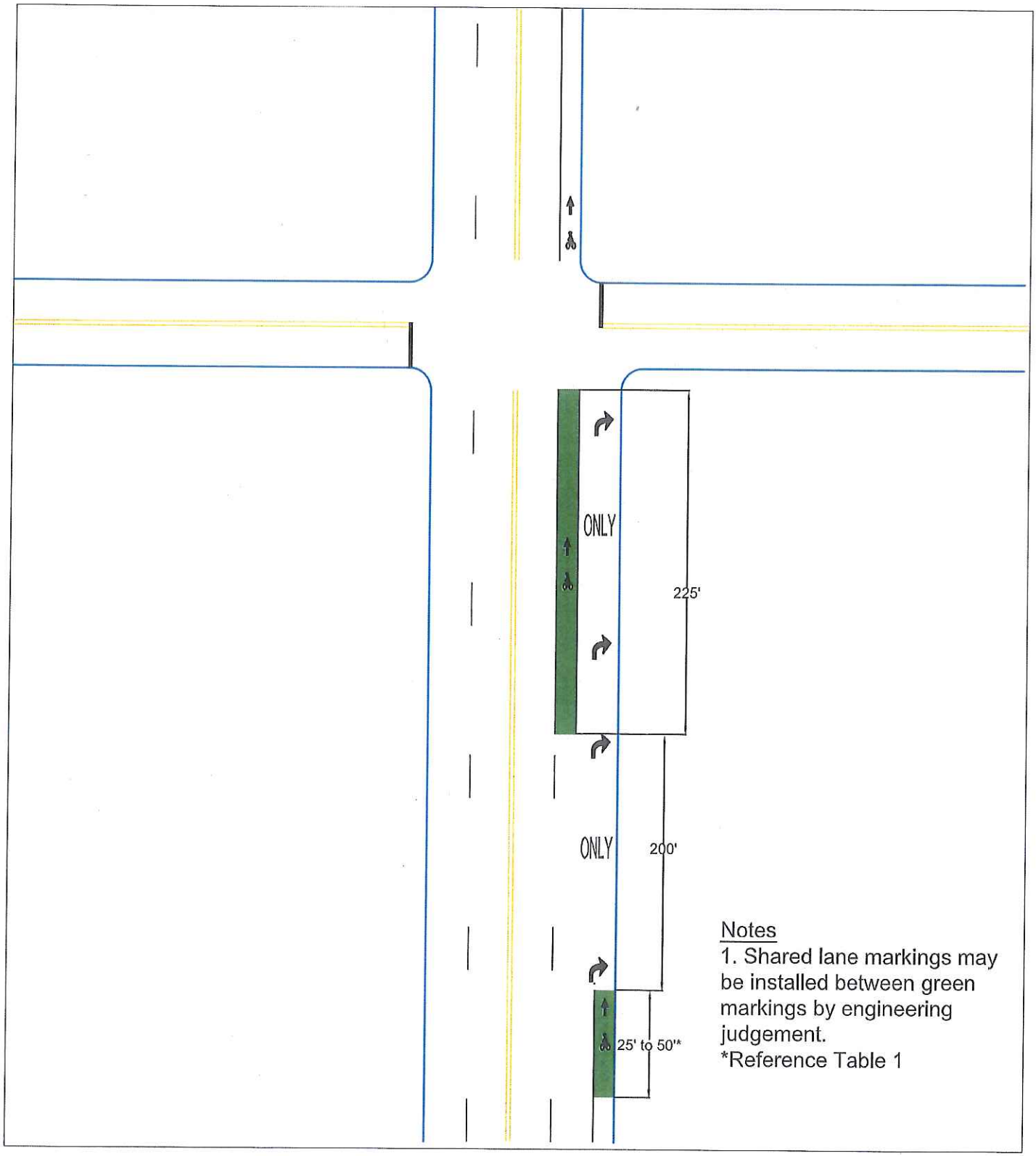


Figure 4. Two-Way Separated Bicycle Lanes Crossing Public Street/Driveway Example Layout

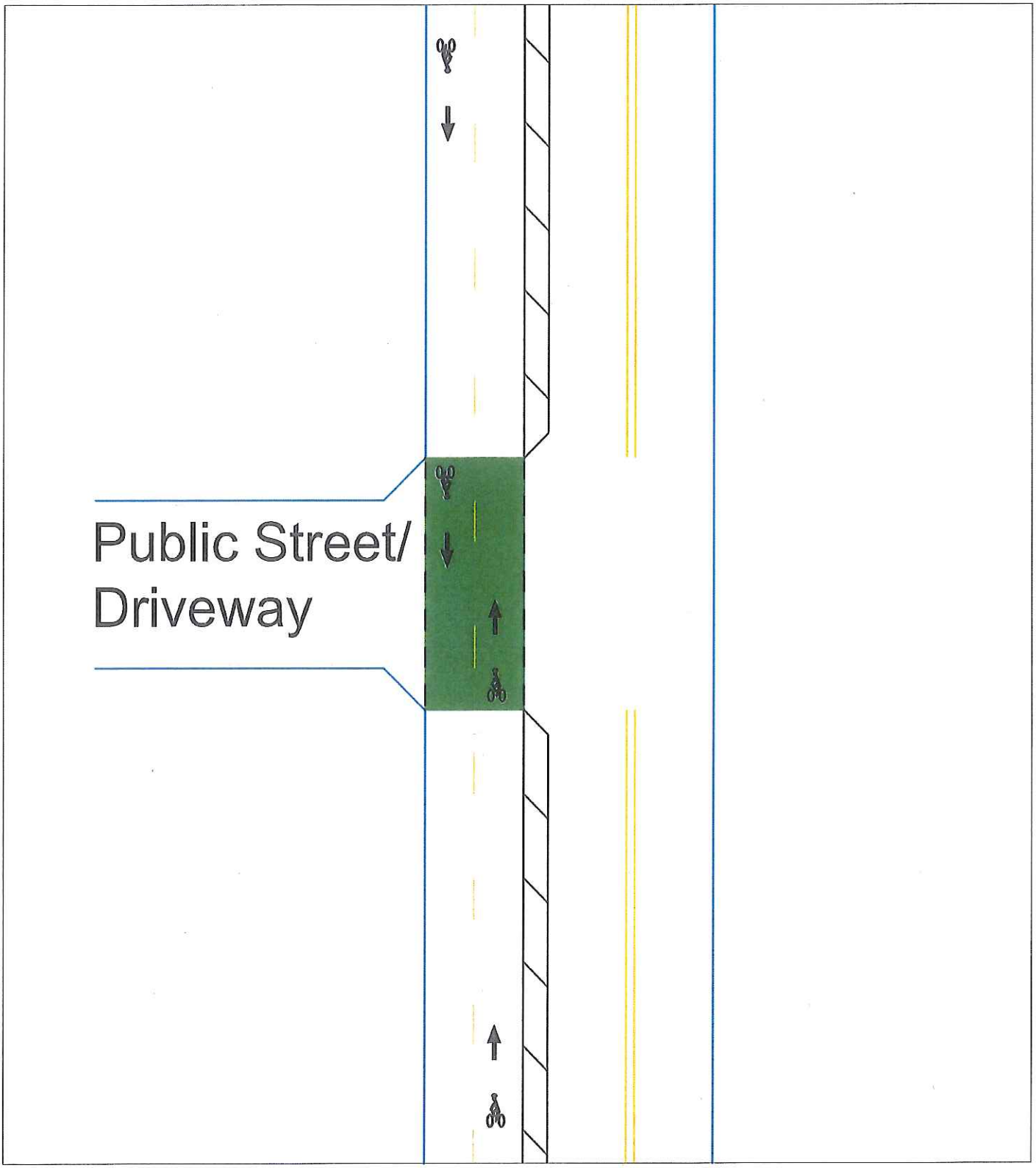
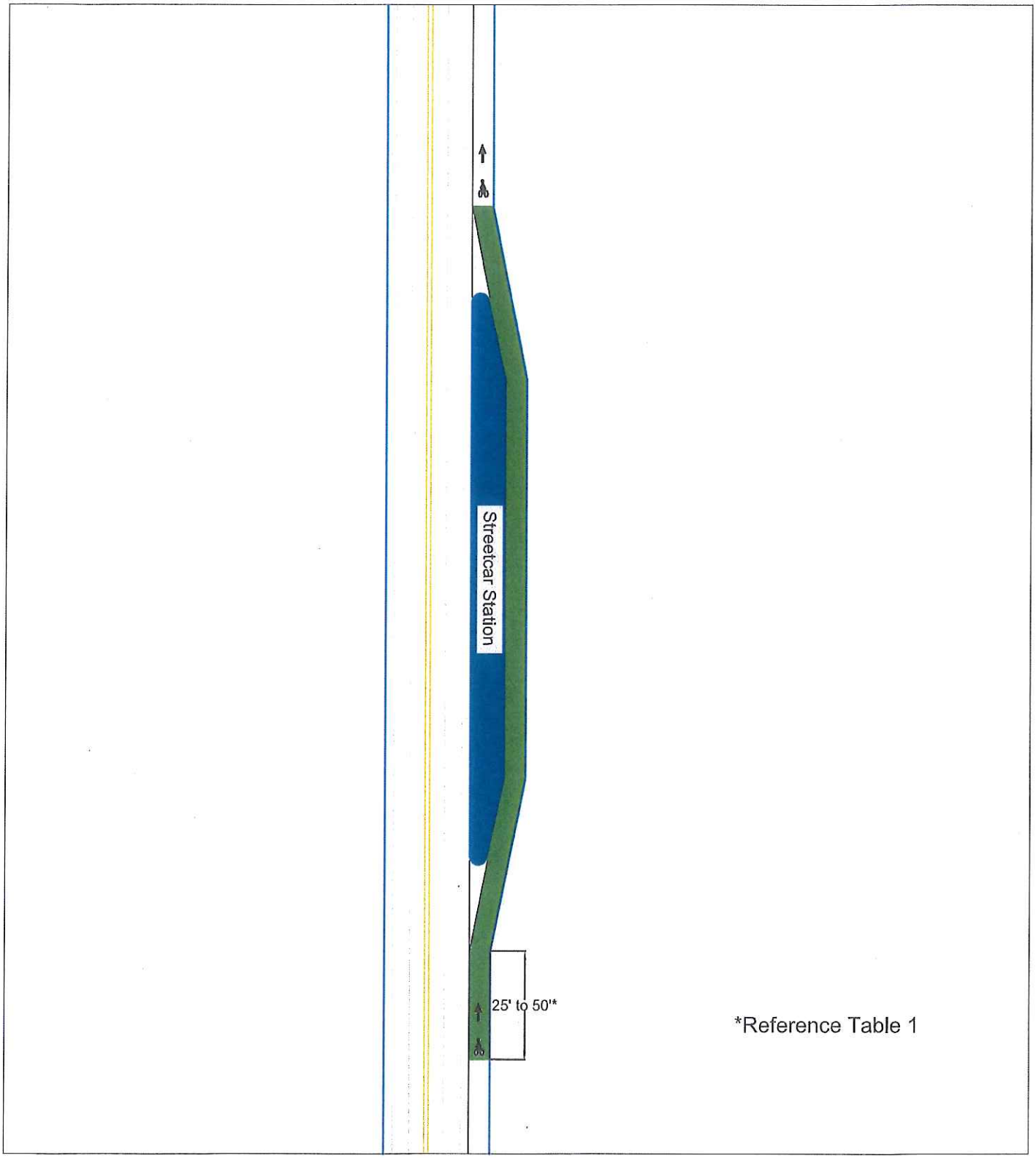


Figure 5. Directing Bicyclists Around Conflict Zones Example Layout



CITY OF CHARLOTTE

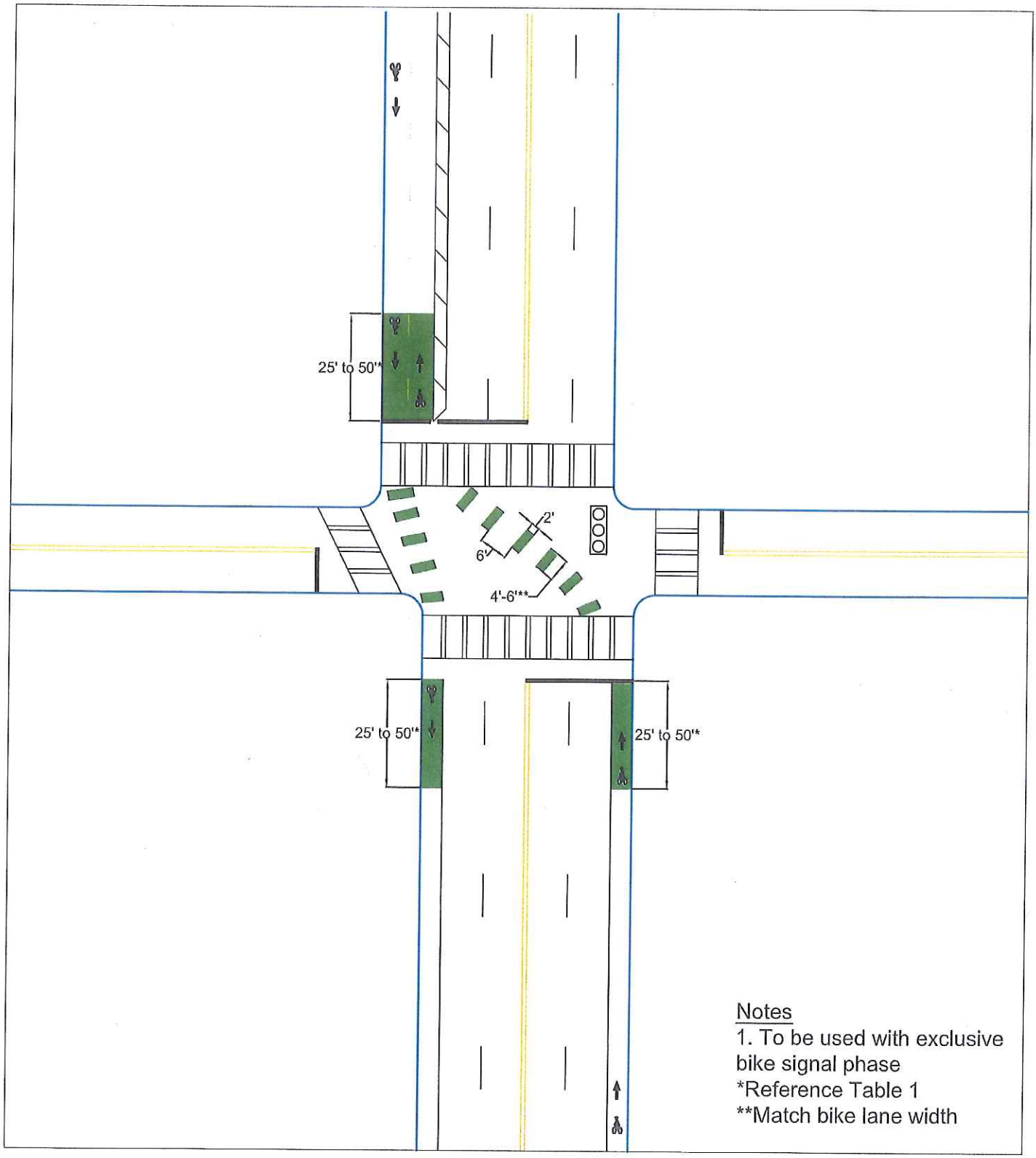
DEPARTMENT OF TRANSPORTATION

ENGINEERING & OPERATIONS DIVISION

Technical Memorandum No. 17-01

Green Pavement Markings

Figure 6. Directing Bicyclists at Transitions Between Bicycle Facilities Example Layout



CITY OF CHARLOTTE

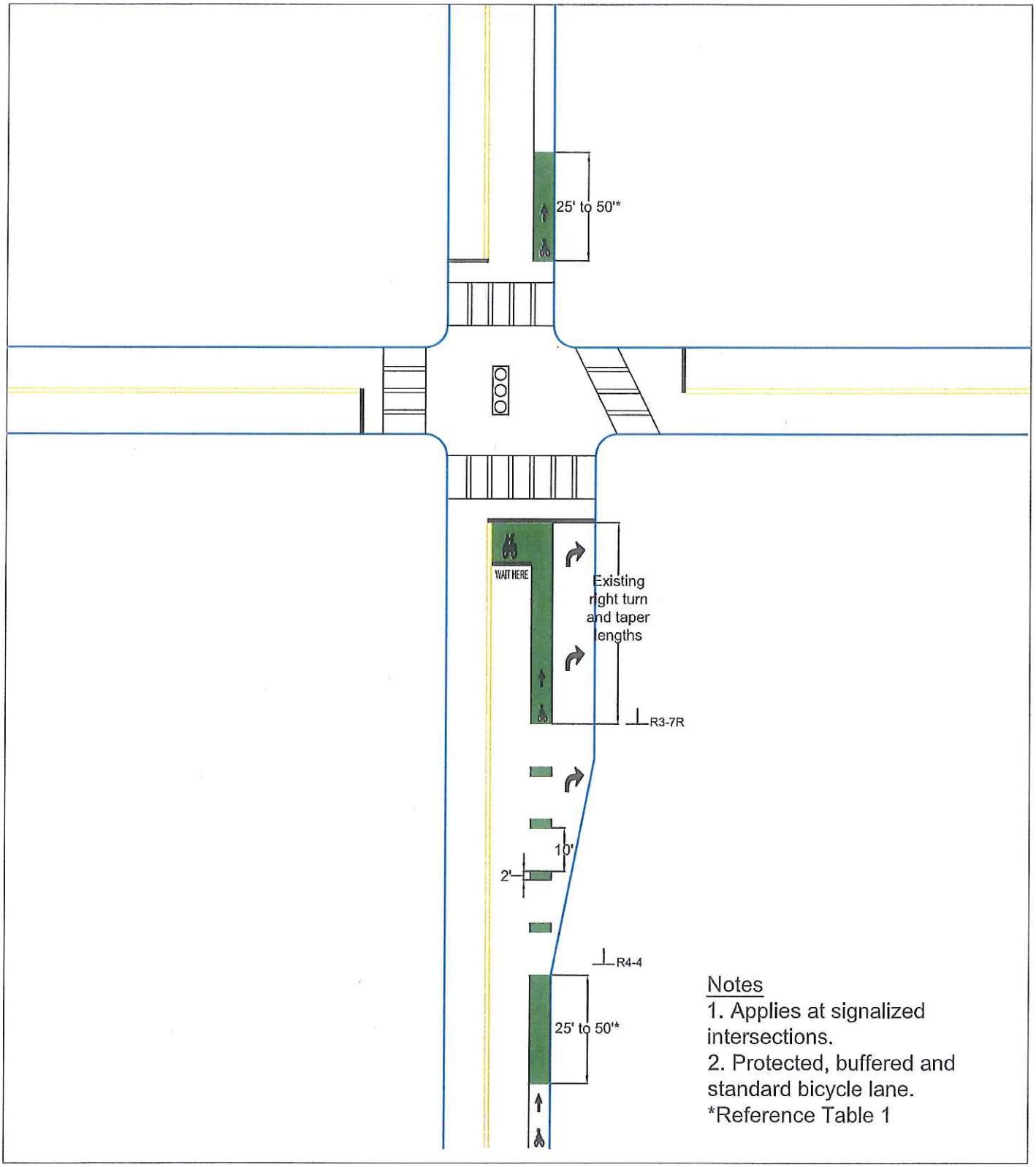
DEPARTMENT OF TRANSPORTATION

ENGINEERING & OPERATIONS DIVISION

Technical Memorandum No. 17-01

Green Pavement Markings

Figure 7. Bicycle Box With Exclusive Right Turn Lane Example Layout



CITY OF CHARLOTTE

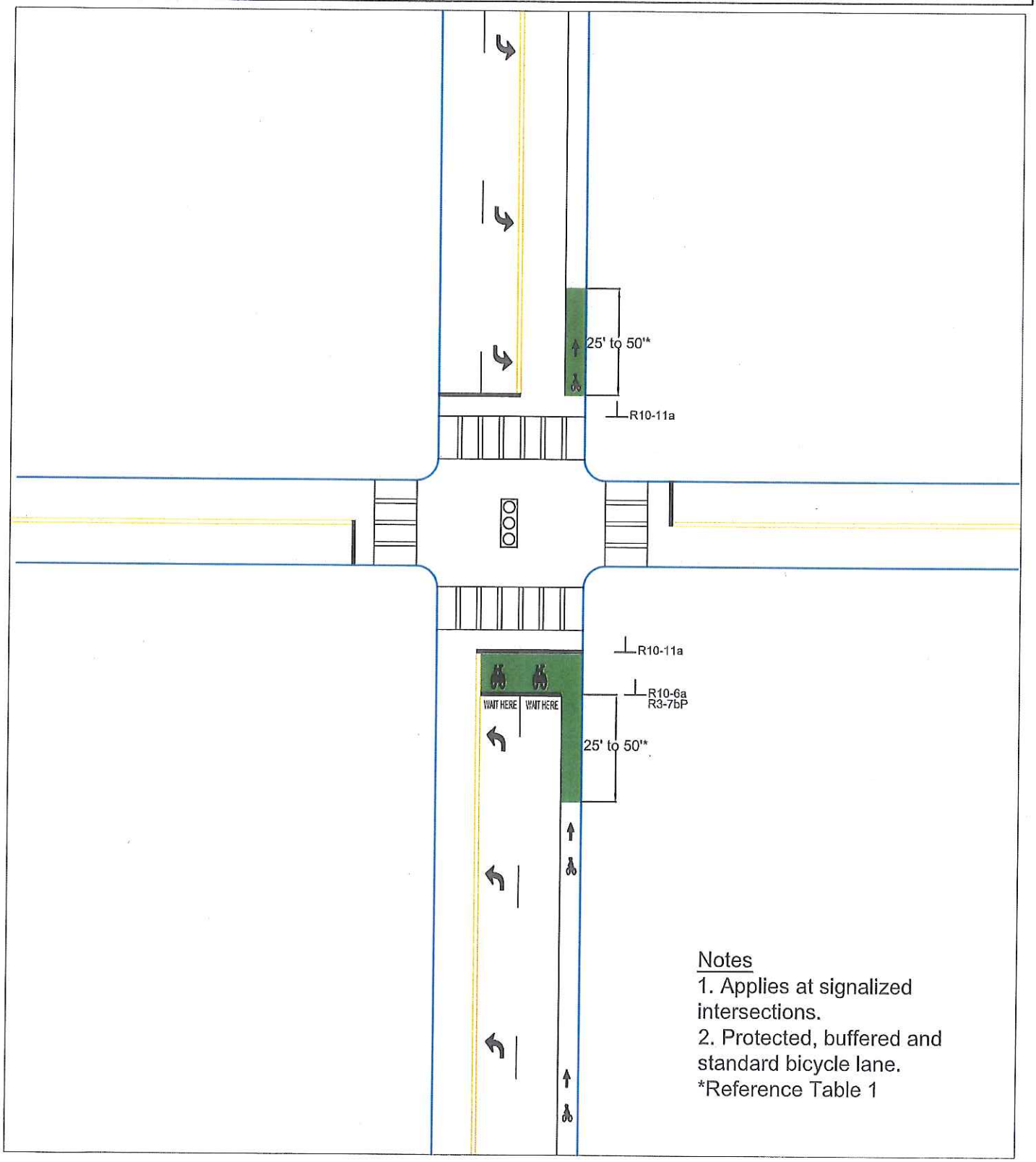
DEPARTMENT OF TRANSPORTATION

ENGINEERING & OPERATIONS DIVISION

Technical Memorandum No. 17-01

Green Pavement Markings

Figure 8. Bicycle Box Example Layout



CITY OF CHARLOTTE

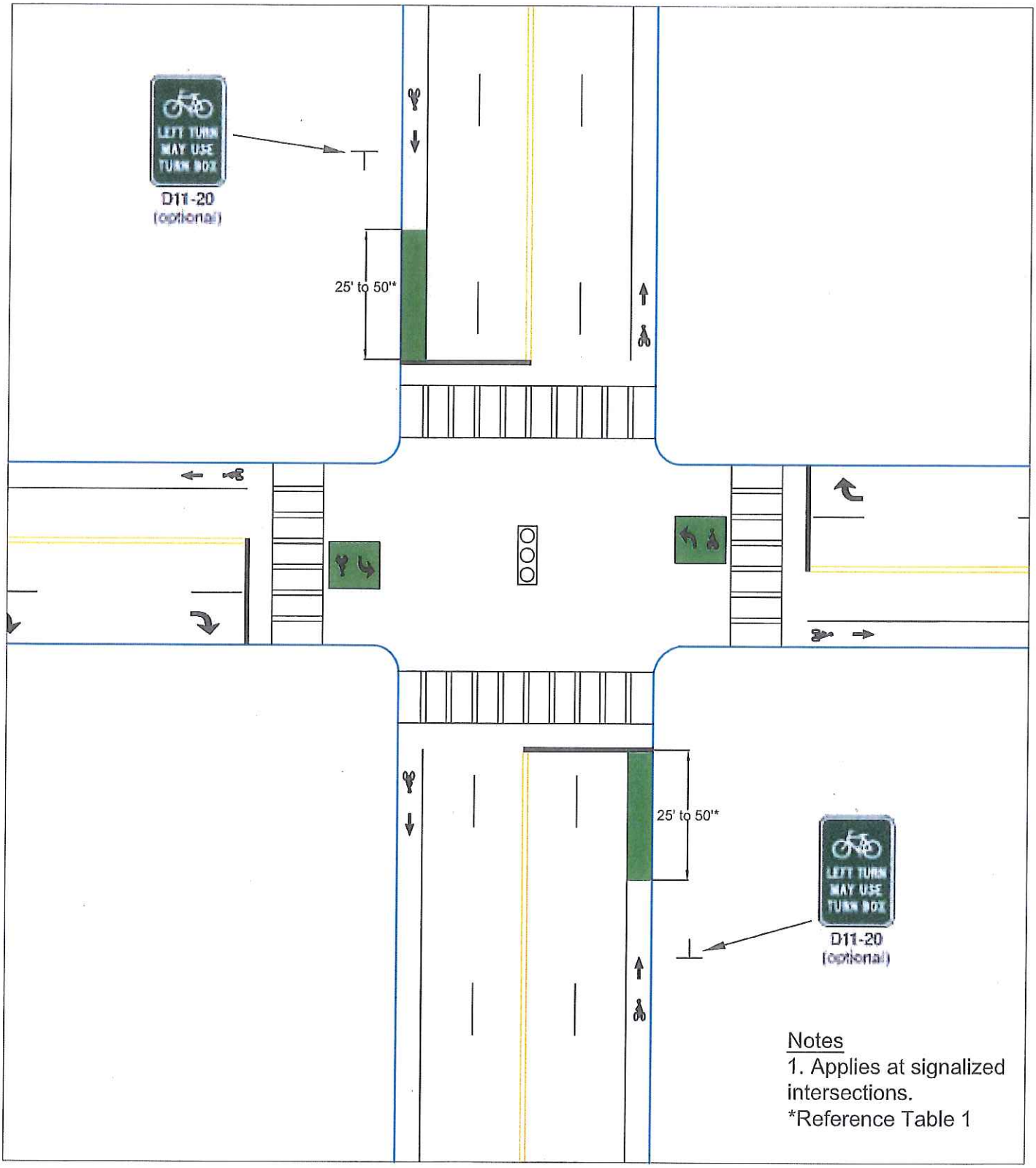
DEPARTMENT OF TRANSPORTATION

ENGINEERING & OPERATIONS DIVISION

Technical Memorandum No. 17-01

Green Pavement Markings

Figure 9. Two Stage Bicycle Turn Box Example Layout



600 East Fourth Street
Charlotte, NC 28202

CHARLOTTE-MECKLENBURG STORM WATER SERVICES
LIST OF AVAILABLE RESOURCES

REFERENCE MANUALS

Charlotte Land Development Review Checklist
https://charlottenc.gov/ld/Documents/Checklists/Site%20Checklist%20-%20Engineering.pdf

Charlotte Land Development Standards Manual (CLDSM)
https://charlottenc.gov/ld/CLDSM/Pages/default.aspx

Charlotte-Mecklenburg BMP Design Manual
https://charlottenc.gov/StormWater/Regulations/Pages/BMPDesignStandardsManual.aspx

Charlotte-Mecklenburg Storm Water Design Manual
https://charlottenc.gov/StormWater/Regulations/Pages/StormWaterDesignManual.aspx

Charlotte Water Design Manual
https://charlottenc.gov/Water/Development/Resources/Pages/DesignManual.aspx

City of Charlotte Landscape Construction Standards
https://charlottenc.gov/ld/CLDSM/Documents/Landscape%20Construction%20Standards%20Revision%2011.pdf

NCDOT Manuals and Handbooks
https://connect.ncdot.gov/Pages/Manuals-Handbooks.aspx

NCDOT Roadway Standard Drawings
https://connect.ncdot.gov/resources/Specifications/Pages/2018-Roadway-Standard-Drawings.aspx

Post-Construction Stormwater Ordinance Administrative Manual
https://charlottenc.gov/StormWater/Regulations/Documents/PCSO_2016_ADMINISTRATIVE_MANUAL_revisions_FINAL.PDF

DESIGN/BIDDING RESOURCES

City Item Codes Spreadsheet
https://charlottenc.gov/Engineering/Bids/Pages/SpecialProvisions.aspx

Special Provision Online Library
https://charlottenc.gov/Engineering/Bids/Pages/SpecialProvisions.aspx

Special Provisions Details
https://charlottenc.gov/Engineering/Bids/Pages/SPdetails.aspx

Charlotte-Mecklenburg STORM WATER Services
25 YEARS
600 East Fourth Street
Charlotte, NC 28202

CHARLOTTE-MECKLENBURG STORM WATER SERVICES
DESIGN REVIEW GUIDELINES FOR ENGINEERING SERVICES PROJECTS

Last Revision: July 1st, 2015

Calculation Requirements:

- ☐ Include calculations based on "10% rule" Guideline Document (model and design hydraulics to the point of adequate conveyance, then use the City of Charlotte 10% rule for funding determination).

- ☐ Drainage Area Map:
  - Drainage map at legible scale with bar scale and north arrow.
  - Map reflects full build out under current zoning for proposed improvements.
  - Contour lines shown and labeled.
  - T_c paths included.
  - Maximum sheet flow lengths of 100 linear feet.
  - T_c values computed with SCS methodology to determine sheet and shallow concentrated flow.
  - If applicable, soil types should be shown.
  - Storm drainage maps are labeled by inlet number and indicate acreage of drainage areas.
  - No more than 1 acre of concentrated flow to the street.

- ☐ Pipe System Calculations:
  - Non-culvert pipe systems should be designed for the 10-year storm event.
  - Manning's calculations need to be performed.
  - Manning's *n*, *CN*, *C* values correctly assigned.
  - Velocities should be within acceptable limits both within the pipe system and at the outlet (10 feet/second maximum).
  - 0.5% minimum pipe slope.
  - HGL below structure rim elevations: Make sure HGL calculations show system not surcharging in the 10-year storm event, and not in the 25-year storm event at low points.
  - Use appropriate starting WSE's and tail water elevation (0.8 x diameter should be minimum downstream WSE).
  - Appropriate system losses should be used and able to be reviewed (Inlet/Junction Loss *K*, Outlet Loss *K*, Bend Loss *K*, Friction Loss).
  - Hydraulic connectivity – make sure WSE's as shown in the calculations follow the geometry of the system.
  - Hydrologic connectivity – make sure all sub basins are being accounted for.

- ☐ Inlet Capacity Calculations:
  - Check to make sure maximum spread is not violated.
  - Is the correct allowable spread (i.e. is there valley gutter, bike lane...) being evaluated?
  - Are the correct *K* coefficients and methodologies being used per the design manual?
  - Are the transverse and longitudinal slopes based on actual road conditions (survey)?
  - Is all by-pass correctly assigned to downstream inlets?
  - 4 inches/hour should be used to calculate spread on on-grade inlets.

- 25-year storm event should be used to evaluate inlets in a **sump** to ensure that a travel lane is still present (25-year storm event calculations for all catch basins are required to properly evaluate by-pass to inlets in sump conditions).
- Verify correct equation (weir vs. orifice) is being used at low points.
- Is all water captured before entering intersections, located in median or super elevation transitions or any other areas of concern?
- Curb grades should be minimum of 0.5%, unless in sag.
- Verify correct *P* value is used for type of grate.

☐ Culvert Calculations:
- Has *HW/D* ≤ 1.2 been met? If not, is there detailed information for why it was not met?
- Correct flow is used based on road classification.
- Appropriate entrance loss coefficients based upon entrance condition (e.g. headwall etc.) being used?
- Have both outlet control and inlet control conditions been checked?
- 10% Rule: Often culvert upgrades violate the 10% Rule because existing attenuation is eliminated. Be sure existing vs. proposed 10% rule calculations take into account the loss of storage – if they are accounting for it you should see a stage-storage-discharge relationship for the culvert in the existing calculations.
- Verify all culvert data matches what is being shown on plans.
- 12-inch freeboard for pipes ≤ 36 inches; 18-inch freeboard for pipes > 36 inches (For box culverts, freeboard will be based on the height of the box).
- If significant upstream storage is present, consider using iterative loop to balance *HEC-1* and *HEC-RAS*.

☐ Erosion Control (move to pipes/culverts)
- Is appropriate method (per CMSWDM) being used to size rip-rap aprons?
- Is inlet protection shown where needed?
- Is outlet protection shown at all outfalls?

☐ Channel Calculations
- Make sure supporting calculations are shown.
- Verify correct temporary and permanent linings are shown based on velocity and shear stress.
- Channel geometry needs to be specified (typical detail or cross-sections).
- Channel calculations / geometry needs to be referenced to plan sheet locations.
- 10-year design needed for capacity, check road flooding for relevant storms based on road classification.
- Maximum 2:1 (*H:V*) side slopes.
- Minimum 6-inch freeboard.
- 5:1 taper should be present in widening/narrowing of channels.
- Maximum channel bottom width of 10 feet.

Plan Requirements:

☐ Is RCP used throughout unless special conditions exist?

☐ Is 15 inches the minimum pipe size for picking up non-subsurface storm water?

☐ Minimum cover on all pipes should be 2 feet. If not Class IV or Class V may be required.

- ☐ Does proposed drainage system follow a logical path?
- ☐ All drainage pipes should be labeled with size, material, slope, and inverts.
- ☐ Confirm all storm drainage easements are being shown in accordance with CLDSM requirements.

"Storm Drainage Easements shall be provided for all storm drainage pipes and shown on site plans, construction plans and plats with widths specified below. The following note shall be placed on all grading plans and plats; "The purpose of the storm drainage easement (SDE) is to provide storm water conveyance. Buildings are not permitted in the easement area. Any other objects which impede storm water flow or system maintenance are also prohibited."

PIPES		**CHANNELS**	
Diameter	Width	Drainage Area	Channel Easement Width
15" – 24"	15'	1 – 45 *Ac*	20'
30" – 36"	20'	45 – 120 *Ac*	30'
42" – 48"	25'	120 – 500 *Ac*	40'
54" +	30'	500 *Ac* +	see std. 20.30

- ☐ Are end structures shown on all pipes (**no open-ended pipes**)?
- ☐ Verify pipe network information matches calculation information.
- ☐ Verify pipe network information matches drainage summary table (this can be spot checked at 70%, with a final check at 90% and beyond).
- ☐ Are catch basins placed at intersections to avoid flow into the intersection?
- ☐ Are relevant Emerald drainage requests being handled/considered?
- ☐ Tie-in of new curb & gutter – Will water drain away or toward road? Are yards lower than the roadway and drop inlets needed?
- ☐ For areas where islands, medians, bulb-outs, or other curb extensions are shown, make sure sufficient spot grades are shown to ensure water flows in a continuous grade.
- ☐ Are potential utility conflicts identified? Are relevant utilities shown on profiles?
- ☐ Look for excessive fill over pipes, especially increased fill on existing pipes.
- ☐ All abandoned pipes under roadways and near structures should either be removed or filled with flowable fill. The length and pipe material of the affected pipe should be labeled on plans or drainage summary table.
- ☐ Maximum of one (1) acre runoff draining directly into the street at one point.
- ☐ Minimum slope on pipes, curb (0.5%).
- ☐ Verify channels shown on plans match calculations.
- ☐ Verify pipe profiles are shown with all crossing utilities and other relevant features or utility conflicts are otherwise identified.

Storm Water Services
Construction Review List

Overall Construction Plans and Specifications

Cover Sheet

Ensure cover sheet identifies the mainline of work and then shows secondary systems in order of plans
Check location map to see if scope has changed.
Ensure legend has proper markings per updated cover sheet and that the items in legend are used where applicable
Look at vicinity map to familiarize myself with location and look at virtual charlotte for reference
Ensure proper signatures/approvals

Notes Sheet

Ensure notes are updated and check for new permit and erosion notes.
Check to see that standards listed are being used in plans and are applicable.
Check CLDS and NCDOT Roadway Standards to make sure appropriate standards have been used (structures, pipe, etc.)

Drainage Structure Table

Check station numbers match plans
Check structure elevations match plans
Check pipe lengths and pipe size match plans, estimate, and SP's
Check drainage structures and headwalls are correct standards, match SP's, and labeled with the correct bid item and unit

Standard Detail Sheets

Ensure current details are being used
Ensure detail sheets are referenced to the correct drawings
Check to ensure proper structures are utilized (i.e. boxes and HW's) on drainage table versus plans
Check drainage table to ensure structures are paid properly
Check designed structures (i.e. boxes and HW's) for grades and how they correspond with the plans

Plan Sheets

Check for duplicate information
Check for adequate access for work being performed
Verify all work is in the easements
Look to see if tree save is acceptable and see if other trees are in the construction zone. (Tree save on bid projects and tree remove on point repair.)
Look at phasing of work to see how workflow and vehicular and/or pedestrian traffic will maneuver
UPDATE THIS NOTE: Ensure OE lines will not be a conflict and poles are being relocated if within 5 feet
Check construction phasing versus utilities and traffic control to ensure no conflicts
Looking for limits of removal on items (fence, water, sewer, etc.)
Ensure everything on the plans has a pay item and corresponding SP

Ensure details match referenced plan sheets on drainage table
Ensure cross sections and profiles sheet matches
Check for soft dig information and verify depth doesn't conflict with storm system
Check for construction impacts to residents/business owners and ensure proper traffic plans are incorporated to accommodate traffic flow
Check for utility conflicts along alignment and locations of utilities.
Identify construction lay down areas or if adequate room is provided to complete work
Ensure limits of trench excavation for culverts correspond to SP if Foundation Protection is needed and possible active shoring
Ensure rip rap apron is dimensioned (length, width, depth) with appropriate class and Tons
Make sure all asphalt, concrete work, etc. is labeled and has correct standards
Check to see if utility replacement/relocation is needed per Charlotte Water Standards

Profiles
Ensure profiles are accurate and have proper information
Ensure grades tie in to existing ground (structures, headwalls, endwalls, rip rap aprons, etc.)
Check for possible utility conflicts
Make sure scale is called out and labeled correctly
Check some pipe lengths and station numbers are correct (center of structure to center of structure)
Check some pipe runs for slope calculated correctly
Ensure all profiles are shown, including secondary lines

Erosion Control
Check to see items are marked per legend.
See if slopes have silt fence.
Ensure correct standards are referenced

Traffic Control
Check to make sure project can be constructed per traffic control phase
Check traffic control phases with construction phases

Structures Detail
checking to see proper structure being used for pipe installed

Utility Design
Ensure all utility designs are per Charlotte Water Standards
Check for conflicts with storm drain installation
Check some elevations, grades, and slopes

PROWAG/CDOT
Make sure ramp designs have been added to the plans as needed
Spot check standards and elevations

Water Quality

Check to make sure all plans have correct standards
Check notes and construction sequence
Check access and constructability
Spot check elevations and grades
Make sure appropriate channel details are provided, most up to date, and values edited by engineer

Estimate

Check to make sure the items listed aren't covered under comp. grading
Check to see any possible bid items from plans have not been left out of the estimate
Check to make sure all SPU items have been added to the estimate per the plans
Check a few CIC codes to make sure code matches item description and are correct
Ensure units are per current standards
View some costs to ensure they're in line with current costs
Ensure current item descriptions are used
Check some quantities to ensure they are accurate
Check to make sure items match with SP's (Correct SP No. and units)

Special Provisions

check to make sure current SP is used
Check to make sure the SP's have the latest units
Check water article to make sure it's current and correct items are used per updated article
Check SPU's for consistency with latest version
Read over changed SP's to make sure they correspond with other language and plans
Verify that the language in the SP matches the detail

CHARLOTTE-MECKLENBURG STORM WATER SERVICES
TEN PERCENT RULE

How far downstream are Capital Improvement Projects (CIPs) responsible to fund improvements?
Case-by-case judgement based upon:

- Downstream impacts;
- Existing drainage requests;
- Engineering judgement; and
- Reasonableness related to CIP scope and funding.

How are downstream impacts evaluated?
By determining:

- The Point of Adequate Conveyance – How is the receiving system going to function once the project is completed; and
- The Ten Percent Point – Helps to define how the project impacts the receiving system.

What is the Point of Adequate Conveyance?
The point at which a drainage system can handle the new post-project flow without causing significant erosion, street flooding or flooding that significantly impacts the use of the property during the design storm.

How is the Point of Adequate Conveyance determined?
By the designer's post-project design calculations that extend along the downstream system.

Where is the Ten Percent Rule evaluation needed?
Where the drainage system downstream of a project outfall is **NOT** adequate to convey the post-project design flows.

What is the Ten Percent Point?
The point downstream of an outfall where peak flow increases (due to the CIP) are equal to or less than 10% of the pre-project flow.

How is it calculated?

- Use **EXISTING** land use
- Compute pre-project flow at project outfalls
    - Route attenuation behind culverts when applicable
- Compute post-project flow at project outfalls accounting for:
    - Increased impervious area
    - Loss of storage attenuation (due to culvert size increases)
    - Changes in times of concentration

Project Limits for Drainage Analyses

At the beginning of the planning phase, the limits of the system to be evaluated by the drainage analysis shall be recommended by the project engineer (e.g. consultant). The Engineering Services Project Manager and Storm Water Services Project Contact will review these limits and agree to final project limits. These limits typically include all existing drainage systems within the project limits as well as portions of the downstream systems that are receiving runoff from the project. The Engineering Services Project Manager shall ensure that the project engineer provides a map for review showing the following:

1. Upstream and downstream limits of each existing drainage system to be considered in the drainage calculations.
2. All discharge locations (i.e. outfalls, tie-ins to existing systems) for evaluation of downstream impacts.

When requested by the Engineering Services Project Manager, the Storm Water Services Project Contact will provide information on drainage requests, storm drainage inventory etc., to assist with this process. Engineering judgment should be used to determine these limits, considering drainage area, extent of proposed improvements, size of existing systems, existing problems, etc.

Drainage calculations should be provided for review as early as possible in the preliminary design phase in order to identify existing drainage systems that are undersized or will become so after project improvements are made. Drainage calculations should follow the practices and procedures set forth in the Charlotte-Mecklenburg Storm Water Design Manual and include hydrologic evaluation of all areas draining into the area of interest and hydraulic evaluation of all proposed and existing (to remain) pipe systems within the agreed upon project limits. Current zoning should be used to determine design flows (e.g. full build-out condition). Spread analyses are required to ensure an adequate number of inlets. In most cases, evaluation of the E&PM's *Ten Percent Rule* for all discharge locations will also be required.

Ten Percent Rule

Evaluation of the *Ten Percent Rule* involves the comparison of the design peak flows for existing and post-improvement conditions at project discharge locations. In order to accurately compute these peak flows, hydrologic and hydraulic calculations must account for increased impervious area, loss of storage attenuation in the system, and changes in times of concentration. This requires computation of routed flows through the system for both existing and post-project conditions. When computing the *Ten Percent Rule* limits, existing land use should be used for both the existing and proposed computations. The goal is evaluate the impact of the project on the downstream receiving system, not future development. This is in contrast to the project design computations, which should use future land use (e.g. full build-out of current zoning) when computing design flows. The *Ten Percent Rule* policy should be included as an attachment in every design phase project scope for projects which alter drainage characteristics.

Ten Percent Rule Analysis at each Outfall

If the existing drainage system is adequate to carry the new design flow and still meet City standard, then no improvements would be required as part of the Capital Improvement Project (CIP) downstream of the original discharge location. However, where a receiving system is not adequate to convey post-project flows, the CIP is responsible to improve this system within certain limitations, set forth by the *Ten Percent Rule* policy. The purpose of this policy is two-fold:

a. Determine the "impact point" downstream on each receiving system where post-project peak flow is found to increase by 10% over existing conditions.
b. Determine the downstream limit of project drainage improvements to be funded through the CIP.

The impact point is defined as the location along each receiving system that experiences a 10% increase in peak flow over existing conditions. The CIP is responsible to fund any needed drainage improvements down to that point, or to the point of "adequate conveyance", whichever is further. Adequate conveyance is defined as the point at which a drainage system "can handle the new flow without causing significant erosion, street flooding, or flooding that significantly impacts the use of a property during the design storm." Note that adequate conveyance is not necessarily set by City design standard, but will be judged based upon downstream impacts, existing Emerald drainage requests, engineering judgment, and reasonableness as related to the CIP scope and available funding. For example, if peak flow is increased by 5% due to the project, but the proposed CIP discharge pipe is 36" in diameter, and the receiving system is a 24" pipe, the point of adequate conveyance would most likely extend to a system of 36" or greater in size.

Determination of Downstream Limits

Each project will be evaluated on a case-by-case basis, with the goal to not create new drainage problems. For each outfall, the Engineering Services Project Manager and Storm water Services Project Contact will agree on the limits of downstream improvements on each project outfall based upon the *Ten Percent Rule* computation results, engineering judgment, the existing receiving system condition, and reasonableness as related to the CIP scope and available funding.

Responsibility of the CIP for upgrade of existing systems to meet City standards may be reduced or eliminated depending upon the extent of construction and impact to water runoff. For example, many sidewalk projects and some streetscape projects do not require major modification to the roadway surface and do not produce changes to runoff volume and peak flow. It may be acceptable in these cases to waive the *Ten Percent Rule* threshold and leave existing systems in place for future upgrade by Storm Water Services.

Evaluation and Repair Guidelines for New Drainage Pipe

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All newly-installed pipe installations should require post installation inspection (PII) to determine the condition of the pipe. The following criteria should be applied to all pipe material types and should be utilized to determine the course of action, if any, to be taken when there are cracks, deflections, bulges, creases, tears, spalls, or delaminations in the pipe. The final decision on course of action and acceptability will be determined by the Engineer.

XXDOT requires inspection on newly-installed drainage pipe to determine the condition of the pipe. Initial analysis shall be performed upon delivery of PII Report to determine if any major problems exist with the contractor's installation methods. The analysis of the information provided in the PII Report will be performed by an Engineer within XXDOT. The following criteria will be applied to all pipe material types and will be utilized to determine the course of action, if any, to be taken when there are cracks, deflections, bulges, creases, tears, spalls, or delaminations in the pipe. The final decision on course of action and acceptability will be determined by the XXDOT Engineer.

Cracks (Rigid Pipe):

- Cracks < 0.01" typically do not require repair or remediation.
- Cracks > 0.01" and < 0.05" are acceptable. However, multiple cracks of this size in an 8' section may require minor repair.
- In accordance with AASHTO LRFD Bridge Construction Specifications Section 27.6.4, record cracks greater than 0.01" wide. Monitor these cracks in any subsequent inspections.
- Cracks > 0.05" but < 0.10" are acceptable unless the following additional conditions exist:
    - Minor repair is required if the pipe is located in a corrosive environment.
    - If vertical offset across a crack is exhibited, the following guidelines shall be followed:
        - When vertical offset is less than 0.10" provide minor repair.
        - For vertical offset greater than 0.10" a determination will be made by the Department on the repair method or acceptability of the pipe.
- Cracks > 0.10" will be given consideration by the Department to replace the pipe or allow a Site Specific Repair. See the last section of these guidelines for details concerning Site Specific Repairs.

Cracks or Tears (Flexible Pipe)

HDPE, PVC, or CMP exhibiting any crack/tear

- Consideration will be given by the Department to replace the pipe or allow a Site Specific Repair for any tear that is through the liner of HDPE or for any tear in the wall of CMP or PVC. See the repair section of these guidelines for details concerning Site Specific Repairs.

Deflection (Flexible Pipe)

- Base all deflection measurements on the certified-actual inside pipe diameter supplied by the manufacturer or actual measurements obtained on the project.
- Pipe deflections > 0% but < 5.0% typically do not require repair or remediation.

- Pipe deflections > 5.0% but < 7.5% will be evaluated by the Department and a determination made as to acceptability or replacement.
- Pipe deflections > 7.5% require replacement.

Joint Separation (All Pipe Types)

- For joints that are Soil Tight – If infiltration of soil is observed and the joint gap is less than AASHTO guidelines and the manufacturer's requirements, provide minor repair. If not able to repair, replace as needed. If Infiltration of soil is evident and the joint gap is greater than AASHTO guidelines and greater than manufacturer's recommendations, provide Site Specific Major Repair or replace as needed.

Slabbing (Rigid Pipe)

- For pipe with slabbing, provide a site specific repair or replace pipe.

Spalling (Rigid Pipe)

- For pipe with spalling that does not have exposed reinforcement, evaluate to determine if a minor repair is necessary.

- For pipe with spalling that has exposed reinforcement, evaluate to determine if site specific major repair will be appropriate. If not, replace the pipe.

Repairs (All Pipe Types)

Minor Repairs

Can be made with approved materials or methods and do not require a site specific analysis.
Examples of minor repairs can be found in ASTM C990 14.1 and the ACPA "Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe" Manual.

Other repair resources can be found by visiting the following link http://www.dot.state.fl.us/construction/ContractorIssues/PipeMatrix/MatrixMain.shtm and choosing the type of pipe under evaluation.

Site Specific Repairs

Will be designed by a Professional Engineer, sealed and submitted to XXDOT by the contractor for evaluation and approval. Examples of major repairs can be found in the ACPA "Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe" Manual.

Any repairs made to the installed pipe must be certified by the contractor and the repair contractor. This certification will state that all repairs will have the same service life as newly-installed pipe.

By applying the outlined evaluation and repairs to a post installation inspection report, an owner can be confident that the installed pipe will meet or exceed national standards.

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Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe

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I. POST INSTALLATION EVALUATION AND REPAIR OF INSTALLED REINFORCED CONCRETE PIPE

SCOPE

This document, its references and companion resource materials contain a detailed discussion of the evaluation and repair of newly installed reinforced concrete pipe (RCP). The document was developed for the sole purpose of providing information to allow the reader to properly evaluate post installation inspection data collected from newly installed Reinforced Concrete Pipe (RCP). There are similarities between the inspection and evaluation of older pipelines, however, that is beyond the scope of this document.

The owner of the evaluated pipe system normally places the monetary burden of repair, remediation and/or replacement on the contractor, if new pipe installations are found to have damage. The Matrix and this commentary can be used to provide the evaluation team and the contractor with a reasonable approach to economically evaluate what defects are in need of repair. This document provides good descriptions of basic repair methods that can help guide the contractor and/or owner in selecting and reviewing possible repair methods. Owners benefit with assistance in assessing repairs of pipe systems and by evaluating repair options submitted by contractors. This document should not be directly used to select a specific repair method for a project without the evaluation and guidance from a design professional as the selection of specific repair method is a complicated decision influenced by site specific conditions, budget, availability, and schedule.

Note: many of the evaluation issues and/or repair techniques are not applicable to other drainage piping products.

FOREWORD

Many state transportation departments and municipalities throughout North America and around the world place great emphasis on storm drainage infrastructure. One way this increased emphasis has manifested itself, is through the use of Post Installation Inspection for new pipe installations. As more post installation inspection data is generated and presented to owners, engineers, and inspection professionals, the need to properly and quickly evaluate the issues identified in the inspection documents becomes critical. The decision maker must be trained to differentiate between items that are purely aesthetic from conditions that require remediation to maintain the intended service life for the installed pipe system. Needless repair of minor aesthetic imperfections will lead to unnecessary cost increases. Likewise, failure to remediate a deficiency may lead to unanticipated maintenance and/or replacement.

This document addresses possible issues identified in post installation inspection reports and/or video documents of newly installed RCP. The accompanying RCP Evaluation and Repair Matrix provides evaluation guidance for cracks, spalling, slabbing, and joint integrity. Furthermore, a commentary is provided as an overview of possible remediation and repair techniques. Please note, the repair and remediation procedures outlined are potential options. Each repair or remediation procedure should be carefully reviewed by a professional whose decision is based upon individual site conditions, importance of the facility, defect severity, local availability and design considerations.

BACKGROUND

To best understand and evaluate RCP, one must first understand how RCP and the soil embedment work in concert to accommodate loads, how RCP is designed, and how the finished RCP structural design strength is confirmed prior to installation of critical elements. *The goal is to provide a discussion with references for installed conditions one might see in accurate post installation inspection reports.*

This commentary along with review of the reference material will help the user to properly differentiate acceptable aesthetic conditions from conditions that may require remediation.

LOADS

When properly designed and installed, the RCP and soil embedment work together to support the imposed soil column and any live load, fluid load or surcharge load.

Structural Strength Provided by Soil - Depending on the Standard Installation Type, the pipe may be designed to provide the majority of structural strength of the installed system. A SIDD Type IV bedding installation (weakest soils/least compaction required) would require the RCP to carry a large majority of the load, while a SIDD Type I bedding installation (strong granular soils combined with good compaction/consolidation) would allow more of the load to be carried by the soil embedment materials. All SIDD Installation Types are fully defined and discussed in ASTM C 1479[1].

Structural Strength Provided by Pipe - The structural strength of the pipe is provided by manufacturing RCP with two complimentary products; concrete and steel reinforcement. Similar to an engineered concrete beam, RCP utilizes concrete to resist compressive forces and steel reinforcement to resist tensile forces that are present under load, see Figure 1.

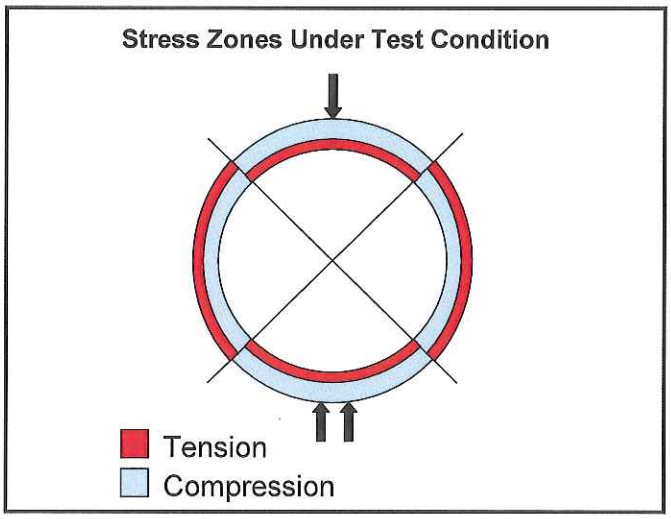


Figure 1: Zones of Tension and Compression in Reinforced Concrete Pipe during Three Edge Bearing Test (field conditions of installed pipe similar.)

The attributes of the steel reinforcement in the pipe wall are under-utilized, unless the pipe wall cracks. As with a concrete beam, the concrete wall of an RCP will crack to transfer tensile loads to the steel reinforcement. The steel reinforcement in the tension areas of the pipe wall is designed to control the crack width and to increase the load carrying capability of the RCP. A properly designed reinforced concrete pipe is expected to crack under service load conditions. Owners, Inspectors and Design Professionals should not be overly concerned when hairline cracks or cracks up to 0.01 inch in width that are visible in collected inspection data. ACPA CP Info "Cracks In Installed Reinforced Concrete Pipe"[2] is a good resource to understand more about significance of cracks in installed RCP.

DESIGN

National Standards (ASTM & AASHTO) allow two methods for designing RCP; the Indirect Design Method and the Direct Design Method. Both methods satisfy service limit states and strength limit states required by AASHTO LRFD Bridge Design Specifications.[3]

The Indirect Design Method is the most common design method utilized by design professionals. RCP has been successfully designed utilizing the Indirect Design Method since the early 1900s. The Indirect Design Method correlates the anticipated installed pipe load to a standard Three-Edge-Bearing (3EB) test D-load. ASTM C-76 (AASHTO M 170) provides the required design load (D-Load), steel areas, and concrete strengths for each strength class of pipe.

The Direct Design Method allows the designer to determine the required concrete strength and steel areas for the pipe installation conditions based upon structural analysis. Typically, most engineers utilize the Direct Design Method for designs that are not included in ASTM C-76.

The reader may want to review "Concrete Pipe Design – Direct Design Versus Indirect Design/Strength Tested Pipe"[4] to learn more about application of the Direct and Indirect Design Methods of RCP.

STRUCTURAL CONFIRMATION AND SIGNIFICANCE OF THE 0.01 INCH CRACK

The Indirect Design strength class of RCP is confirmed through the use of Three Edged Bearing (3EB) Testing Method as defined in ASTM specification C497. Figure 1 along with the test apparatus in Figure 2 illustrates the loading points of the 3EB test. Pipe producers use this test on representative samples of finished pipe sections prior to shipment to the job site.

ASTM C-76 sets forth two design loads, $D_{0.01}$ and D_{ULT}, for each strength class of pipe. As the pipe is loaded during the test, small hairline cracks form. This is an indication that the load on the pipe is sufficient to create tensile stresses greater than the tensile strength of the concrete. As the test load increases, the crack width increases and the tensile forces are transferred to the reinforcing steel. The pipe satisfies the $D_{.01}$ strength criteria and AASHTO Service Limit State if the $D_{.01}$ test load is reached before the formation of a crack 0.01" in width and 12 inches long. As the test load approaches D_{ULT}, the reinforcing steel controls the crack width. Professor Spangler's paper on "The Case Against the Ultimate Load Test for Reinforced Concrete Pipe"[5] discusses the use of the D_{ULT} Test and how pipe reacts in the field condition vs 3EB Test Loads.

Figure 2: Three-Edge-Bearing Test Machine

"Some engineers insist that a crack in a concrete pipe in excess of 0.01-inch represents a failure or partial failure situation. Such a conclusion is utterly ridiculous and represents a disservice, not only to the concrete pipe industry, but taxpayers as well". This quote from Professor M.G. Spangler, a well respected authority and early pioneer in the design of concrete pipe, should be taken into consideration when inspecting a project using reinforced concrete pipe. ASTM C 76 further states; *"The 0.01 inch crack is a test criteria for pipe tested in the Three-Edge-Bearing test and is not intended as an indication of over stressed or failed pipe under installed conditions."*

We strongly urge evaluation and design professionals to tour an RCP production facility to see how RCP is produced and witness a 3EB Quality Assurance Strength Test. This type of hands-on experience will greatly help one understand crack development during a RCP test load. It will also help the individual to gain a perspective on the 0.01 inch design crack compared to smaller "hairline" cracks. One will see that a 0.01 inch crack is insignificant in size; that a 0.05 inch width crack (0.05 inch = thickness of a dime) is

very small; and a 0.10 inch width crack can develop in a heavily loaded pipe section - capable of handling additional loads. Note that ***AASHTO LRFD Bridge Construction Specification Section 27*** allows acceptance of cracks up to and beyond 0.10 inch (the thickness of two dimes) in reinforced concrete pipe.

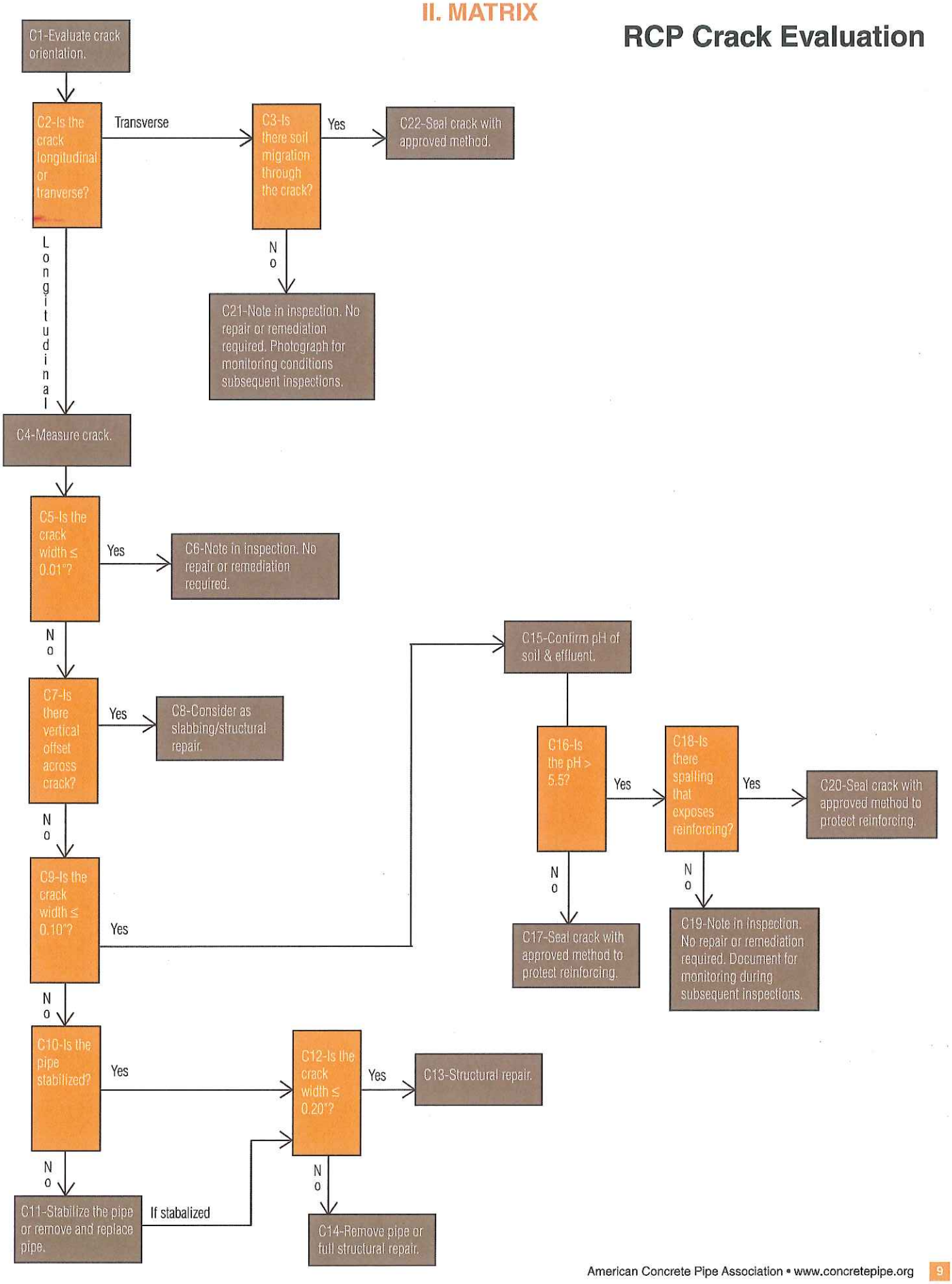
JOINT PERFORMANCE

Pipe joint evaluation considerations are a key component of evaluating the overall performance and acceptability of new RCP installations. The structural and hydraulic performance of the joint affects the stability of the supporting soil embedment around the pipe, the line/grade of the pipeline, integrity of the overlying backfill, pavement structure and compliance to leakage requirements.

"AASHTO Designation: PP 63-091 Provisional Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains[6]" provides transportation professionals with a joint selection and joint performance guidance document. AASHTO clearly identifies and defines several possible joint design performance levels for storm drainage piping. AASHTO worked with the major pipe industries to develop joint design descriptions and testing criteria for: soil tight joints, silt tight joints, leak resistant joints and water tight joints. The joint performance evaluation portion of the Matrix was developed with these key joint performance guidelines in mind.

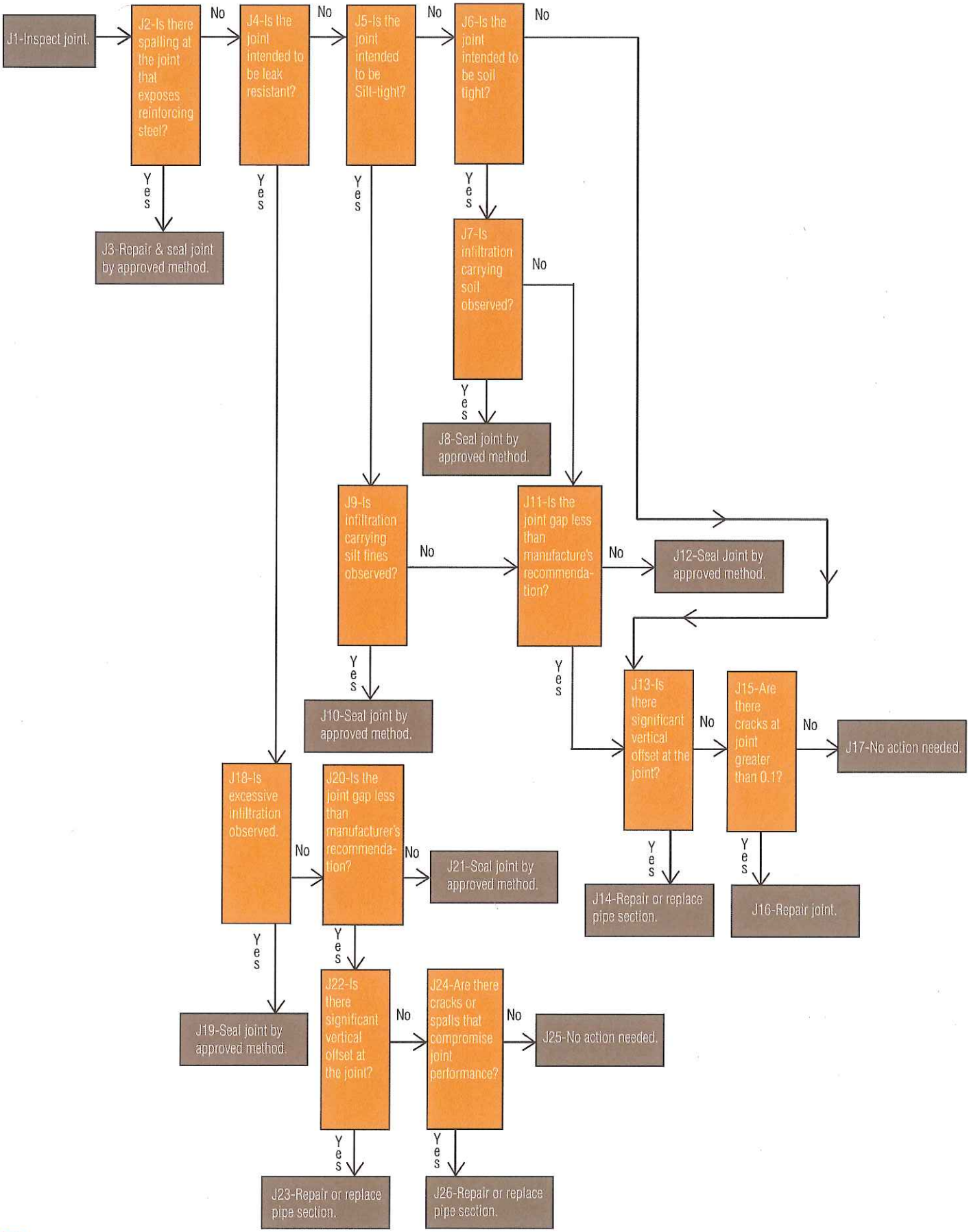
Several FHWA and AASHTO Documents included in the reference materials of this document address the importance of joint design and field performance. All of the reference background materials are relatively consistent in their approach and identification of the items that should be of concern for the evaluation team for the installed pipe system.

RCP Crack Evaluation



Back to start

RCP Joint Evaluation



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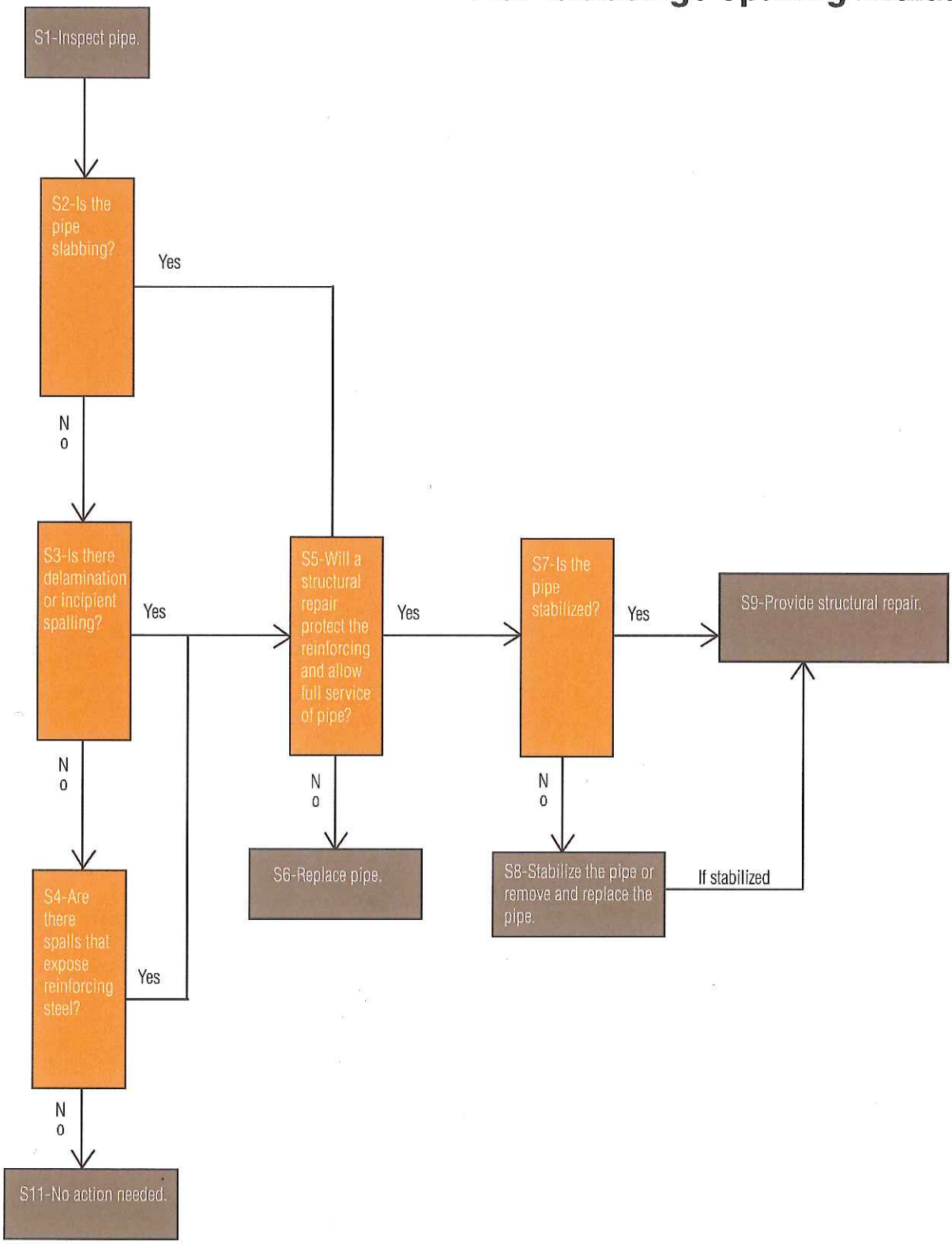
RCP Slabbing / Spalling Evaluation



III. CRACK EVALUATION AND REPAIR

C1 (CRACK INSPECTION), C2 (LONGITUDINAL /TRANSVERSE CRACKS)

It is important to understand that the orientation of a crack in the pipe wall will assist in determining the severity and possible cause of the crack. There are excellent references to better understand crack orientation, crack severity, and possible causes of issues that may be found in pipe inspections. The ***AASHTO LRFD Bridge Construction Specification Section 27.6.4 & 5*** contains several brief explanations in the commentary portions of that document about the cause of various crack location or crack patterns. The following is an excerpt from FHWA Culvert Inspection Manual[7] that discusses possible causes of certain crack locations and or patterns one might find in installed RCP:

> *Longitudinal Cracks--Concrete is strong in compression but weak in tension. Reinforced steel is provided to handle the tensile stresses. Hairline longitudinal cracks in the crown or invert indicate that the steel has accepted part of the load. Cracks less than 0.01 inches in width are minor and only need to be noted in the inspection report. Cracks greater than hairline cracks, or those more than 0.01 inch in width but less than 0.1 inches, should be described in the inspection report and noted as possible candidates for maintenance. Longitudinal cracking in excess of 0.1 inch in width may indicate overloading or poor bedding. If the pipe is placed on hard material and backfill is not adequately compacted around the pipe or under the haunches of the pipe, loads will be concentrated along the bottom of the pipe and may result in flexure or shear cracking, as illustrated in exhibit 108.*

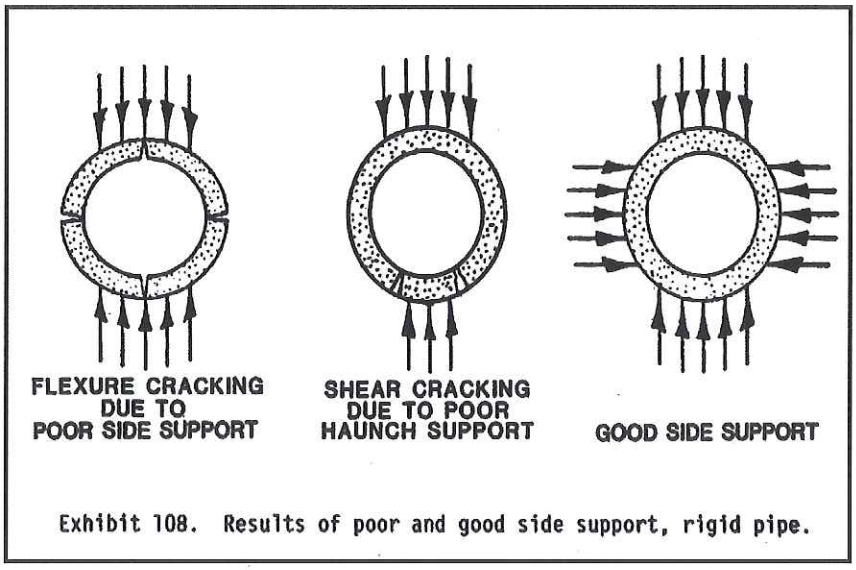


Exhibit 108. Results of poor and good side support, rigid pipe.

> *Other signs of distress such as differential movement, efflorescence, spalling or rust stains should also be noted. Examples of longitudinal cracking are shown in exhibits 109 and 110. When cracks are wider than 0.1 inch measurements should be taken of fill height and the diameter of the pipe both horizontally and vertically to permit analysis of the original design. Crack measurements and photographs may be useful for monitoring conditions during subsequent inspections.*

Back to matrix

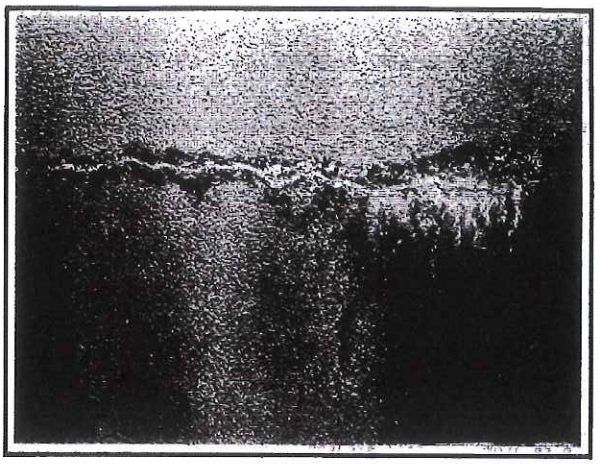
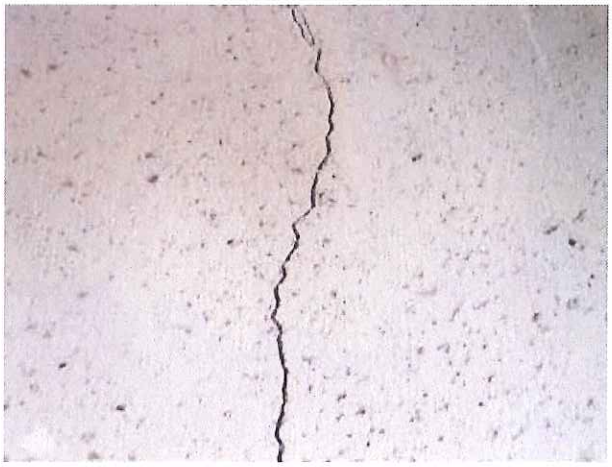


Exhibit 109. Minor longitudinal crack with efflorescence.



d. Transverse Cracks--Transverse or circumferential cracks may also be caused by poor bedding. Cracks can occur across the bottom of the pipe (broken bell) when the pipe is only supported at the ends of each section. This is generally the result of poor installation practices such as not providing indentions (bell holes) in hard foundation material for the ends of bell and spigot-type pipe or not providing a sufficient depth of suitable bedding material. Cracks may occur across the top of pipe (broken back) when settlement occurs and rocks or other areas of hard foundation material near the midpoint of a pipe section are not adequately covered with suitable bedding material. Transverse cracking is illustrated in exhibit 111.

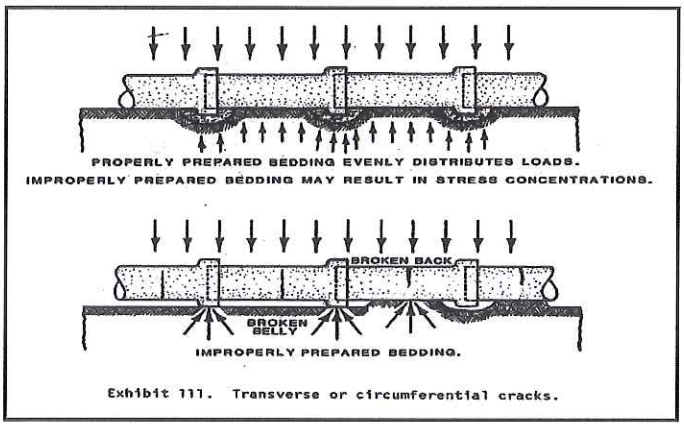
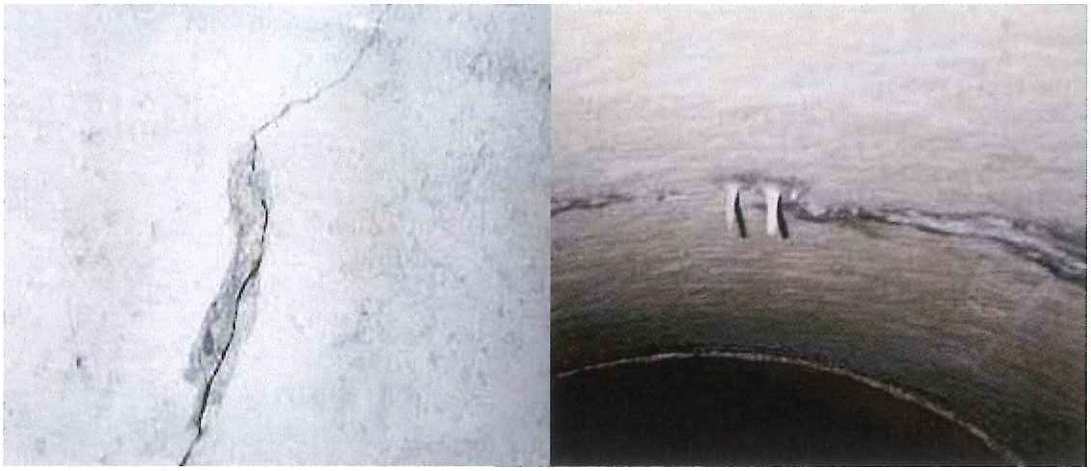


Exhibit 111. Transverse or circumferential cracks.



Circumferential Crack with minor spalling along crack & circumferential crack with autogeneous healing.

C3 (SOIL MIGRATION W/ TRANSVERSE CRACK)

Circumferential/Transverse cracks can be evaluated similar to a joint integrity evaluation process. If the circumferential crack is not allowing transport of backfill material into the pipe, and the pipe does not have a vertical offset that could impede flow, and the pipe is in a non-corrosive environment, it should only be noted in the inspection report. Under these conditions, no remediation would be required. The severity of a circumferential crack is limited, because this type of crack will not affect the structural load capacity of the RCP pipe wall; it can be viewed similar to just another joint in the system.

The steel reinforcement arrangements utilized in RCP are comprised of longitudinal steel wires running length wise along the pipe and circumferential steel wires which transverse the reinforcement assembly. The longitudinal wires are typically smaller in diameter and spaced further apart as compared to the circumferential reinforcement. The longitudinal reinforcement functions to space the circumferential wires and help hold the reinforcement assembly in shape during the RCP production process. The circumferential steel in the reinforcement arrangement provides the structural component of the assembly. A circumferential crack will transverse across the longitudinal steel. As previously stated, the longitudinal steel reinforcement has a minor role in structural integrity of the pipe wall; therefore circumferential (transverse) cracks are of much less structural concern than longitudinal cracks. Circumferential steel provides the structural component of the completed steel cage.

Circumferential steel provides the structural component of the completed steel cage

Repair of a circumferential crack would be warranted if there is soil migration into the pipe, or if there is significant vertical offset that could significantly impede flow. Causes of circumferential cracks are generally related to poor bedding or foundation support. Improper handling and storage of RCP during the construction process can also induce stress to cause cracks in the pipe wall or jointing surfaces. It is important for the installer and inspector to understand proper storage, handling and installation techniques of RCP to limit damage of the product. The ACPA *Installation Manual*[8], and ACPA *Dos and Don'ts*[9] are both good training resources to help installers and inspectors better understand proper installation, storage and handling techniques and guard against issues that can damage RCP.

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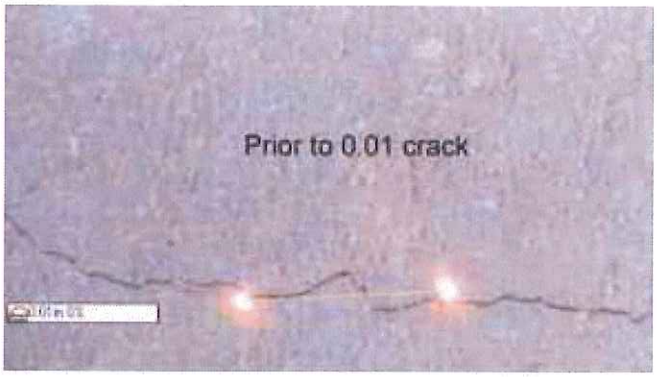
C4 (CRACK MEASUREMENT)

The evaluation of longitudinal cracks should begin with crack width measurement. Length and width measurement is key to the evaluation of a longitudinal crack in RCP. The information collected about the crack can indicate not only the severity, but also the possible causes of the cracks observed. Longitudinal cracks can be measured with feeler gauges if the pipe is large enough for entry (inspection team must follow all OSHA safety requirements). Longitudinal cracks in smaller diameter pipes can be measured with laser micrometers.



Crack measurement utilizing laser micrometer.

Measurement of crack with feeler gauge.

Example of autogenous healing.

Longitudinal crack width measurement is used to classify a given crack as hairline (crack less than 0.01 inch), design (crack 0.01inch - 0.10 inch) or a stress (crack greater than 0.10 inch). The current ***AASHTO LRFD Bridge Construction Specification Section 27.6.4 & 5***[10] addresses longitudinal cracks in detail, but it is important to understand that the crack width criteria set forth in AASHTO requires evaluation by a pipe or drainage professional for longitudinal crack widths exceeding design crack widths of 0.01 inch.

C5, C9, C12 (CRACK WIDTH)

AASHTO LRFD Bridge Construction Specifications Section 27.6.4 & 27.6.5[10] describes potential longitudinal cracks observed in concrete pipe culverts and a simplified summary is as follows:

C9 (CRACKS < 0.1")

According to AASHTO, evaluation is not needed unless longitudinal crack width is greater than 0.01 inch. The commentary goes on to state that crack widths up to 0.10 inch are generally acceptable if the pipe is in a non-corrosive environment.

From a structural integrity standpoint, crack widths less than 0.10 inch should be considered acceptable if located in a non-corrosive environment as discussed in AASHTO Section 27. Sealing these types of cracks can prove to be difficult - especially in small diameter pipelines that do not permit man entry. Sealing hairline and design cracks is not required unless corrosive conditions exist that can further deteriorate the pipe. Research indicates that hairline and design cracks in the pipe wall often heal themselves through a process known as autogenous healing. Autogenous healing occurs between the crack surfaces of buried pipe. The healing process is a result of a chemical reaction that takes place in the presence of moisture and air. During this process, calcium carbonate (a hard white crystalline substance) forms when moisture and oxygen re-

act with un-hydrated cement in the pipe wall. The healing process results in a monolithic pipe structure that is often stronger. References included at the end of the commentary, provide a more in depth discussion on the topic of autogenous healing of concrete pipe and structures. (See "Autogeonous Healing of Cracks [11] and Healing of Cracks in Lightweight Concrete.[12])

C7 (VERTICAL OFFSET)

It is important to note any significant vertical offset across all cracks. In pipes large enough for man entry, the vertical offset across the crack can be measured by using leaf gauges. In video inspections of smaller pipes, a visual estimation may be the only way to evaluate the vertical offset across a crack.

RCP exhibiting a crack with vertical offset in obvert (Top) of pipe

Concrete slabbing near invert due to radial tension shear.

C8 (SLABBING)

A pipe under structural distress caused by a load that creates high shear stresses in the pipe wall can be identified by offset across the face of the crack. Vertical shear cracks usually are found in the haunch (area between invert and springline) areas of the pipe as opposed to flexural cracks which are usually found at the invert and obvert of the pipe wall. (See Picture on left) If a significant vertical offset is apparent in the video inspection while using no magnification, the offset is most likely large enough to warrant further investigation to determine if future slabbing of the pipe wall is of concern. AASHTO Section C27.6.4 commentary has a good discussion of shear cracks.

C10 (MEASURING STABILIZATION)

Before structural repairs can be made to an installed RCP, it must be determined if the installation has stabilized. As RCP deforms in a slabbing, radial shear, or gross deformation condition, the pipe loses rigidity and approaches a flexible or semi-rigid structure condition. Reinforced concrete pipes under extreme earth loading that is experiencing gross deformation may still be capable of accepting additional load and an "ultimate" load is practically never reached. In this condition, passive soil pressures generate at the sides of the pipe until the pipe and surrounding soils reach a stabilized state. Once the pipe-soil system has stabilized, the system is said to have reached equilibrium; meaning further pipe deformation is prevented due to the counter balancing soil pressure, which develops in response to the horizontal deformation of the pipe against the soil. This equilibrium state can be determined by establishing permanent horizontal and vertical reference points at 12, 3, 6 and 9 o-clock positions throughout the pipe run. The distance between the horizontal and vertical points are then determined with a solid rod micrometer (see picture to right) and recorded.

Measurements should be taken over a three week period to determine if the pipe-soil system has reached equilibrium. If the installed pipe-soil system has reached equilibrium, cracks can be reamed out with air chisel or power grinder, damaged concrete removed and the areas patched with Portland cement grout or epoxy cement grout. Patches of this kind will not add strength to the pipe, but will protect the reinforcing steel from corrosion.

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Soil consolidation continues with time after the final fill is placed over the pipe. Therefore, AASHTO Section 27 requires that an elapsed time of 30 days (4 weeks) pass before conducting Post Installation Inspection and Evaluation of the installed reinforced concrete pipe. When cracks greater than 0.1 inches are found during the inspection, measurements should be taken over the next three week period resulting in a total of 7 weeks to determine if the pipe-soil system has reached equilibrium. If the installed pipe-soil system has reached equilibrium, cracks can be reamed out with air chisel or power grinder, damaged concrete removed and the areas patched with Portland cement grout or epoxy cement grout. Patches of this kind will not add strength to the pipe, but will protect the reinforced steel from corrosion. Should the installed reinforced concrete pipe not reach equilibrium, then some type of structural repair should be made that will not solely rely on structural integrity of the installed pipe. Removal and replacement of the installed pipe or structural slip line are potential final options.

C11 (ACHIEVING STABILIZATION)

Reinforced concrete pipe with multiple cracks in excess of 0.10 inch and determined to have not reached equilibrium may be equalized by drilling holes through the pipe wall at the haunch area and injecting pressure grout between the pipe and the embedment soil. This will effectively increase the lateral pressure along the length of the pipe and improve the bedding condition to such an extent that the supporting pipe strength is made adequate to carry the vertical load without further deformation. Again, the pipe should be monitored as described in the proceeding paragraph. Once the pipe-soil system has reached equilibrium, cracks can be structurally repaired.

C12 (CRACKS >0.1" AND < 0.2")

Cracks larger than 0.10 inch in width are rare and should be structurally evaluated to determine if the pipe is structurally capable of supporting the loads. As discussed above, if the pipe system has reached equilibrium the pipe has proven to have accommodated the load. The cracks should be structurally remediated. Possible remediation actions could include sealing the cracks with structural epoxy type materials placed in the crack plane or Full Barrel repairs such as: Cured in place liners, Fold and Form liners, Epoxy resin Liner, or slip line systems.

C15, C16 (PH)

AASHTO and other resources also utilize pH conditions of the installed pipe environment to identify if a corrosive environment exists for the subject installation. In a corrosive environment, a design or stress crack in the pipe wall could deteriorate further, as the pipe wall material is attacked by the acidic influent or soil conditions. Evaluation of the influent, ground water and soil conditions should be made as outlined in ASTM G51, Standard Test Method for Measuring pH of Soils for Use In Corrosion Testing and ASTM D1293, Standard Test Method for pH of Water. The FHWA Culvert Inspection Manual[7] contains the following discussion on corrosive soil and water conditions and should help one evaluate, if test results from samples would indicate pipe is in a corrosive environment:

> *Certain soil and water conditions have been found to have a strong relationship to accelerated culvert deterioration. These conditions are referred to as "aggressive" or "hostile." The most significant conditions of this type are:*
>
> *a. pH Extremes--pH is a measurement of the relative acidity or alkalinity of water. A pH of 7.0 is neutral, values of less than 7.0 are acid, and values of more than 7.0 are alkaline. For culvert purposes, soils or water having a pH of 5.5 or less are strongly acid and those of 8.5 or more are strongly alkaline.*

California Department of Transportation DIB 83-01[13] "Problem Identification and Associated Repair for Culvert Barrels" 5.1.1.2 CRACKS states the following with respect to crack width and corrosive environment:

> *"For culverts that have been newly installed and backfilled, cracks should not exceed 0.01 inch in width in severely corrosive environments (pH of 5.6 or less, water containing vegetal or animal wastes, seawater, or other water with high concentration of chlorides). Conversely, for culverts installed in a non-corrosive environment (neutral pH close to 7, low concentrations of salt, vegetal or animal wastes), cracks of up to 0.1 inch in width of the installed pipe are acceptable if they are not excessive in number."*

Professor Spangler also noted his opinion on the durability of RCP, "Cracks up to approximately 1/16-inch in width will not permit corrosion except under the most adverse conditions."

C18, (SPALLING)

Spalling may be seen along the edges of cracks. Minor spalling that does not expose the reinforcing steel is no structural concern as long as pipe is in a non-corrosive environment as previously discussed. If spalling along a crack exposes the circumferential steel reinforcement, the spalled area should be repaired. Note; exposed circumferential reinforcing steel should be differentiated between exposed longitudinal steel and/or exposed steel spacers to prevent unnecessary repairs.

Crack exhibiting minor spalling along edge of crack.

C17, C20, C22 (REPAIR METHODS FOR CRACKS IN RCP)

The decision process between the need to seal a crack versus the need to structurally repair a crack has been discussed above in the crack evaluation section of this document.

There are many reasonable repair methods for the various crack conditions. It is challenging to provide guidance as to what repair method is best for a specific defect for a specific project. The list of possible repair methods outlined on the RCP Evaluation and Repair Matrix is consistent with repair methods discussed in detail in FHWA Culvert Repair Practices Manual[14], California Department of Transportation DIB 83-01[13], and Chapter 14 "Culvert Inspection, Material Selection, and Rehabilitation Guideline" of the AASHTO Highway Drainage Manual[15].

The following repair techniques are excerpts from California Department of Transportation DIB 83-01[13]:

CRACK REPAIR IN CONCRETE PIPE USING A MAXIMUM STRENGTH, NON-SHRINK, PORTLAND CEMENT OR MORTAR (REFER TO INDEX 5.1.1.2) – CAL DIB 83-01(13)
Dimensions of "V" Grind shall be 0.25 inch wide minimum and approximately 0.5 inch deep. 1 inch deep Grinds may damage reinforcement. The Grind shall be cleaned of any grinding dust and surface thoroughly moistened before filling with non- shrink Portland cement or Mortar (e.g. Jet PlugTM by Jet Set California Inc, see Appendix F) to ensure a good bond.
The mortar mix should be mixed to a low-slump consistency with only enough water added to gain a consistency of heavy glazing putty. Allow repair to become firm to touch 6 to 10 minutes after installation. Then shave to grade with a trowel edge. Do not overwork.

If the new patch is not under water, a curing agent shall be used to cover the new patch plus 1 inch on either side of the new patch immediately after patch is firm. It should be noted that when longitudinal cracks are found at the crown of the pipe, usually the invert of the pipe is also cracked.

Crack repair method for Cracks in RCP from "FHWA Culvert Repair Practices Manual.

APPENDIX B-25: PROCEDURES FOR REPAIRING CRACKS IN CONCRETE

APPLICATIONS
The following discussion applies to the repair of cracks in Portland cement concrete.

COMMENTS
The procedures and materials that should be used for repairing cracks in Portland cement concrete will frequently depend upon the cause of the crack, its location, and the environment surrounding it. Shrinkage cracks may be quite narrow and shallow and have little influence on the structural behavior, whereas wider and deeper cracks may have been caused by structural loading and may signify more serious effects on structural load carrying capacity. Both types of cracks may have an influence on long term durability of the structure.

With regard to procedures for repairing cracks in concrete culverts, there is always an overall requirement that cracks be clean and preferably dry before they are repaired. Obviously, it may be difficult to meet both of these criteria for cracks in culverts. The cracks will generally be old by the time they are found, and if they are wide enough, they may be full of sand or dirt. In addition, they may be continuously wet from water from either the inside or the outside of the culvert. Thus, generally some work will be needed to prepare the crack for the repair material.

There is a choice of materials that may be used to repair cracks. The materials generally may be categorized as either flexible crack fillers or rigid materials that are more permanent that may create a structural repair. The latter group includes both Portland cement-based mortar and structural adhesives including epoxy systems that may be filled with aggregate or a powder or unfilled.

The general opinion of many practitioners is that cracks that are moving because of movement in the structure should be repaired with a flexible sealing-type material,

whereas stationary cracks may be filled with a rigid material. This is not an absolute rule, but it does highlight the need to determine whether the crack is moving. For most concrete culverts it may be assumed that the crack is moving, especially since there is a close relationship between soil pressures and the resistance (and strength) of a concrete culvert; and the soil pressures that may have caused cracking will continue to be exerted on the culvert. Under some situations the condition may have stabilized. Thus, there is a rationale that the structure is probably still moving and it should be filled with a flexible material. However, there is also another principle in soil-structure behavior that if conditions are allowed to continue they will be come worse, as the soil pressures will continue to deform the structure until collapse occurs. From that standpoint it may be best to try to strengthen or stabilize the structure so that it can resist the increasing soil pressures, in this case by effecting a structural repair on the more serious cracks. This will require filling the cracks with a rigid material. If tensile, flexure of shear forces will occur it may be necessary to use a structural adhesive. Some of these materials may be installed in wet or submerged cracks.

PROCEDURES

1. Installation of a Flexible Sealant

The following is a general procedure for filling a crack with a flexible sealant. The manufacturers of such sealants will have more specific recommendations for their particular materials if the highway agency has not established such procedures.

a. Clean the surface of the concrete.

b. Route a groove into the surface of the crack, so that it will serve as a reservoir for the sealant.

c. Clean concrete dust and debris out of the crack by sand-blasting, air-water jet, or both.

d. Fill the crack with the sealant by pressure injection or troweling. If troweling is to be done a bond breaker should be first applied to the surface of the concrete on both sides of the crack so that the sealant will not have a wide width at the top of the crack.

e. Scrape excess sealant off the concrete surface, so that the surface will be smooth. (For some types of cracks it may be desirable to trowel a shallow depression in the surface of the sealant.)

2. Installation of a Portland Cement Mortar or Grout

Wide cracks may be repaired by filling with Portland cement grout, as follows:

a. Clean the surface of the concrete.

b. Install built-up seats and grout nipples at intervals along and astride the crack to provide a pressure tight contact with the injection apparatus.

c. Seal the crack between the grout nipples, with a cement paint, sealant, or grout.

d. Flush the crack to clean it and to test the seal.

e. Grout the crack. The grout mixture may contain cement and water or cement plus sand plus water, depending on the width of the crack. However, the water-cement ratio should be kept as low as possible to provide maximum strength and low shrinkage. The grout may include a water reducer or other admixtures to improve the properties of the grout.

3. Repair by Injection of Epoxy Adhesive

The following is from guidelines of the Pennsylvania DOT.

Back to matrix

Equipment

a. Type – The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the tow components at the nozzle. The pumps shall be electric or air powered and shall provide in-line metering and mixing.

b. Discharge Pressure – The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any preset pressure up to 200 psi plus/minus 5 psi an shall be equipped with a manual pressure control override.

c. Ratio Tolerance – The equipment shall have capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive with a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.

d. Automatic Shut-Off Control – The injection equipment shall be equipped with sensors on both the component A and B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

Preparation

a. Surfaces adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil efflorescence or other foreign matter detrimental to bond of epoxy injection surface seal system. Acids and corrosives shall not be permitted for cleaning.

b. Entry ports shall be provided along the crack at intervals of not less than the thickness of the concrete at that location.

c. Surface seal material shall be applied to the face of the crack between the entry ports. For through cracks, surface seal shall be applied to both faces, if possible.

d. Enough time for the surface seal material to gain adequate strength shall pass before proceeding with the injection.

Epoxy Injection

a. Injection of epoxy adhesive shall begin at lower entry port and continue until there is an appearance of epoxy adhesive at the next entry port adjacent to the entry port being pumped.

b. When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped, and epoxy injection shall be transferred to the next adjacent port where epoxy adhesive appeared.

c. Perform epoxy adhesive injection continuously until cracks are completely filled.

d. If port to port travel of epoxy adhesive is not indicated, the work shall immediately be stopped and the engineer notified.

Finishing

a. When cracks are completely filled, epoxy adhesive shall be cured for sufficient time to allow removal of surface seal without any draining or runback of epoxy material from cracks.

b. Surface seal material and injection adhesive runs or spills shall be removed from concrete surfaces.

c. The face of the crack shall be finished flush to the adjacent concrete showing no indentations or protrusions caused by the placement of entry ports.

IV. JOINT EVALUATION

J1 (JOINT INSPECTION)

Evaluation of the joints for installed concrete pipe requires both visual interpretations of inspection data, as well as actual measurements to determine severity of some items of note in the joint inspection process. Whether inspection is manual or by video, the entire circumference of every joint should be inspected.

The Matrix and subsequent commentary on Joint integrity follows the guidelines set forth in ***AASHTO PP 63-09 "Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains***[6]. AASHTO PP63-09 provides transportation designers with joint selection criteria and joint performance requirements for several different performance levels for each of the major pipe types including RCP.

J2, J3 (SPALLING)

During handling and installation it is possible to damage joint surfaces. Minor spalled areas of the joint surface do not need repair, unless steel reinforcement is exposed or the broken area is allowing transport of fine soil to migrate into the storm system.

J4 (LEAK RESISTANCE)

Leak resistance - Leak resistance refers to a system that is not completely (100 percent) watertight, but allows some defined allowable rate of water leakage into or out of the system.

Leak-resistant joint - a joint which limits water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the project specified head or pressure.

J5 (SILT TIGHTNESS)

Silt-tightness - refers to a pipe system's resistance of fine soil migration through the openings of the joint.

Silt-tight joints - a joint that is resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. Silt-tight joints provide protection against infiltration of backfill material containing a high percentage of fines, and typically utilize some type of filtering or sealing component, such as an elastomeric rubber seal or geotextile.

J6 (SOIL TIGHTNESS)

Soil tightness - refers to a pipe system's resistance of course grained soil migration through the openings of the joint.

Soiltight joint - a joint that is resistant to infiltration of particles larger than those retained on the No. 200 sieve. Soiltight joints provide protection against infiltration of backfill material containing high percentage of coarse grain soils, and are influenced by the size of the opening (maximum dimension normal to the direction that the soil may infiltrate) and the length of the channel (length of the path along which the soil may infiltrate).

J7, J9 (INFILTRATION)

When the water table is higher than the invert of the pipe, water may seep into the culvert or pipelines during low flows. Infiltration can also occur during flood events if gravity flow systems become pressure flow and cause suction from pressure differentials in inlet control culverts.

Back to matrix

Infiltration can cause settlement and misalignment problems if it carries fine-grained soil particles from the surrounding backfill (Soil Migration). In such cases, measures should be taken to seal the joints.

J8, J10, J12, J16, J18, J19 (JOINT SEALING)

If joint is allowing fine particle migration, the joint should be sealed.

DIB 83-01 - 5.1 Problem Identification and Associated Repair for Culvert Barrels(13)

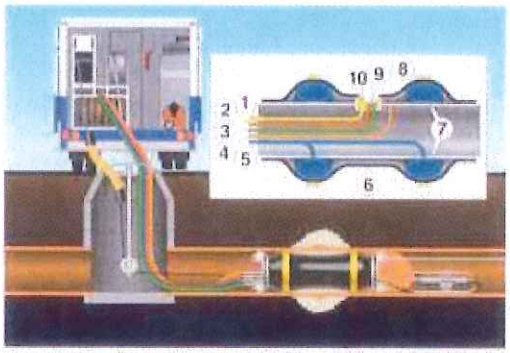
"Internal grouting, internal joint seals, or some of the lining methods such as sliplining, or lining with CIPP will stop infiltration. In general, for culvert repair work, Portland cement based grout, with and without special admixtures, is usually adequate and much less expensive than the foaming and chemical grouts that are used to resist high external and internal fluid pressures. Internal grouting can be specifically designed to stop infiltration at deteriorated, continuously leaking or open joints. See FHWA Culvert Repair Practices Manual Volume 1, pages 5-37, 6-11, 6-14, and Volume 2, Appendices B-30 and B-26 for procedures on grouting voids and sealing culvert joints. Also see Index 11.1.1.

Internal Chemical Grouted Joint

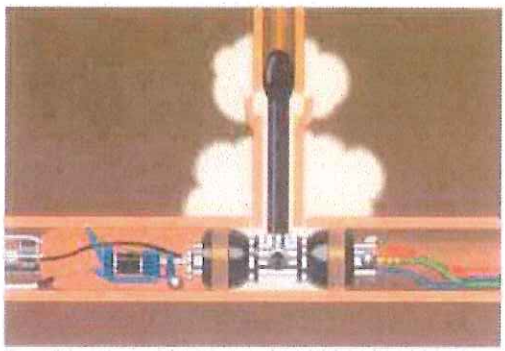
Chemical grouting is the most commonly used method for sealing leaking joints in structurally sound, sewer pipes that are under the groundwater table. Chemical grouting will not provide structural repair. However, other methods such as using repair sleeves in combination with chemical grouting are appropriate for structural repairs (see discussion towards end of this section). Attempting to utilize chemical grout to seal joints that are not leaking or have no physical infiltration of ground-water during the sealing process has produced questionable results. Some types of chemical grouts have failed in arid regions where the grout has dried up during periods of low groundwater and in coastal regions where the ground is subject to tidal fluctuations. The long-term service life for chemical grouting is unknown. One study concluded the life expectancy for chemically grouted joints was no more than 15 years, other

references indicate a 20 year service life, and it is known to last even longer in other applications such as sealing tunnels and dams.

In non-human (small diameter) entry pipes, grouting is generally accomplished using a sealing packer and a closed circuit television (CCTV) camera. The sealing packer and CCTV camera are pulled through the pipe with cables. Concurrently, air or water testing equipment is used to test the joint and determine the effectiveness of the sealing.



Modern injection packers are very sophisticated, consisting of: (1) Pressure Sensing Line, (2) Chemical "A" Line, (3) Chemical "B" and Air Pressure Line, (4) Sleeve Air Line, (5) End Seal Air Line, (6) Sleeve, (7) End Seal Elements, (8) Sealing Pads, (9) Chemical Injection Ports, (10) Pressure Sensor Element



New injection packers can seal lateral connections and the first few feet of service lines with chemical grout quickly and cost-effectively

In pipes with large enough for human entry, pressure grouting is accomplished using manually placed inflatable pipe grout sealing rings or predrilled injection holes and a hand-held probe (see figure below):

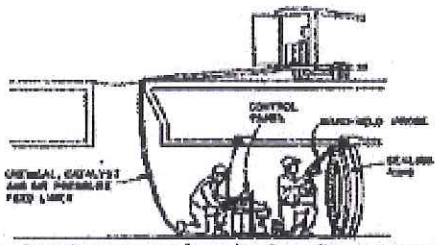


FIGURE 6.4. Typical arrangement for sealing large diameter pipe with grouting rings.

Illustration of gel grout penetrating outside the pipe joint

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The two basic groups of chemical grouting materials are gels and polyurethane foams. Polyurethane foam grout forms in place as a gasket and cures to a hard consistency but retains a rubber-like flexibility. The seal takes place in the joint and there is only minimum penetration outside the pipe. The service life of polyurethane foam is not moisture-dependent and therefore it can be considered for use in locations with wet-dry cycles. Gel grouts penetrate outside the pipe and infiltrate the soil surrounding the joint. The mixture cures to an impermeable condition around the joint area.

The service life of the non-urethane type gels discussed below is moisture-dependent, and therefore these types should not be considered for use in locations with wet-dry cycles. Urethane gel however, is different from the acrylamide, or acrylate gels in that water is the catalyst and they may be used in locations with wet-dry cycles to form either an elastomeric collar within the pipe joint as well as filling the voids in the soil outside the joint.

The most commonly used gel grouts are of the acrylamide, acrylic, acrylate and urethane base types. Acrylamide base gel is significantly more toxic in its pre-gelled form than the others but grout toxicities are of concern only during handling and placement or installation and EPA has now withdrawn a long standing proposal that sought to ban the use of acrylamide grouts. Due to its very low viscosity, acrylamide has long been the material of choice to repair underground structures in the sanitary sewer industry. The non-toxic urethane base gels are EPA approved for potable water pipelines because they use water as the catalyst rather than other chemicals. Because of soil and moisture variability, formulating the correct mixture is largely dependent on trial and error on a case-by-case basis, and is difficult to accurately specify in design.

If the pipe is round and large enough for human entry and the external hydraulic head pressure is low, it may be possible to use an internal steel expansion ring gasket joint sealing system in conjunction with pressure grouting to fill voids in the soil behind the joint. See FHWA Culvert Repair Practices Manual Volume 2, pages B-111 to B-116. If corrosion and abrasion protection is needed, it may be necessary to cover the steel expansion ring with shotcrete or cement mortar; however, rings are available in stainless steel for enhanced corrosion protection."

J11, J20 (JOINT GAP)

All producers have joint designs for their products that meet the required performance criteria as outlined in the technical specifications or design guidelines. Soil tight joints may consist of a joint with butyl mastic joint material, a silt tight joint may include a rubber gasket, or a butyl mastic joint material and may in some cases be combined with an exterior joint wrap and a leak resistant joint normally requires a joint design that utilizes a rubber gasket. Each manufacturer may also produce pipe with a slightly different concrete joint configuration on their pipe when compared to another pipe manufacturer. Actual joint geometry and tolerances should be provided by the manufacturer to determine acceptable joint tolerances to meet the required joint performance criteria set by the owner/project specifications. Note; even properly installed joints can appear to not be fully homed when inspected with CCTV inspection equipment, because of the lack of perspective and measurement. The pipe manufacturer should always be consulted when evaluating acceptable joint gaps.

J13, J22 (VERTICAL OFFSETS/MISALIGNMENT)

Significant vertical offset or severe misalignment at the joint may indicate the presence of serious problems in the embedment soils. If progressive settlement is present, joint repair should not be performed until a solution to stabilize the surrounding soil has been found. If the vertical offset or misalignment is a result of leaking joints and soil migration, a determination should be made whether the migration is due to water exfiltration or infiltration of the soil material. A combination of grouting the external voids and sealing the culvert joints may be warranted using chemical grouting or other joint repair methods. **CCTV inspection equipment may amplify acceptable alignment such that it appears to be misaligned at the joint sections.** Depending on the manufacturing process, RCP may be produced with a slight internal taper which could naturally create a joint offset. ASTM C76 sections 9.1 & 12.1 give some guidance on how much this natural offset could be. RCP produced within the maximum allowable manufacturing tolerances could have a natural offset that ranges from ¼" on 12" diameter, varying linearly up to 3/8" on 24" diameter, and continuing to over ½" for pipes larger than 48" diameter. Joint designs also allow for movement or minor adjustment in the field for line and grade. These minor misalignments should not be of concern and are taken into account when using the recommended hydraulic design criteria for concrete pipe systems.

J15, J24 (CRACKS)

A cracked joint, while not ideal, may provide the intended performance. If no other problems are evident, such as misalignment and the cracks are not open (less than 0.10 inch in width) or spalling, cracked joints may be considered a minor issue to be noted in inspection report. Severe joint cracks are similar in significance to separated joints. Separated joints are often found when severe misalignment is found. In fact, either problem may cause or aggravate the other. Embankment slippage may also cause separations to occur. An attempt should be made to determine whether the separations are caused by improper installation, soil migration along the length of the pipe, or uneven settlement of fill. If soil migration is determined, an attempt should be made to determine whether the migration is due to ground water, water exfiltration, or infiltration of backfill material.

Repair of large cracks can be made in a similar fashion to those methods discussed in crack repair portion of this document. Internal joint seals or joint repair methods, discussed in joint infiltration repair section, could also be considered.

Crack near joint of RCP.

Small crack near joint.

V. SPALLING AND SLABBING EVALUATION

S1 (INSPECTION)

During the inspection of the pipe, there may be noticeable vertical offset combined with some spalling along longitudinal cracks in the haunch areas of the pipe. These could be signs of structural distress and should be carefully investigated. They may be likely candidates for some type of repair or remediation.

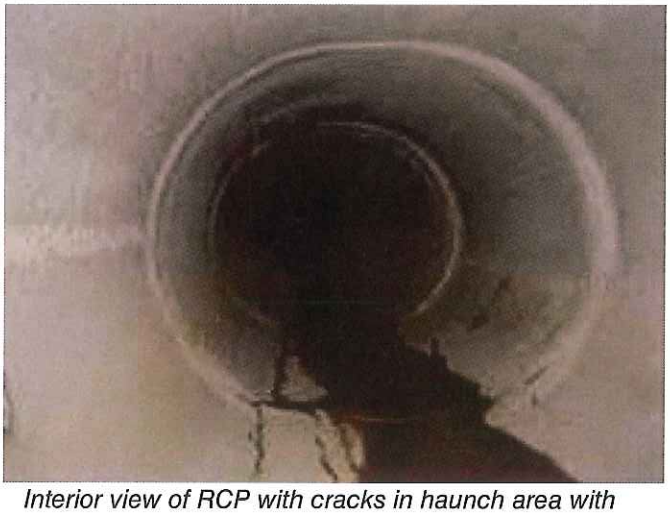
S2, S3 (SLABBING & SPALLING)

Spalls are fractures of the concrete parallel, or inclined to the surface of the concrete. Spalls are caused by excessive shear forces, or may be caused by corrosion of the reinforcing steel in areas where it does not have sufficient cover.

Crack exhibiting minor spalling along edge of crack.

Slabbing can be a radial failure of the concrete due to excessive deflection, and may be difficult to distinguish from spall fractures. In slabbing, the concrete cover over the reinforcement is forced away from the reinforcement as the pipe deflects and the reinforcement steel straightens out. This is a serious structural problem normally identified as radial tension shear and is caused by overloading, usually under very high fills. Sections which have experienced extreme slabbing should be repaired or replaced.

Crack with vertical offset – early indication of possible radial tension shear in pipe wall.



Interior view of RCP with cracks in haunch area with vertical offset. Early sign of possible slabbing and radial tension shear forces present in wall of pipe.

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S4 (EXPOSED REINFORCING)

If the spalling occurs along crack planes, or if the pipe is exhibiting slabbing, it is important to remove all delaminated and/or loose concrete from above the steel. If the pipe is stabilized and equilibrium has been achieved, the exposed reinforcement can be cleaned and protected, so pipe can maintain an appropriate service life and be repaired in a way to maintain long-term structural strength.

Concrete slabbing near invert due to radial tension shear.

S5 (STRUCTURAL REPAIR)

Even though slabbing is a structural issue that requires proper attention, in many cases it can be remediated in a way to reestablish adequate structural integrity. If repaired properly, the pipe can provide the anticipated service life.

S6 (REPLACEMENT)

If the pipe wall has experienced excessive deformation to the point the pipe cannot be stabilized, the pipe may need to be replaced.

S7 (MEASURING STABILIZATION)

As the RCP deforms in a slabbing, radial shear, or gross deformation condition, the pipe loses rigidity and approaches a flexible or semi-rigid structure condition. Reinforced concrete pipe under extreme earth loading that is experiencing gross deformation may still be capable of accepting additional load and an "ultimate" load is practically never reached. In this condition, passive soil pressures generate at the sides of the pipe until the pipe and surrounding soils reach a stabilized state. Once the pipe-soil system has stabilized, the system is said to have reached equilibrium; meaning further pipe deformation is prevented due to the counter balancing soil pressure, which develops in response to the horizontal deformation of the pipe against the soil. This equilibrium state can be determined by establishing permanent horizontal and vertical reference points at 12, 3, 6 and 9 o'clock positions throughout the pipe run. The distance between the horizontal and vertical points are then determined with a solid rod inside micrometer, and recorded.

Measurements should be repeated weekly over a three week period to determine if the pipe-soil system has reached equilibrium. If the installed pipe-soil system has reached equilibrium, cracks can be reamed out with air chisel or power grinder, damaged concrete removed and the areas can be repaired to protect the steel reinforcement from corrosion and re-establish the invert flow line.

Soil consolidation continues with time after the final fill is placed over the pipe. Therefore, AASHTO Section 27 requires that an elapsed time of 30 days (4 weeks) pass before conducting Post Installation Inspection and Evaluation of the installed reinforced concrete pipe. When delamination or spalling is

found during the inspection, measurements should be repeated weekly over a three week period resulting in a total of 7 weeks to determine if the pipe-soil system has reached equilibrium. If the installed pipe-soil system has reached equilibrium, cracks can be reamed out with an air chisel or power grinder, damaged concrete removed, and the areas can be repaired to protect the steel reinforcement from corrosion and re-establish invert flow line.

S8 (ACHIEVING STABILIZATION)

Reinforced concrete pipe with more extensive slabbing that have not reached the equilibrium state can be stabilized by drilling holes through the pipe wall at the haunch area and injecting pressure grout between the pipe and the embedment soil. This will effectively increase the lateral pressure along the length of the pipe and improve the bedding condition to such an extent that the supporting pipe strength is made adequate to carry the vertical load without further deformation. Again, the pipe should be monitored as described in the proceeding paragraph. Once the pipe-soil system has reach equilibrium, the loose slabs of concrete may be removed and a protective cover applied over the steel as in the proceeding paragraph.

S9 (STRUCTURAL REPAIR)

Structural repair for slabbing can include High Strength Portland Cement Grout, or more exotic repairs for severely spalled and deformed pipelines such as Epoxy Resin Mortar Applied Liners, Fold and Form Liner systems, or Slip line of entire line (all of which have been discussed in other areas of this document).

It is challenging to provide guidance as to what repair method is best for a specific defect on a specific project. Selection of a repair method is based upon many variables that include cost, availability, access, pipe size, and job schedule. It should also be noted that new materials or application methods are also consistently being developed by the repair industry. The list of possible repair methods outlined on the RCP Evaluation and Repair Matrix for the various conditions are consistent with repair methods discussed in detail in FHWA Culvert Repair Practices Manual[14], California Department of Transportation DIB 83-01[13], and Chapter 14 "Culvert Inspection, Material Selection, and Rehabilitation Guideline" of the AASHTO Highway Drainage Guidelines.[13]

Spall Repair – FHWA Culvert Repair Practices Manual()
"Spalling is generally the result of corrosion of reinforcing bars that initially causes horizontal (or in plane) cracking of the concrete and then subsequent delamination and spalling of the surface concrete off of the reinforcing bars. Information on concrete patching is provided in appendix B-28.

Slabbing Repairs

The terms slabbing, shear slabbing, and slab shear refer to a problem of radial failure of the concrete over the inner layer of reinforcement, due to excessive deflection and straightening of the reinforcing cage. The deformation causes radial tension and diagonal shear tension in the concrete that splits the concrete at the level of the interior layer of reinforcement. It is characterized by large slabs of concrete "peeling" away from the reinforcement. Slabbing is a serious problem that may occur under high fills with reinforced concrete pipe of inadequate D-load strength and/or on inadequately deep bedding on a rock foundation. Slabbing is a phenomenon that occasionally occurs during installation of precast concrete culverts as well as the result of bad soil conditions and a high water table. The corrective action that should be undertaken will depend upon the amount of bending and distortion that has taken place in the concrete section and the likelihood that additional movement and slabbing will occur.

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If it is determined that the cause of the slabbing has been corrected (during construction) or that additional distortion and slabbing is unlikely, then the corrective action is rather simple and straightforward. If this is the case, and it may be determined that the culvert is structurally stable, then the primary concern is protection of the inner (and exposed) layer of steel reinforcing against corrosion. Information on procedures for patching concrete is provided in appendix B-28.

APPENDIX B-28. PROCEDURES FOR PATCHING CONCRETE

APPLICATIONS
The following procedure may be used to patch spalled, delaminated and broken area of Portland cement concrete.

COMMENTS
Although there are many materials that may be used for patching concrete, the overriding principle for such repairs is that it be done carefully and with good workmanship. The cracked, spalled, or otherwise deteriorated area to be repaired must be properly prepared, good materials must be used, and the work must be properly protected until the materials have gained sufficient strength and other physical properties to withstand the expected environmental and loading conditions. The alternative to this produces a patch that will not endure and the patching work will be a total waste of time and money. Moreover, loss of the patch may create worsening or additional problems that will certainly require even more time, material, and funding to correct. Depending upon the site conditions, even well prepared and installed patches may not last very long, and it should be an established practice to periodically inspect critical patches to ensure that the structure is performing adequately.

The material that normally provides the most permanent patch for Portland cement concrete is Portland cement concrete. The closer the physical properties of the patch are to the existing material, the better. It is important to minimize shrinkage of the patching material. This may be done by using a low water/cement ratio material. A water reducing admixture may also be used. Inclusion of a latex additive to the concrete or mortar will also reduce the amount of water required for workability and also reduce the permeability of the patch material. Other performance-proven additives can be used to reduce setting time and to increase strength.

Proper curing is important for all concrete work and especially important for patching. Thin patches present a particularly difficult problem because they dry out quickly. The existing concrete will tend to absorb the moisture in the patching material. If exposed to the sun or wind, moisture is lost even more rapidly. If possible, patches should be covered with moist burlap.

The following provides some guidance for patching Portland cement concrete.

2. Remove delaminated and/or broken concrete from the distressed area. For some areas or structures it may be desirable to make a ¾ inch deep sawcut around the area to be patched. For delaminated and spalled areas, the edge of the repair should be extended 12 to 18 inches into good concrete to be ensured that all cracked concrete is removed. Deteriorated concrete may be removed with power-driven hand tools. If used, pneumatic hammers should not be heavier than a nominal 30 pounds.

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A 15 pound chipping hammer may be useful, particularly around reinforcing bars. Care must be taken to not apply heavy vibrations to reinforcing bars, to prevent breaking bond with the concrete.

3. The repair area should then be air – or sand-blast cleaned to remove all dust and debris. Do not use water to clean the area.

4. Apply a cement or cement-latex grout or an epoxy resin to the sides and bottom of the area to be repaired.

5. Place the patching material in the distressed area, in accordance with State, ACI or the manufacturer's guidelines. The material should be placed before the bonding layer (step 4) begins to set up. The patch material should then be struck off, finished, and edged as required.

6. The patch area should then be covered with wet burlap or a moisture barrier and allowed to cure with disturbance.

RESOURCE COMMITMENT = 1:	*5*	*4*	*3*	*2*	*1*
	Heavy		*Medium*		*Low*
COST RELATIVE TO REPLACEMENT = 1:	*5*	*4*	*3*	*2*	*1*
	High		*Medium*		*Low*

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GENERAL CULVERT BARREL REHABILITATION

The preceding discussion has addressed specific types of distress or damage, and techniques for repairing them have been presented. When the extent or type of distress severely limits the structural strength or the functional adequacy of an existing culvert barrel and it cannot be effectively repaired, other procedures should be considered to restore the structural strength and the serviceability of the culvert. The following discussion presents techniques that may be considered.

The viability of these techniques will depend upon site-specific conditions, the cost of materials and labor, and the type and extent of the inadequacy.

Most of the following techniques for restoring the structural strength and serviceability of culverts also reduce the internal cross sectional area of the culvert, which may accordingly reduce the hydraulic capacity of the culvert. The actual reduction in hydraulic capacity will depend upon many factors; including the size, type and condition of the existing culvert as well as upon details of the corrective action. Decisions regarding the corrective action, and justification for downsizing, must be done as the result of analysis of site-specific conditions by a hydraulic engineer.

Current hydrology design and analysis practices may show that older culverts are oversized, and in fact, could be downsized without adversely affecting existing upstream conditions. By flood routing a hydrograph through a culvert system designed for only the flood peak, it is frequently possible to justify downsizing of an existing culvert, provided that there is some temporary storage caused by roadway embankments. It may also be helpful to note that modern culverts are almost always constructed with headwalls, endwalls and wingwalls, but that many older (and some

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modern) culverts are not constructed with these features. Thus, under certain hydraulic related, site-specific, circumstances replacement of an older style culvert inlet with an improved inlet can dramatically increase the capacity of the culvert or justify downsizing the culvert barrel.(4)(5)

Flood hazard related problems due to culvert downsizing or inadequate capacity might be solved with upstream detention or retention ponds. Another possibility is for the hydraulics engineer to consider risk analysis that may permit justification of a lower flood design frequency.

Sliplining

One of the more effective ways to restore a culvert to a functional condition is by sliplining, which is the process of lining the culvert with either conventional or new types of prefabricated culvert products. In a sense, almost any type of culvert can be sliplined with almost any kind of culvert material. The proper selection of the most appropriate material will depend upon many factors, including:

- *Type, kind and size of the existing culvert;*
- *Structural and functional (hydraulic) conditions and adequacy of the existing culvert;*
- *Site-specific conditions*

Urban or rural location

Flat or mountainous terrain

Amount and velocity of water passing through the culvert at the time of the work;

- *Effluent characteristics;*
- *Design life requirements;*
- *Service life assigned;*
- *Economic factors including the cost of materials, labor and equipment; and*
- *Expected maintenance.*

Depending on the materials and techniques used for the sliplining, it may be possible to restore the structural strength of deteriorated culverts and to minimize the loss in hydraulic capacity. It may also be possible to eliminate the influence of environmental conditions that led to the deterioration of the existing culvert, such as the effects of acid mine runoff or caustic water, by selecting a lining or interior coating material that is resistant to such conditions. Although the lining process may reduce the internal cross-sectional area of the existing culvert, some plastic, precast concrete and lined corrugated metal pipe have a lower Manning's roughness coefficient than that of the existing culvert.

Procedures - There are a wide variety of individual techniques that may be used to slipline a culvert, that depend upon the above factors as well as the contractor's knowledge and experience with this type of work and the equipment that must, or can, be used for the work. The following steps are normally required for the sliplining process:

Divert and/or control water passing through the culvert.

Clean and make any repairs in the existing culvert that may be necessary prior to sliplining. Repair embankment as well by identifying voids and grouting behind and culvert.

Construct a guideway on the invert of the culvert, to facilitate the sliplining of sections into the existing culvert.

Install segments of the liner in the culvert, by sliplining, and connect them together.

Grout or seal the space between the liner and the existing culvert.

Perform a check to ensure complete grouting of annular space after sliplining.

As necessary, complete the project by constructing or modifying head- and wing-walls on the ends of the culvert.
There are many technical details that must be worked out for the actual construction project, including: (1) how the liner sections will be moved into place in front of the culvert, (2) how the sections will be slid into the culvert, and (3) if and how structural interaction will be established between the liner and the existing culvert.
Although there are some procedures that are relatively simple and straightforward, others are much more complex. In some cases it may be possible to stipulate standard construction procedures while at other times the procedures should be left open for contractor innovation, which may permit a contractor to use special equipment or techniques that may reduce the cost of the work.
More detailed information on the sliplining process and techniques that have been used are provided in appendix B-39 and B-40 on sliplining and grouting sliplined culverts.

Inversion Lining

Inversion lining is a process by which a culvert is lined with a resin-impregnated polyester felt tube that provides a continuous lining of the existing culvert. The felt liner is impregnated with thermosetting polyester resin and the interior surface is coated with a layer of polyurethane provide corrosion and abrasion resistance and some reduction in roughness for increased hydraulic efficiency. The thermosetting resin is cured in place by the heating and recirculation of the water that is used in the inversion of the polyester felt tube. The continuous lining eliminates problems due to both exfiltration and infiltration of water that may have been passing through the walls and joints of the existing culvert. Depending on the thickness of the liner and the type of resin used, some structural strength may be provided to enhance the strength of the existing culvert.
The process may be used with all types of culvert materials including the following: brick, concrete, corrugated metal, stone masonry, terra cotta, and timber. It provides a close fitting liner for all shapes including: round, oval, trapezoidal, elliptical and arched in sizes from 6 inches to over 72 inches. A particular advantage of this type of liner is that it will bridge all joints and irregularities in the interior surface of the existing culvert. Because of its initial flexibility, the liner will conform to barrels that are longitudinally curved or sections that are displaced, with open joints between them.
The liner is custom-made to the exact diameter, thickness, and length of the culvert to be lined. The liner may be pre-impregnated with the thermosetting polyester and polyurethane resins and shipped to the jobsite in a refrigerated truck or it may be impregnated at the jobsite. The latter method is frequently used when the culvert is long and over 48 inches in diameter, because of the weight of the resin-saturated liner and difficulty in handling it in the uncured state. Precautions must be exercised that the impregnated liner is kept cold until the culvert is properly prepared and the lining operation can proceed without stop.
Consideration should be given to the requirement for sufficient water to invert the liner and to completely fill the culvert. If the culvert is in a municipal area it may be filled with water from a fire hydrant. In rural areas it may be necessary to truck water to the site."

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VI. CONCLUSION

This document is for the sole purpose of assisting design professionals and project owners in the evaluation of concerns, and possible repairs for newly installed reinforced concrete pipe (RCP). While addressing possible issues that may occur while evaluating post installation inspection of RCP, the reference materials cited contain much more detailed information than what is presented within this document. Decision makers are encouraged to review the complete list of reference material to make a more fully informed decision based upon actual site conditions and design considerations of each individual project.

VII. REFERENCE AND SUPPORT DOCUMENTS FOR RCP EVALUATION AND REPAIR MATRIX

Note: Some documents are copyright protected therefore only links are provided to allow purchase/view from user.

1. ASTM C1479 - 10 Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations http://www.astm.org/Standards/C1479.htm
2. ACPA CP Info "Cracks In Installed Reinforced Concrete Pipe" www.concretepipe.org/wp-content/uploads/2014/09/CP-Info-Cracks-in-installed-Reinforced-Concrete-pipe.pdf
3. AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 5th Edition, 2010 Interim Revisions https://bookstore.transportation.org/item_details.aspx?id=1615
4. Concrete Pipe Design Direct Design versus Indirect Design/Strength Tested Pipe (Available thru The American Concrete Pipe Association)
5. The Case Against the Ultimate Load Test RCP By M.G. Spangler (Available thru The American Concrete Pipe Association)
6. AASHTO PP-63-09 "Standard Practice for Joint Selection"
7. FHWA Culvert Inspection Manual http://www.fhwa.dot.gov/engineering/hydraulics/library_arc.cfm?pub_number=31&id=57
8. Concrete Pipe Installation Guide http://www.concretepipe.org/wp-content/uploads/cpinstallation.pdf
9. Concrete Pipe Installation Procedures – Do's and Don'ts http://www.concretepipe.org/wp-content/uploads/2014/07/CPInstallationProcedures_DosandDonts.pdf
10. AASHTO LRFD Bridge Construction Specification - Section 27
11. Autogenous Healing of Cracks 1999 by Carlos Edvardsen ACI Materials Journal Technical Paper
12. Healing of Cracks in Lightweight Concrete 1989 by Avi Mor, et al American Society for Testing and Materials
13. Design Information Bulletin (DIB) #83-01-5.1 Problem Identification and Associated Repair for Culvert Barrels http://www.dot.ca.gov/hq/oppd/dib/dib83-01-5.htm
    CADOT DIB #83 Appendix http://www.dot.ca.gov/hq/oppd/dib/dib83-01-12.htm
14. FHWA Culvert Repair Practices Manual Vol.1 http://isddc.dot.gov/OLPFiles/FHWA/010551.pdf
    FHWA Culvert Repair Practices Manual Vol. 2 http://www.linkpipe.com/PDF/Pages_from_010550.pdf
15. AASHTO Highway Drainage Guidelines 4th Edition – Copyright 2007 https://bookstore.transportation.org/item_details.aspx?ID=1012

ADDITIONAL READING AND RESOURCES:

Crack Evaluation:

ACPA Buried Facts –"Culvert Inspection"
http://www.concrete-pipe.org/buried_facts/culvert_insp.pdf

OCPA RCP Pipe Info Book, see Significance of Cracking
http://www.ocpa.com/_resources/OCPA_PipeInfoBook.pdf

ACPA CP Info"Significance of Cracks in Concrete Pipe"
http://www.concrete-pipe.org/cpinfo/Significance%20Of%20Cracks%20In%20Concrete%20Pipe.pdf

"Effects of Cracks in Reinforced Concrete Sanitary Sewer Pipe"
http://www.concretepipe.org/wp-content/uploads/2014/10/CP-Info-Effects-Of-Cracks-In-Reinforced-Concrete-Sanitary-Sewer-Pipe.pdf

"Effects of Cracks in Reinforced Concrete Culvert Pipe"
http://www.concretepipe.org/wp-content/uploads/2014/10/CP-Info-Effects-Of-Cracks-In-Reinforced-Concrete-Culvert-Pipe.pdf

RCP Durability:
"Precast Concrete Pipe Durability"
http://www.concretepipe.org/wp-content/uploads/CPInfoDurability072116.pdf
"Culvert Durability Study"
http://www.concretepipe.org/wp-content/uploads/2015/05/culvert_dura.pdf

PIPE Repair:
Free Trial of TAG-R Trenchless Rehabilitation Decision Software – Available @ Louisiana Tech University Trenchless Technology Center – Purchase TAG-R @ NASSCO.com
http://www.tagronline.com/login.asp

http://www.concrete.org/general/RAP-1.pdf
http://www.concrete.org/general/RAP-2.pdf
http://www.concrete.org/general/RAP-3.pdf
http://www.concrete.org/general/RAP-4.pdf
http://www.concrete.org/general/RAP-5.pdf
http://www.concrete.org/general/RAP-6.pdf
http://www.concrete.org/general/RAP-7.pdf
http://www.concrete.org/general/RAP-9.pdf
http://www.concrete.org/general/RAP-10.pdf
http://www.concrete.org/general/RAP-11.pdf

City of Charlotte
Storm Water Services
Rigid Pipe Repair Guide for Newly Installed Concrete Pipe
September 8, 2016

This guide is based on general information found in the American Concrete Pipe Association (ACPA) and Federal Highway Association documentation on practices and methods for prescribed treatments of deficiencies in newly installed reinforced concrete pipe. The intent of this guide is to provide a consistent means for determining specific treatments to concrete pipe deficiencies acceptable for Storm Water Services based on the information available and this approach does not take the place of structural engineering assessment. With all new construction, it is the contractor's responsibility to certify all repairs meet industry standards, manufacturer's recommendations and restores the life expectancy of the product and installation of its original intent. Contractor shall also certify the life expectancy of the repair is equal to or exceeds the manufacturer's pipe life cycle. The City expects newly installed concrete pipe to meet all industry standards and therefore should not need repairs or treatment as such. These treatments are intended to only be used in rare cases of unexpected deficiencies. In most cases, the appropriate selection of treatments is to be applied to the respective deficiencies as noted in the section below label *Repairs and Treatments*.

It is understood that the contractor is responsible for any and all cost associated with all repairs to deficiencies including and not limited to infrastructure replacement, inspection of the treatment being applied during installation, and inspection in 11 months to ensure an acceptable repair has been provided. The cost of inspection may include pipe video or confined space entry with video documentation. The contractor shall certify the repairs meet all industry standards and the restored pipe meets the original product life expectancies prior to the City accepting the final product.

In order to use this guide, familiarity of the ACPA "Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe" document is essential. The intent of the coding for repair methods in this guide is consistent with that document.

The expectation of pipe video review for newly installed pipe is that the contractor has provided the appropriate cleaning to clearly reveal all interior surfaces, exposed 360 degrees of joints and any deficiencies present. No deposits (including material placed over joints) will be in the pipe that hinders the ability to evaluate the entire interior pipe surface or 100% of all joint areas. If the pipe does not meet these conditions, the contractor may be responsible for paying the additional cost to re-video the subject pipe. Storm Water Services reserves the right to not accept any pipe installation where the pipe joints have been treated with hand applications of cement, mortar or grout installed in a means other than described below (usually referred to as hand wiping or troweling). Pipe video inspections may also be rejected should this unacceptable application been determined until such time the treatment has been removed or pipe replaced as determined to yield an acceptable view and inspection of the joint.

The following information describes the categories of deficiencies and the appropriate treatments respectively. It is the owner's (City of Charlotte) prerogative to accept or reject installation and treatment that does not yield a product intended life cycle and performance based on workmanship and product material condition. Following these guidelines are intended to restore pipe conditions to meet or exceed the original intended life expectancies and intended design goals.

There are at least three main categories of repairs: minor, major and site specific (when minor and major are not applicable).

This document only covers these major categories and doesn't intend to be a complete guide for all conditions and situations.

Repairs and Treatments

Minor: Minor repairs are typically used on imperfections, minor defects, and minor handling damage and are considered when non-aggressive treatment techniques are not warranted. Some of these types of repairs are cosmetic surface repairs (spalling), installation of replacement seals and pressure injecting of polyurethane foam materials (example-hydrophilic/hydrophobic polymers). Some minor repairs are only allowed prior to installation of pipe and post installation (as approved by the engineer) and may result in major repairs being required.

Example: J8, J10, J12, J16, J18, J19

Major: Major repairs typically are necessary to address structural issues, including but are not limited to replacement of the pipe, installing cured in place pipe lining (CIPP Lining), resin-impregnated polyester lining, sectional repair with silicate resin glass fiber and concrete pipe collars.

Example: S9

Site Specific: When a determination can't be made based on available data (pipe video) then an onsite assessment may be necessary to determine the appropriate treatment. These repairs will be determined by the engineer based on field conditions and design intent. This treatment may be applicable for any of the other treatments based on the engineer's discretion.

Types of repairs in more detail from
Appendix B – NASSCO Pipeline Assessment (PACP)
Reference: *NASSCO Pipeline Assessment Certification Program*

JOINTS

- **Infiltration, migration of soils, offsets small-medium**
  Minor Repair

- Replacement seals and pressure injecting of polyurethane foam materials (example-hydrophilic/hydrophobic polymers). Most common method used to repair leaking joints. Access may limit treatment available.
    - Small pipes (manual access not available). CIPP, Sectional repair with silicate resin glass fiber or concrete pipe collars. Replacement of pipe.
    - In pipes large enough for human entry, pressure grouting with polyurethane foam materials is accomplished using predrilled injection holes and hand-held probe, sectional repair with silicate resin glass fiber or concrete pipe collars. Replacement of pipe.

- Typical NASSCO Codes:
  IS, ISB, ISC, ISJ, ISL, IW, IWB, IWJ, IWL, ID, IDB, IDC, IDJ, IDL

- **Severe infiltration, migration of soils, voids present, and large offset**
  Major Repair

    - Replacement of the pipe, installing cured in place pipe lining (CIPP Lining), resin-impregnated polyester lining, and sectional repair with silicate resin glass fiber and concrete or pipe collars.

    - Typical NASSCO Codes:
      JOS, JOM, JOSD, JOMD, JSS, JSM, JAS, JAM, IR, IRB, IRC, IRJ, IRL, IG, IGB, IGC, IGJ, IGL

- **Mastic Visible (as determined by the engineer)**

    - Treatment for mastic being visible in the pipe joint will be determined based on the data available and amount of mastic that has migrated away from the sealing area of the spigot/bell or tongue/ groove. The amount acceptable is determined by the engineer based on his/her discretion of an acceptable seal being accomplished. Should observations indicate that a significant amount of mastic material is not within the sealing surfaces of the joint, and then minor treatment techniques are appropriate. If observations indicate that sufficient mastic material appears to be within the sealing area of joint, then no treatment is warranted. However, with either of these determinations, the pipe may be re-inspected again in 11 months to certify that no damage appears to the seal or infiltration is evident. Should the seal area appear to show signs of deficiencies at that inspection then additional treatment will be warranted and extended contractor warranty will be expected.

CRACKS

- **Longitudinal, circumferential**

<0.01T	typically no repair required with no signs of soil movement through the crack.
>0.01" and <0.05"	Multiple cracks in an 8' section may need minor repair.
>0.05" and <0.10"	Minor repair in corrosive environment (determined by engineer) or if vertical offset in crack <0.10".

>0.10" Major repair

Minor repair

- Crack Repair Methods: (C17, C20, C22, etc.) assuming access is available
  - Preparing cracks for minor repair
  - Use maximum strength non-shrink Portland cement or mortar
  - Prepare crack with "V" grind 0.25" width and 0.5" deep.
  - Clean of any grinding dust and moisten surface before filling

- Typical NASSCO Codes:
  CL, CC

- **Spiral and Multiple Cracking**
  Major Repair

  - Replacement of the pipe, installing cured in place pipe lining (CIPP Lining), resin-impregnated polyester lining, sectional repair with silicate resin glass fiber and concrete pipe collars.

- Typical NASSCO Codes:
  CS, CM

DAMAGED

- **Spalling, surface damage (no exposed reinforcing)**
  Minor Repair

  - Minor spalled area requires no repair. Assuming access is available
  - 20% or more of surface area spalled:
    - Use maximum strength non-shrink Portland cement or mortar
    - Prepare surface by grinding broken segments are to be remove.
    - Clean of any grinding dust and moisten surface before filling.

  - Typical NASSCO Codes:
    SRI, SAV, SAP, SAM, SRV, SSS, SSC, SCP, S2

- **Slabbing, surface damage (exposed reinforcing)**
  Major Repair

  - Pipe integrity compromised exposed reinforcing or reinforcing deformed:
    - Replace pipe if reinforcing is exposed and or compromised.
    - Typically pipe replacement is necessary.

  - Typical NASSCO Codes:
    SRC, SMW

- **Broken, Fractured, Hole, Separation, Deformed, major surface damage (reinforcing exposed)** ***Major Repair***

  - Typically requires pipe replacement.
  - Replacement of the pipe, installing cured in place pipe lining (CIPP Lining), resin-impregnated polyester lining, sectional repair with silicate resin glass fiber and concrete pipe collars.
  - Minor spigot or bell damage may be repaired prior to installation.
    - Use maximum strength non-shrink Portland cement or mortar
    - Prepare surface by grinding broken segments are to be remove.
    - Clean of any grinding dust and moisten surface before filling.

  - Typical NASSCO Codes:
    BSV, BVV, HSV, HVV, SAM, SRP, SRC, SMW, JOL, JOLD, JSL, JAL, FL, FC, FM, FS, FH, DR, X

Proposed alternatives will be considered on a case by case basis at the owner's desecration. Storm Water services continues to explore new technology and products. The owner reserves the right to approve the use of non-standard applications in situation where limited risk and liability occurs with the intent to monitor on as needed until a final approval can be made.

The guide above is to be used as a general approach to determine the treatment to defects of newly installed RCP that follow industry standards. These suggested treatments are not to take the place of engineering practices. The engineer ultimately has discretion to require additional measures based on engineering judgment and specific conditions. The contractor is still ultimately responsible for certifying appropriate workmanship has been used in applying these treatments and is responsible for the ultimate repair to all deficiencies. The final condition is for the workmanship to restore compliance, functionality, and life expectancy to meet or exceed the original expectations.

October 22, 2013

Susan Tolan, P.E.
Charlotte-Mecklenburg Storm Water Services
600 East Fourth Street
Charlotte, NC 28202

Subject: **Recommendations of Foundation Protection Provision for Charlotte-Mecklenburg Storm Water Services Charlotte, North Carolina AMEC Project No. 6234115433.35**

Dear Ms. Tolan:

AMEC Environment & Infrastructure, Inc. (AMEC) is pleased to provide recommendations of foundation protection provision for the use of Charlotte-Mecklenburg Storm Water Services. AMEC developed the recommendations, as presented in the attachments, based upon our past project experience and discussions with you and staff members in your office.

We have enjoyed assisting you and look forward to continuing our geotechnical designs and construction material testing services for the City. If you have any questions concerning this report, please contact us.

Sincerely,
AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

Mel Y. Browning, P.E.
Senior Engineer – Geotechnical

Bon Lien, P.E., Ph.D.
Principal Engineer – Geotechnical

Attachments: Foundation Protection Provisions
Exhibit - A
Exhibit - B

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Charlotte, NC 28202

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Charlotte, North Carolina
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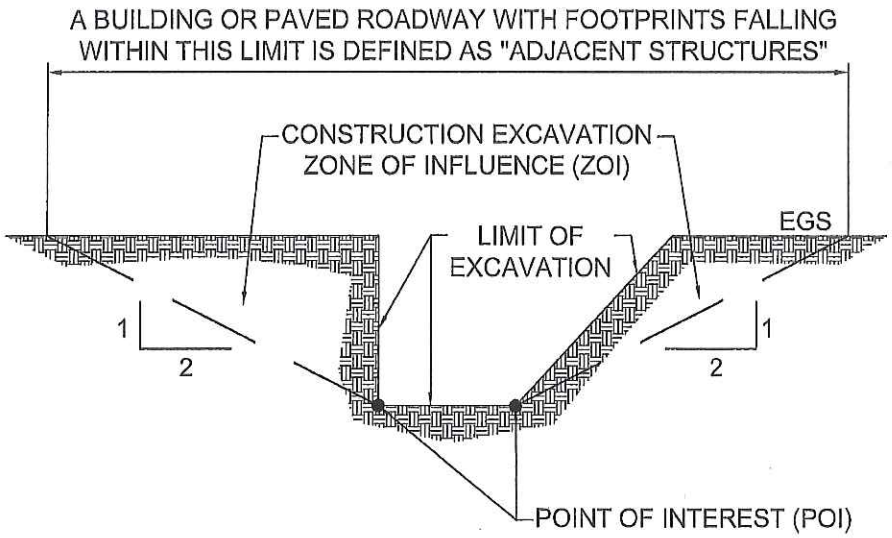

NOTES:
EGS = EXISTING GROUND SURFACE

AMEC Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
CHARLOTTE, NC 28208
TEL: (704) 357-8600 FAX: (704) 357-8638

amec

LICENSURE: F-1263 NC

CLIENT
CHARLOTTE-MECKLENBURG STORMWATER SERVICES

EXHIBIT - A

DWN BY: CMW	DATUM: .	DATE: 22 OCTOBER 2013
CHK'D BY: BL	REV. NO.: A	PROJECT NO: 6234-11-5433
PROJECTION: .	SCALE: AS SHOWN	

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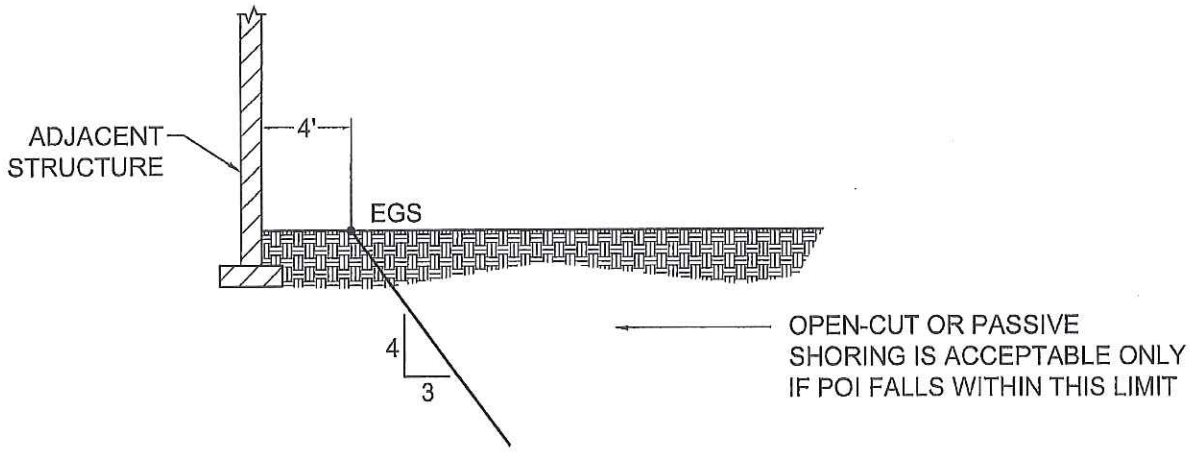
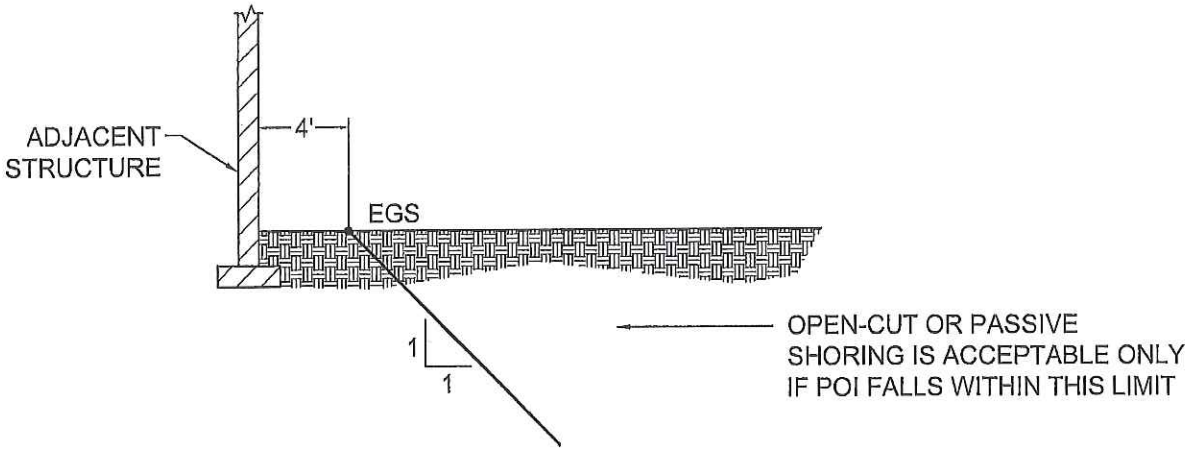
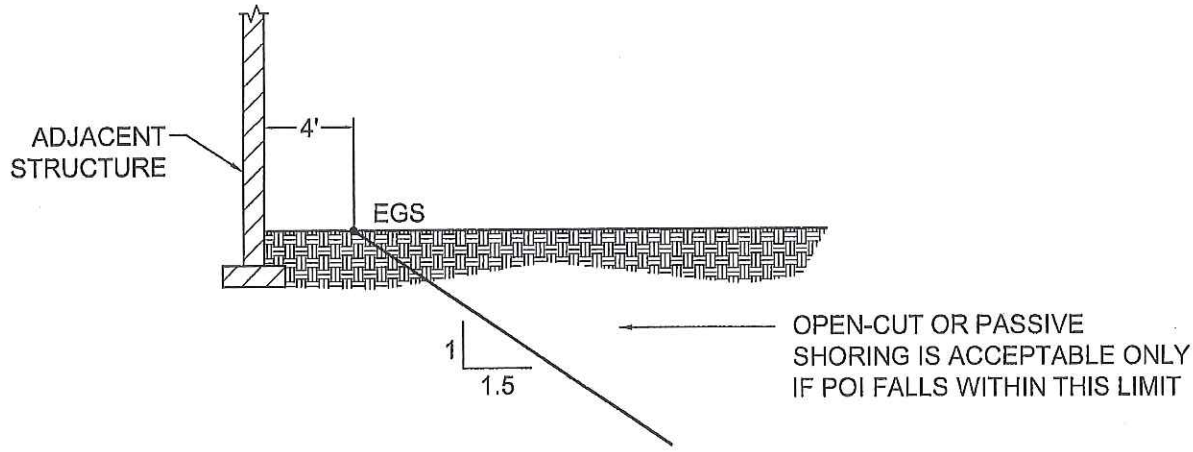


TYPE "A" SOIL



TYPE "B" SOIL



TYPE "C" SOIL

AMEC Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
CHARLOTTE, NC 28208
TEL: (704) 357-8600 FAX: (704) 357-8638

amec

LICENSURE: F-1263 NC

CLIENT
CHARLOTTE-MECKLENBURG STORMWATER SERVICES

EXHIBIT - B

DWN BY: CMW	DATUM:	DATE: 22 OCTOBER 2013
CHK'D BY: BL	REV. NO.: A	PROJECT NO: 6234-11-5433
PROJECTION:	SCALE: AS SHOWN	

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FOUNDATION PROTECTION

The Contractor shall follow guidelines presented hereafter and be responsible for evaluation and implementing measures for controlling ground movements or settlements, and protecting foundations of existing structures adjacent to either temporary or permanent excavations.

Definitions –

Foundation Protection: Foundation Protection (FP) is defined as measures taken throughout the planning, design, and construction phases of a project to prevent or mitigate possible damages to existing foundations due to nearby construction or excavation activities.

Point of Interest: The Point of Interest (POI) is a point at the bottom of the proposed/actual trench that is closest to the Adjacent Structure.

Construction Excavation Zone of Influence: The construction excavation Zone of Influence (ZOI) is generally defined by drawing a boundary line starting at the POI continuing upward with a 2 horizontal to 1 vertical (2H:1V) slope and projected to grade level. See Exhibit-A.

Adjacent Structure: Adjacent structure is defined as a building / superstructure or paved public and private roadway / driveway with footprints located within the Construction Excavation ZOI in a plan view.

Passive Shoring: A passive shoring system, such as conventional trench box shoring, is utilized mainly to keep workers safe throughout the excavation and underground utility installation process, and is not effective in controlling ground movements in areas adjacent to the excavation.

Active Shoring: An active shoring system, such as a slide rail shoring system, soldier pile and lagging with or without tiebacks or internal bracing, or sheet piling, is more effective in maintaining pressure against the soil at all times with limited over-excavation during the construction and limiting ground movement outside the excavation.

Unless otherwise directed by the City, or deemed necessary by the Contractor and his/her geotechnical/structural professionals, foundation protection guidelines hereafter are applicable to the Adjacent Structures.

Pre-construction Condition Survey – A pre-construction condition survey of the adjacent structures shall be performed prior to the beginning of construction. The survey will consist of descriptions of the interior and exterior conditions. Descriptions and photographs shall be taken of cracks, damage, or other existing defects. The survey will document both inside and outside structure conditions with relevant

photographs (in both hardcopy and digital formats) and video (in a digital format). The pre-construction condition survey must be performed in the presence of the City's representative, Contractor's representative, and owner of the structure. The Pre-construction Condition Survey Report shall be signed and sealed by a geotechnical/structural professional. No construction shall begin prior to completion of the pre-construction condition survey. The City may, at their discretion, perform their own pre-construction condition survey consistent with the method above.

Adjacent Structure Foundation Assessments – The Contractor and his/her professional representative shall follow foundation protection guidelines herein to evaluate the potential need of protecting adjacent structure foundations, and submit a Structure Foundation Assessment Report to the City.

Structure Foundation Assessment Report – The Structure Foundation Assessment Report shall include, but not be limited to, the findings from the pre-construction condition survey, a discussion of the proposed construction adjacent to the structure noting specific excavation depths and widths, and any potential impact to foundations and structures and measures needed to protect the adjacent structures. If designed FP is deemed necessary, then the FP measures and designs, including, but not limited to, plans, drawings calculations, and details, shall be submitted with the Structure Foundation Assessment Report. The report shall indicate whether excavation support systems, if utilized, will be removed upon completion of the project or remained in place. The report shall also include a proposed construction monitoring system plan, if deemed necessary by the City. The Structure Foundation Assessment Report shall be prepared, signed and sealed by the Contractor's qualified geotechnical/structural Professional Engineer licensed in the State of North Carolina. The Contractor shall submit the complete Structure Foundation Assessment Report to the City for review prior to construction or implementation of FP measures. Failure to provide for sufficient review period, time for revision and resubmittal, or incomplete submittals will not be grounds for contract time extension.

Requirements of Excavation and Shoring – All work shall adhere to the requirements herein, OSHA Standards and Interpretations Subpart P-Excavations, Trenching and Shoring, and all other applicable ordinances, codes, statutory rules and regulations of the Federal, State and local authorities. In the event of a conflict, comply with the more restrictive applicable requirements.

The Contractor shall perform open-cut excavations with stable sloping sides or benches, or utilizing either passive or active shoring systems.

Guidelines – Unless otherwise directed by the City, the Contractor shall follow the guidelines below, as a minimum, in performing excavations:

Passive Shoring:

- Referring to Exhibit-B, either open-cut or passive shoring could be utilized for cases in which a line drawn from a point at 4 feet horizontally away from the nearest edge of the footprint of the adjacent structure (including buildings, paved roadways, etc., as defined previously) to the POI is no steeper than:

    - 1.5 horizontal to 1 vertical (1.5H:1V) for Type C Soil
    - 1H:1V for Type B Soil
    - ¾H:1V for Type A Soil

  Types A, B, and C soils are defined in accordance with OSHA Standards and Interpretations Subpart P-Excavations. The default soil type shall be C if soil classification is not based on soil testing data obtained at the project site. Benching in Type C Soil is not acceptable. For stable rock, the maximum cut slope could be vertical and no shoring may be needed.

- If the above described drawn line is steeper than those specified for the various types of soil, an active shoring system shall be utilized. However, if measures of underpinning the adjacent structures (such as helical piers, screw-piles, push-piles, micropiles, etc.) are implemented prior to the excavation, then a passive shoring system is acceptable. The underpinning shall be designed by a Professional Engineer licensed in the State of North Carolina in accordance with the Structure Foundation Assessment Report described above.

- Open-cut sloping, benching, and passive and active shoring for excavations greater than 20 feet deep shall be designed by a Professional Engineer registered in the State of North Carolina or approved in manufacturer's tabulated data of pre-engineered shoring systems in accordance with the Structure Foundation Assessment Report described above.

- Having a structure foundation fall within the construction excavation ZOI or undermining below the bottom of foundation or slab-on-grade shall not be allowed, unless a plan with underpinning measures is submitted to the City for approval in accordance with the Structure Foundation Assessment Report described above.

- As excavation and backfill operation progresses, the maximum height of the face of unsupported excavated soil below the passive shoring panels shall not exceed 2 feet.

Active Shoring:

- At locations where foundation protection measures are required, a qualified geotechnical/structural Professional Engineer retained by the Contractor and licensed in the State of North Carolina shall design a foundation protection and/or

construction monitoring system. Design review and field monitoring activities by the City shall not relieve the Contractor's responsibilities for the work. The City and the Contractor shall agree on associated costs in advance of performing the work.

If, during the construction activity, the City determines a modification to the foundation protection measures is required, , the Contractor shall redesign and resubmit revised shop drawings to the City at no additional cost to the City.

Construction Monitoring System – Based on results presented in the Structure Foundation Assessment Report, construction monitoring plans, if deemed necessary, shall be addressed in the Structure Foundation Assessment Report and subject to approval by the City. The monitoring plan may include, but not be limited to, use of crack gages, settlement markers, and survey control points (for monitoring vertical and/or horizontal movements) at the ground surface. The plan shall include, but not be limited to frequencies and established threshold limiting values. All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public. Damaged instruments shall be replaced or repaired prior to continuing excavation, or as required by the City, at Contractor's own cost.

At least two sets of initial survey measurements shall be obtained prior to starting any construction. Elevation survey of control points shall be determined to an accuracy of plus/minus 0.01-ft. The horizontal position of the monitoring points shall be determined to an accuracy of 0.1-ft, unless otherwise directed by the City.

Readings of the instruments shall be taken at least every other day during excavation and installation of excavation support systems, and at least once per week after excavation has reached final depth until the excavation is backfilled. The Contractor shall provide data from instrument readings to the City within 24 hours of readings.

The monitoring instruments shall be removed / abandoned at the end of the project as directed by the City.

401/404 Permitting Services
for Engineering Services Projects

Types of Activities That May Require Permits

- Activities resulting from the placement of fill material:
  - Culvert Crossings and Pipe Systems
  - Rip rap
  - Stream Channel Relocations
  - Streambank Stabilization
  - Restorations & in-stream structures
  - Pond maintenance
  - Excavation (case-by-case)

Jurisdictional Determinations (JD)

- Identifies Waters of the United States (WOTUS) within the project area
- Desktop & Field Assessments
  - Determine potential WOTUS
  - Field reconnaissance

US Army Corps confirms WOTUS presence/boundaries

Other Important Resources

- Threatened & Endangered Species
- Historic Properties
- Cultural Resources

Permitting Process Overview

- Get Storm Water involved early & often throughout the life of the project
- If time and budget allow, obtain JD, protected species, cultural/historic resources investigations
- Only submit notice to agencies after plans are "final"
- 2 years to construct project, submit completion record

Completion & Compliance

- Proof to the agencies we completed the project
- Create evidence that we followed permit conditions including:

  Impact lengths

  Culvert design guidelines

In-stream structure guidelines for aquatic life passage

- Notify City Storm Water Quality during the project if a field change needs to be made

  May require notification to agencies

- Invite City Storm Water Quality to the Pre Construction Conference & final walkthrough

  Make sure project team is aware of permit conditions

  Any issues can be fixed under warranty and project can be closed out successfully

Available Resources

City of Charlotte - Storm Water (Water Quality)

On-call contracts for environmental permitting

On-call contracts for stream design work

"Permit-friendly" design guidance

Strong relationships with agency personnel

Requirements for
Legal Descriptions, Plats and Plans

Table of Contents

1. Requirements for Legal Descriptions

Legal descriptions:

- Are not required to be prepared by a PLS
- Are not required to be signed and sealed unless it's a "metes and bounds" description
- If it is signed and sealed, an original is required
- Paragraph form legal descriptions, as shown below should be submitted to Real Estate in a Word document , if not signed and sealed
- If "Now or Formerly" is utilized on the plat, it should be included in the legal description

Area(s) taken should be set forth on one exhibit.

See example below

AREAS TAKEN

Parcel # ___

Tax Code _____

Exhibit Heading:
Areas Taken
Parcel #
Tax Code

DESCRIPTION OF FEE SIMPLE

Description Heading:
Specifically describes type of taking.

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (____ *acres)* as shown on the attached map prepared by _____ for the City of Charlotte, entitled "PROJECT NAME" the property of "OWNER", dated 00/00/0000, *revised 00/00/0000.*

Legal Descriptions should include a separate paragraph (description) for each area taken.

Note: Include revision date of map, if applicable.

DESCRIPTION OF STORM DRAINAGE EASEMENT

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (____ *acres)* as shown on the attached map prepared by _____ for the City of Charlotte, entitled "PROJECT NAME" the property of "OWNER", dated 00/00/0000, *revised 00/00/0000.*

DESCRIPTION OF PERMANENT EASEMENT FOR _____

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (____ *acres)* as shown on the attached map prepared by _____ for the City of Charlotte, entitled "PROJECT NAME" the property of "OWNER", dated 00/00/0000, *revised 00/00/0000.*

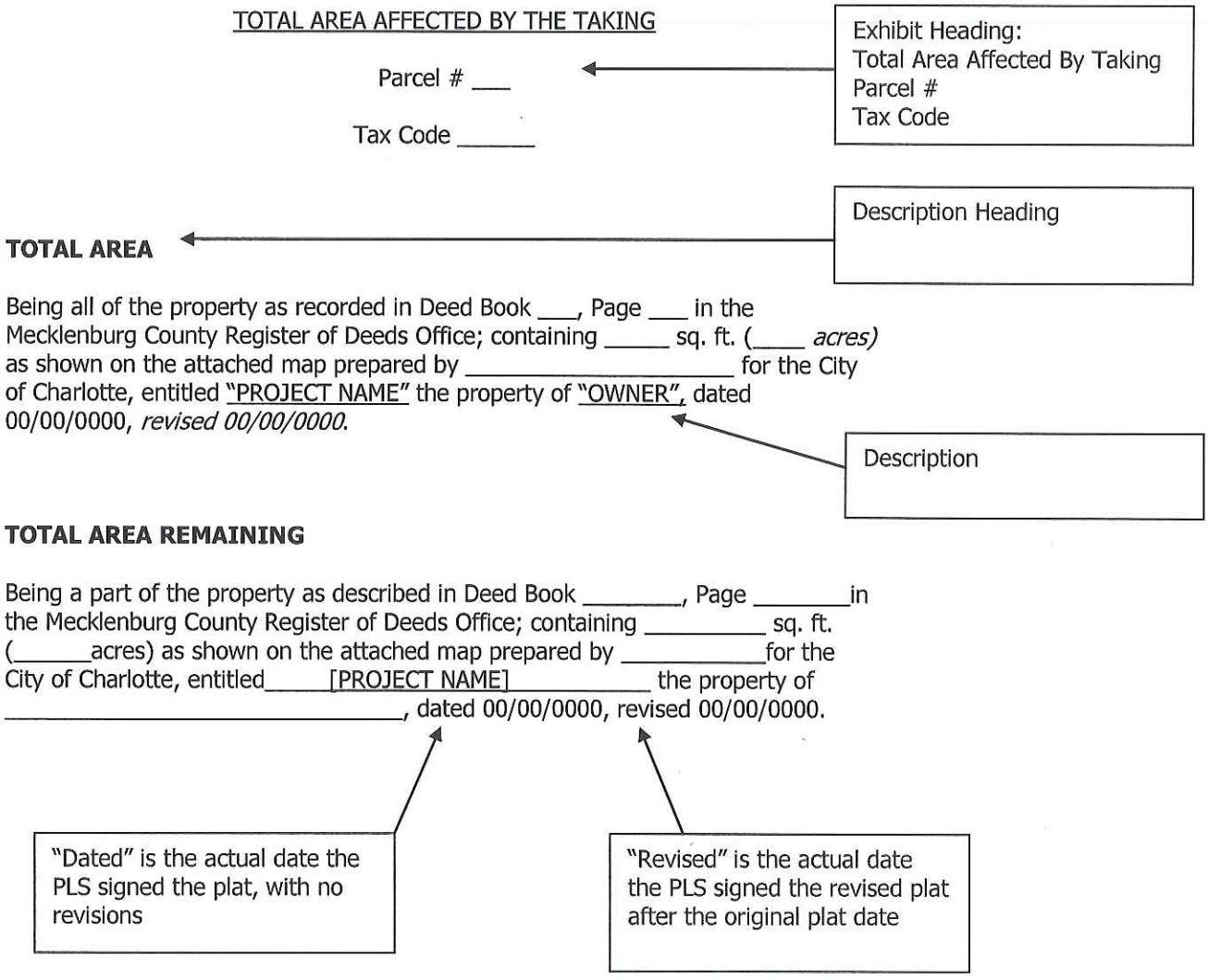
If the Easement to be acquired is listed as "Permanent Easement" on the plat, the purpose will need to be included in the description i.e. "Water Line", Sewer Line, etc.

DESCRIPTION OF TEMPORARY CONSTRUCTION EASEMENT

Additional taking descriptions should be included, as applicable.

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (____ *acres)* as shown on the attached map prepared by _____ for the City of Charlotte, entitled "PROJECT NAME" the property of "OWNER", dated 00/00/0000, *revised 00/00/0000.*

Total area is set forth in a separate exhibit from Area(s) Taken.



Template 1 - Exhibit displaying Areas Taken for a Partial Take (separate page from Total Area)

AREAS TAKEN

Parcel # _____

Tax Code _____

DESCRIPTION OF FEE SIMPLE

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (_____acres) as shown on the attached map prepared by _____ for the City of Charlotte, entitled _____[PROJECT NAME]_____ the property of _____, dated 00/00/0000, revised 00/00/0000.

DESCRIPTION OF STORM DRAINAGE EASEMENT

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (_____acres) as shown on the attached map prepared by _____ for the City of Charlotte, entitled _____[PROJECT NAME]_____ the property of _____, dated 00/00/0000, revised 00/00/0000.

DESCRIPTION OF PERMANENT EASEMENT FOR WATER LINE

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (_____acres) as shown on the attached map prepared by _____ for the City of Charlotte, entitled _____[PROJECT NAME]_____ the property of _____, dated 00/00/0000, revised 00/00/0000.

DESCRIPTION OF TEMPORARY CONSTRUCTION EASEMENT

Being part of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (_____acres) as shown on the attached map prepared by _____ for the City of Charlotte, entitled _____[PROJECT NAME]_____ the property of _____, dated 00/00/0000, revised 00/00/0000.

Template 2 - Exhibit displaying Total Area Affected for a Partial Take (separate page from Areas Taken)

TOTAL AREA AFFECTED BY THE TAKING

Parcel # _____

Tax Code _____

TOTAL AREA

Being all of the property as recorded in Deed Book ___, Page ___ in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (_____acres) as shown on the attached map prepared by _____ for the City of Charlotte, entitled _____[PROJECT NAME]_____ the property of _____, dated 00/00/0000, revised 00/00/0000.

TOTAL AREA REMAINING

Being a part of the property as described in Deed Book _____, Page _____in the Mecklenburg County Register of Deeds Office; containing _____ sq. ft. (_____acres) as shown on the attached map prepared by _____for the City of Charlotte, entitled_____[PROJECT NAME]_____ the property of _____, dated 00/00/0000, revised 00/00/0000.

Template 3 - Exhibit displaying Areas Taken for a Total Take (separate page from Total Area)

AREAS TAKEN

Parcel # _____

Tax Code _____

DESCRIPTION OF FEE SIMPLE

Being ALL of the property as recorded in Deed Book_____, Page _____ in the Mecklenburg County Register of Deeds Office, containing _____sq. ft. (_____ Ac.) as shown on the attached map prepared by_____ _____., for the City of Charlotte, entitled _____[PROJECT NAME]_____, Project No._____, the property of_____, dated 00/00/0000.

Template 4 - Exhibit displaying Total Area Affected by the Taking for a Total Take (separate page from Areas Taken)

TOTAL AREA AFFECTED BY THE TAKING

Parcel # _____

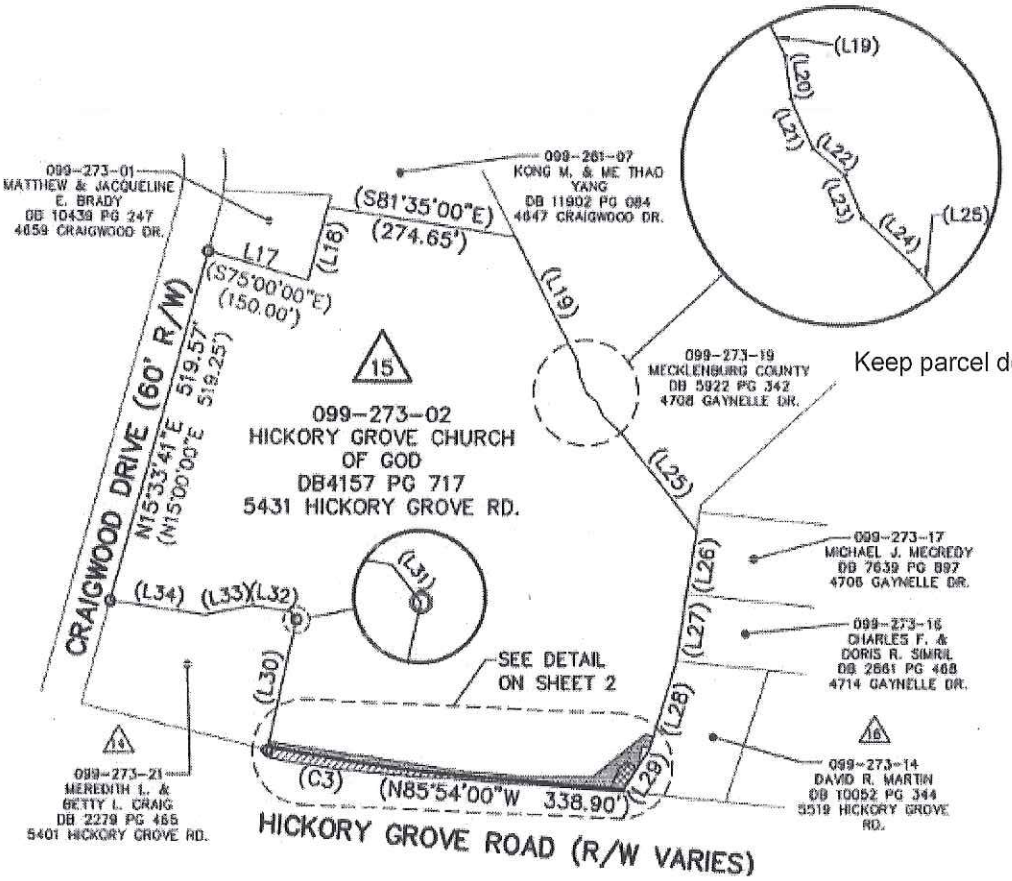
Tax Code _____

TOTAL AREA

Being all of the property as recorded in Deed Book _____ Page _____ in the Mecklenburg County Register of Deeds Office, containing _____sq. ft. (_____Ac.) as shown on the attached map prepared by _____ _____,for the City of Charlotte, entitled ____[PROJECT NAME]_____, Project No._____, the property of _____, dated 00/00/0000.

2. Legal Requirements for Plats

- Plats should be legal size and printed on paper, not Mylar.
- Preliminary plats should be submitted to Real Estate for review prior to finalization.
- Sample plats may be utilized to help minimize revisions prior to the completion of preliminary plats.



Keep parcel details simple and clear

Areas taken should be hatched/shaded

NOTE:

1) BEARINGS AND DISTANCES SHOWN IN PARENTHESES ARE BASED ON RECORDED MAP INFORMATION.

2)	TOTAL AREA	52,118 SQ.FT.
3)	TEMP. CONSTR. EASEMENT	3,386 SQ.FT.
4)	STORM DRAINAGE EASEMENT	1,141 SQ.FT.
5)	FEE SIMPLE IN EXIST. R/W	3,515 SQ.FT.
6)	UTILITY EASEMENT	44 SQ.FT.
7)	FEE SIMPLE OUTSIDE EXIST. R/W	4,010 SQ.FT.
8)	AREA REMAINING	44,593 SQ.FT.

15

099-273-02
HICKORY GROVE CHURCH
OF GOD
DB4157 PG 717
5431 HICKORY GROVE RD.

Parcel data to include parcel #, tax id, owner, DB/PG, and property address.

Area Table/Notes Section to include:
Total Area
Taking Areas
Remaining Area (= Total Area – Fee Simple)

NOTE: If fee simple is not being acquired, then remaining area should equal total area.

CHARLOTTE
ENGINEERING & PROPERTY MANAGEMENT

REVISIONS	HICKORY GROVE ROAD WIDENING	JOB NO. 97097
NAME CHANGE - 2/3/03		FILE NO. 42-155-02
SCALE 1"=50'	PROPERTY ACQUISITION	SHEET 1
DRAWN BY: DLB	OWNER: DELMAS L. HAMMONS CHARLOTTE, MECKLENBURG CO., NC	OF 1
DATE 1/15/03	CHECKED BY DHS SURVEY SUPVR.	

The title block should include the project #, project name, property owner name, date map prepared (including revised dates) and appropriate # of pages.

The Tax ID # and property address are not required in the title block. The Parcel # is not required, but is preferred.

NOTE: Make certain that the number of sheets reflects the number of pages of map being provided for condemnation.

I, _____, CERTIFY THAT THIS PLAT WAS PREPARED UNDER MY SUPERVISION AND THAT THE PLAT WAS PREPARED FOR THE PURPOSE OF ACQUISITION AND EASEMENTS ONLY, AND IS NOT INTENDED TO BE A BOUNDARY SURVEY OF PROPERTY SHOWN.

SURVEYOR'S NAME, NC P.L.S. L-XXXX DATE

SEAL

Make certain to include phone #

The plat recorded with the acquisition documents must be a signed, dated and sealed original and should not post-date the date the agreement was executed

LEGEND

- IRON PIN FOUND
- #6 REBAR SET
- FEE SIMPLE OUTSIDE EXIST. R/W
- TEMP. CONSTRUCTION EASEMENT
- STORM DRAINAGE EASEMENT
- FEE SIMPLE IN EXIST. R/W
- UTILITY EASEMENT (U.E.)

CURVE TABLE

CURVE	RADIUS	LENGTH	CHORD BRG.	CHORD DIST
C1	40.00	29.81	S34°58'31"E	29.12
C2	40.04	42.33	S46°19'41"E	40.39
C3	7.78	8.99	N09°10'28"W	8.50
C4	1243.00	141.06	N15°10'19"E	140.98

LINE TABLE

LINE	BEARING	LENGTH
L1	N64°56'21"W	26.50'
L2	N64°56'21"W	63.19'
L3	N09°36'34"E	16.12'
L4	S79°30'08"E	26.26'
L5	S79°30'08"E	36.50'
L6	N12°55'15"E	32.03'
L7	N12°55'15"E	38.48'
L8	N22°28'13"E	78.34'
L9	N56°14'30"W	47.42'
L10	N33°45'47"E	164.52'
L11	S56°19'30"E	25.51'
L12	S56°19'30"E	22.14'
L13	S23°57'49"W	51.14'

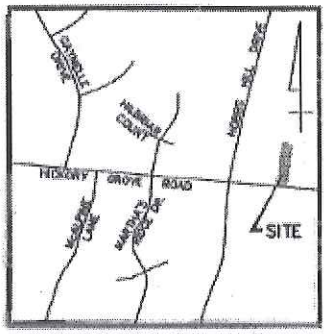
Examples of general requirements:

line/curve table if applicable, vicinity map and legend

Legend may be parcel specific or a Typical Project Legend may be utilized.

NOTE: If a Typical Project Legend is utilized, a revision may be requested by the City's Attorney for condemnation purposes

Vicinity Map



VICINITY MAP (NOT TO SCALE)

Boundary Surveys are required for all Total Takes (total land purchase in Fee), must be on legal size paper to attach to a deed or MOA.

3. Plan Minimum Requirements, if Applicable (Acquisition & Appraisal)

Requirements:

1. Existing R/W lines
2. R/W (by maintenance) lines where applicable
3. Existing easements shown
4. Planned utilities / notes/UBO Plans/Utility Plans
5. Traffic Control Plans
6. Erosion Control Plans
7. Cross sections / Profiles
8. Grading / Cuts / Fill lines
9. Fee taking location lines – Proposed property lines-edge of pavement
10. Proposed permanent easement locations
11. Proposed temporary construction easement locations
12. Railroad R/W
13. Wetlands areas
14. Limits of disturbance
15. Protection and to be Removed notes: Signage / Fencing / Parking / Site Improvement / Driveways, etc.
16. Building footprints
17. Parking footprints
18. Notation of trees, ie. 12" Oak, etc. and Protection notes if applicable
19. Project numbers, tax parcel, address, Parcel numbers
20. Cover Sheet with Legend
21. Typical Sections/Details
22. Proposed Infrastructure/Improvements Shown
23. Matchlines Noted/Station #s and Offsets

4. Plat Minimum Requirements (Acquisition & Appraisal)

Requirements:

1. Parcel No
2. Owner(s) Name
3. Property Address
4. City/Twp, County, State
5. Vicinity Map
6. Tax parcel number
7. Survey date/ Revision Dates
8. Map book & Page/ Deed Reference
9. Square footage & acreage listed for total property, areas taken, total area remaining
10. Railroad R/W, if applicable
11. Existing R/W – R/W by maintenance lines
12. North Arrow
13. Legend
14. Road R/W width/ state road # / Street Name
15. Property Corners Labeled
16. Title block w/ Project Name & #
17. Easements Labeled (and match legend)
18. Map standard notes, if applicable
19. "Page 1 of 1 or 1 of 2"
20. Property ties
21. Bearing & distance
22. Line & cure table, if applicable
23. Acquisition area dimensions are labeled
24. All known existing easements & overlaps, (this includes non-COC easements and 3rd party easements), if applicable
25. All acquired areas are hatched or shaded and match legend
26. Graphics scale and map scale
27. Adjoiner's & deed references
28. Surveyor seal & signature
29. Review Officer's Statement

Area Table or Notes Section Should Include:

1. Total Parcel Area
2. Areas Taken In Fee
3. Proposed Permanent Easements
4. Proposed Easements - Overlapping Areas (or noted elsewhere on plat)
    - Note: If overlap square footages are not provided on the plat, the areas will be required prior to requesting the appraisal. This affects the value of the proposed easements and is needed to establish compensation by the appraiser for the acquisition and possible condemnation.
5. Temporary Construction Easement Areas
6. Total Parcel Area Remaining

General Notes:

1. No color copies of the plat
2. Plats should be legal size ONLY, (paper no Mylar)
3. Boundary surveys are required for all total takes
4. Entire parcel boundary must be shown on all plats
5. "Now or Formerly" can be listed above the owner's name to help reduce revisions, due to ownership changes
6. If we are taking a structure or going thru an improvement, depict on the plat (Physical Survey)
7. If property does not abut a public right of way, depict on the plat
8. "Proposed" should not be listed in the Area Table or Notes section

5. Storm Water Plat Requirements (Acquisition)

Easements and Associated Line Types:

1. Storm Drainage Easement (SDE)
2. Permanent Storm Drainage Easement (PSDE)
3. Public Drainage Easement (E)
4. Temporary Construction Easement (TCE)

Definitions:

1. "SDE"- is the line type utilized for a new Storm Drainage Easement area that will be acquired to construct and maintain the proposed infrastructure for the project.
    a. Which may include:
        i. Permanent Storm Drainage Easement (PSDE), area previously acquired by the DM-Team, which is being "revised" to include the updated storm drainage easement language.
        ii. Public Drainage Easements (E) that we are "accepting".
2. "PSDE"- is the line type utilized for recorded City of Charlotte Storm Drainage Easements, (usually old Maintenance Team blanket easements), plats were not utilized and the recorded easement language is not consistent with the rights and restrictions that are currently required therefore the language needs to be updated.
    a. The surveyor may add a leader with additional language to explain how the easement was recorded, if they are concerned that the "PSDE line type" is not the best description.
3. "E"- is the line type utilized for previously recorded Public Drainage Easements by a Developer or an old Plat Map.
    a. The surveyor may add a leader with additional language to explain how the easement was recorded, if they are concerned that the "E line type" is not the best description.
    b. A Permanent Detention Easement "PDE" is an easement for off-site storm water detention facilities, typically a "third party" easement. A PDE from the subject site to the offsite detention facility is shown on a map that is recorded in the Register of Deeds office.
        i. PDEs are not maintained by the City
        ii. If a PDE is terminated, the easement holder will be out of compliance with storm water requirements.
4. "e"- is the line type utilized for all proposed temporary construction easement that will be acquired to construct and maintain the proposed infrastructure for the project.

Area Table/Notes Section:

1. The Area Table/Notes Section on the plat lists the easement type and square footage to be acquired and typically that is its only function. However, this section will be utilized to differentiate "New SDE" from the easements that are being "revised or accepted", (PSDE or E).
    a. If "PSDE" will be revised/converted to "SDE", the easement type/name should read "PSDE to be revised as SDE".
    b. If "E" will be accepted/converted, the easement type/name should read "E to be accepted as SDE".

2. There will be instances when Storm Water Services will need to acquire new, revise and/or accept easements on a single parcel. In these instances the square footages of each specific easement will need to be "totaled as SDE".

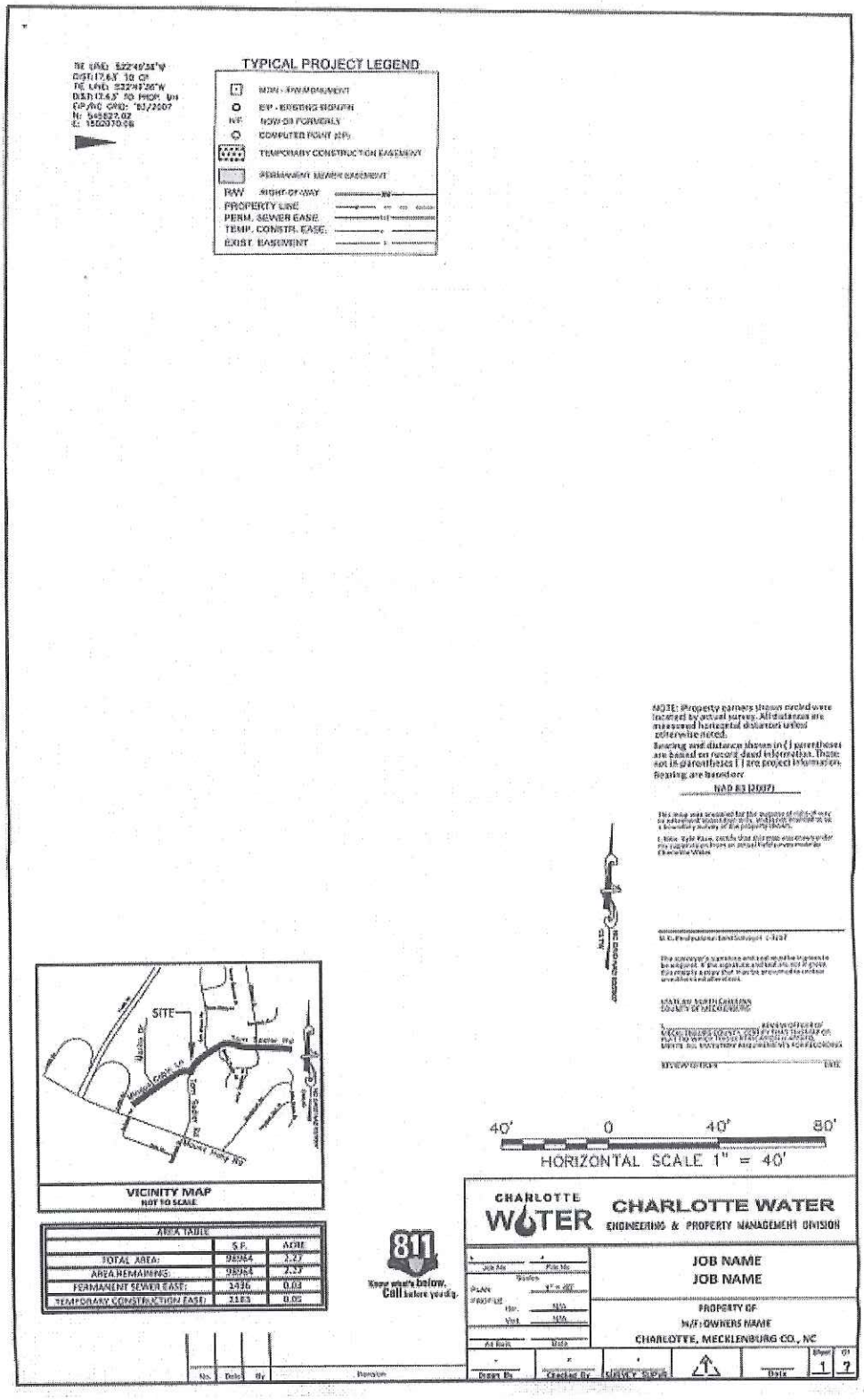
AREA TABLE/NOTES SECTION EXAMPLE

Total Parcel Area	20,000 SF
Temporary Construction Easement (TCE)	500 SF
Storm Drainage Easement (SDE)	1,000 SF
PSDE To Be Revised As SDE	500 SF
E To Be Accepted As SDE	500 SF
Total Storm Drainage Easement	2,000 SF
Total Parcel Area Remaining	20,000 SF

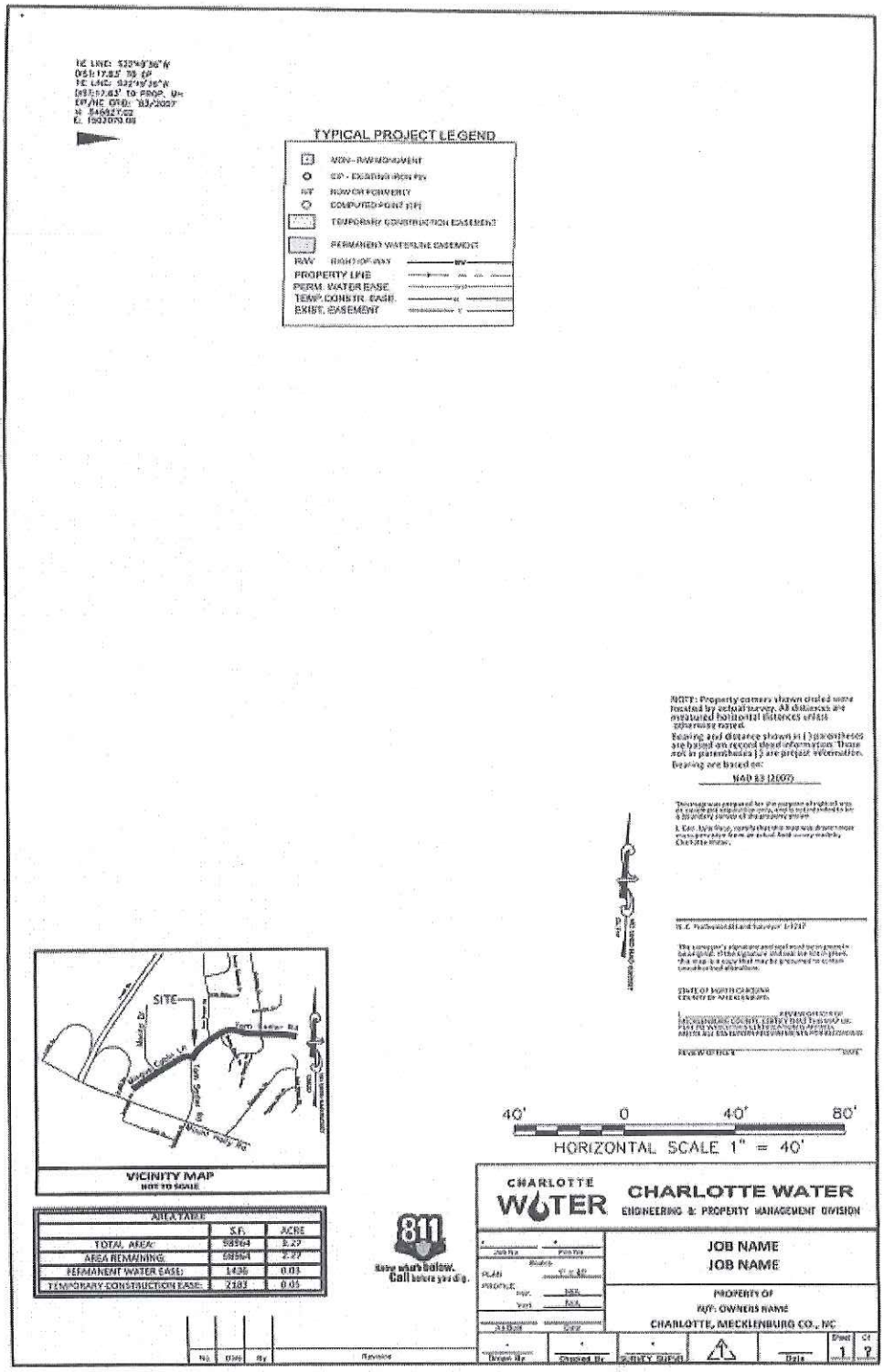
Plat Shading:

1. All proposed easements to be acquired to construct and maintain the project infrastructure should be shaded as SDE or TCE.
    a. All proposed easements, including SDE and TCE shall have distinct shading.
    b. All proposed easement shadings and line types shall be included in the plat legend.
    c. All easement areas to be accepted ("E") or revised ("PSDE") should utilize the same shading as the SDE to be acquired.
2. Existing easements that are not to be revised or accepted should not be shaded.
    a. This will delineate:
        i. The areas to be maintained after project construction is completed
        ii. The areas to be acquired or condemned

6. CLTW "Sewer" Easement Plat Template



7. CLTW "Water" Easement Plat Template



8. Sample Plat Review Checklist

Project Name:	**Project Number:**
Parcel #:	**Owner(s):**

o Parcel No.	o Owner(s) Name	o Property Address
o Vicinity map	o Tax Parcel ID Number	o North Arrow
o Map Book & Page / Deed Reference	o Survey Date / Revisions Dates	o City/TWP, County, State
o Road Name & State Road Number, if applicable	o R/W Width	o Property Ties
o Surveyor Seal & Signature	o Property Corners Labeled	o Easements Labeled & Match Legend
o Legend with Line Types & Hatching/Shading	o Acquisition Area Dimensions are Labeled	o All Acquired Areas are Hatched or Shaded and Match Legend
o Adjoiners & Deed References	o Bearings & Distances	o Graphic Scale
o Line & Curve Table, if applicable	o Map Scale	o Existing Easements & Overlaps, if applicable
o Title Block w/ Project Name & Number	o Map Standard Notes, if applicable	o Spell Check
o Pages (1 of 1 or 1 of 2)	o R/W by Maintenance, if applicable	o Existing R/W
o Railroad R/W Labeled, if applicable	o Square Footage Listed for Total Property, Areas Taken, & Total Area Remaining	o Review Officer's Statement

Area Table or Notes Section Should Include:

o Total Parcel Area	o Areas Taken In Fee	o Proposed Permanent Easements
o Proposed Easements - Overlapping Areas	o Temporary Construction Easement Areas	o Total Parcel Area Remaining

- No color copies of the plat
- Plats should be legal size only, (paper no Mylar)
- Boundary surveys are required for all total takes (ALTA surveys are not required for total takes)
- Entire parcel boundary must be shown on all plats
- "Now or Formerly" can be listed above the owner's name to help reduce revisions, due to ownership changes
- Existing easements should not be shaded or hatched
- Condemnations, the plat will need to be revised if the following is not shown:
  - If Property does not abut a Public Right of Way, depict on the plat.
  - If we are taking a structure or going thru an improvement, depict on the plat (Physical Survey)

9. REPM & Agent Guidelines for Revisions on Plats, Plans and Appraisals

Plats:

1. Whenever a change is requested, be sure to request the change by using the terms **"revision"** and **"correction"** requested. If the plans are revised that require a new plat, this is a "revision". If the plat requires a change due to it being incorrect, this is a "correction".

2. Property owner name(s) need to be spelled correctly, plat correction required.

3. NKA, AKA, FKA, Merger, etc. do not need to be on the plat. These items can be addressed in the agreement, no plat revision is required.

4. For Inc, LLC, LP, etc. the State of incorporation does not need to be on the plat for acquisitions or condemnations. This can be addressed in your agreement.

5. If there are many owners, it is acceptable to have "et al" on the plat to cover all owners. For a Life Estate if et al is used: Betty Jones, Life Estate et al.; list the remainder man in the agreement.

6. If the ownership involves a trust, the plat does not need to include the date. Just make sure the type of trust is reflected on the plat, revocable, irrevocable etc. However, if "dated" is in the legal name of the trust on the deed then this needs to be addressed in your agreement.

7. Survey may note on the plat whether the owner was married, and may state wife, spouse, husband, etc. when the owners acquired the property. If their marital status has changed by divorce or separation where a division of property by divorce decree, free trader agreement etc. has been recorded. The plat will need to be revised to remove the party's name that no longer has a property interest.

8. If the plat includes the name of a married couple (Tenants by the Entirety) and one spouse is deceased, and the remaining spouse has not remarried, it is fine to leave both names on the plat for an acquisition only. The agreement should state widow, widower if this is the case. The deceased spouse's name will need to be removed for condemnations.

9. If the property is acquired through an estate, the plat will need to be revised to include the New Owners Names, the Original DB & PG, and the Estate File #.

10. A plat revision is not required if the adjoining owners information is incorrect.

11. If "Now or Formerly" is listed on the plat and ownership changes, revisions are not required before submitting for condemnation. If Legal believes that revisions are needed, they will request.

Plans:

1. The construction plan sheet does not need to be revised due to ownership changes, misspelled items, etc. as long as the **Parcel # and Tax ID # are correct**, for condemnations and/or appraisals.

Appraisals:

1. If for some reason, an appraisal includes an incorrectly spelled plat or ownership has changed, Do Not Order a revised appraisal for this reason. Put a note on the package that the plat included in the appraisal has a misspelled property owner's name etc. (The property owner's name has no bearing on the value of the property.)

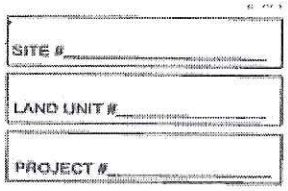
Special Entities:

1. For CMS, the correct name is "The Charlotte-Mecklenburg Board of Education". Use this on all documents and plats.

2. Catholic Churches require the "current" bishop's name on acquisition documents. The plat should reflect the church's name for example, The Roman Catholic Diocese of Charlotte.

3. For Mecklenburg County parcels, adjoiner ownership must be accurate

4. For Duke Energy, the plat should include:



These are internal numbers for Duke and are required on the plat and acquisition documents.

CHARLOTTE BUSINESS INCLUSION
Connecting MWSBEs with opportunities.

Frequently Asked Questions (FAQs)

What is the Charlotte Business INClusion program?

The Charlotte Business INClusion program is designed to promote diversity, inclusion, and local business opportunities in the City's contracting and procurement process for businesses with a significant business presence in the Charlotte Combined Statistical Area.

To find out if you are eligible for the City of Charlotte Small Business Enterprise (SBE) certification, download the City of Charlotte SBE Application.

What are the City registration requirements for MWBEs?

To be eligible for participation in the program as an MWBE firms must meet the following criteria:

- MWBEs must be certified with the State of North Carolina's Historically Underutilized Business (HUB) Office. To learn more about MWBE certification, Click here
- MWBEs with a significant business presence in the Charlotte Combined Statistical Area (CSA) will need to register in the City's vendor database and complete a "Relevant Market Area Certification" form.

Why is the City committed to the Charlotte Business INClusion program?

The Charlotte Business INClusion program provides benefits for both the City and the business community in our region. Participation in the program helps the City increase its contracting opportunities with MWSBE companies, resulting in greater job availability and business growth for the local business community. In addition to contributing to the economic well-being of the region, bringing new MWSBEs into the pool of companies doing business with the City enhances the City's competitive bidding processes and allows the City to track its spending with MWSBE firms.

Why would a business want to become certified as an MWSBE?

Businesses that complete the program application and are certified as an MWSBE will have greater exposure to business opportunities in the City's procurement and contracting. The names of MWSBE firms are listed in the City's vendor database, which is widely used by City buyers in all City Departments. Prime contractors and consultants will also use the City's vendor database to identify MWSBE certified subcontractors for City projects. Only those businesses that are certified by the City as MWSBEs will be counted towards fulfilling the City's MWSBE goals.

Do I have to get certified as an MWSBE to do business with the City?

Your firm does not have to be certified as an MWSBE in order to do business with the City. Anyone can register their business as a vendor with the City by completing a Vendor Registration Form. However, if your business meets the certification requirements for MWSBE certification, we highly recommend that you participate in the City's Charlotte Business INClusion program as it will afford you greater exposure to business opportunities.

Is an MWSBE firm assured of getting a contract with the City?

Not necessarily. MWSBE certification does not guarantee that you will receive a contract with the City of Charlotte. However, MWSBE certification does provide greater exposure for your firm to the business community. It is important to develop a marketing plan and market your business to the City departments who buy what you sell.

What is the difference between an MBE, WBE, and an SBE?

MBE stands for Minority Business Enterprise. An MBE is 51% owned, operated, and controlled by one or more members of a minority race.

WBE stands for Women Business Enterprise. A WBE is 51% owned, operated, and controlled by one or more women.

SBE stands for Small Business Enterprise. An SBE is a race- and gender-neutral designation that is defined based upon economic criteria established by the City.

If I complete the MWSBE application with the City, does that mean I will be certified with other agencies?

No. The City of Charlotte has defined its own criteria for MWSBE designation in the Charlotte Business INClusion program. While other organizations may accept the City's MWSBE designation, you should always inquire what certifications other businesses will accept.

Does having a PO Box or an office in the Charlotte Combined Statistical Area (CSA) allow me to participate in the City's Charlotte Business INClusion program?

If you just have a PO Box in the CSA, you can't participate in the Charlotte Business INClusion program. Your firm must have an office with *"significant business presence"* in the Charlotte Combined Statistical Area (CSA) in order to participate in the CBI Program. The CSA includes the following counties in North Carolina: Anson, Cabarrus, Cleveland, Gaston, Iredell, Lincoln, Mecklenburg, Rowan, Stanly, and Union; and the following counties in South Carolina: Chester, Lancaster, and York.

The City will evaluate a business enterprise's *"significant business presence"* based on all of the evidence supplied by the business enterprise. Several factors will be used to determine significant business presence including, but not limited to:

- Is the business enterprise headquartered or has an office in the Charlotte CSA;
- Number of full-time employees in the CSA;
- Location of managerial or decision-making personnel;
- Lease agreement;
- Post office box, mail drop, or message center;
- Previous work or contracts performed in the Charlotte CSA; and
- Percentage of income or revenue derived from Charlotte CSA.