

**INFRASTRUCTURE DESIGN AND
CONSTRUCTION STANDARDS**

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**Prepared by
ARAPAHOE COUNTY DEPARTMENT OF
PUBLIC WORKS AND DEVELOPMENT**

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ARAPAHOE COUNTY

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CHAPTER 1 - GENERAL PROVISIONS

1.1 SHORT TITLE

These regulations, together with all future amendments, shall be known as the “Arapahoe County Infrastructure Design and Construction Standards” (hereinafter referred to as “Standards”, “Engineering Standards”, or this “IDCS”) and are part of the Arapahoe County Subdivision Regulations (hereinafter referred to as “Regulations”). The original Roadway Design and Construction Standards Manual was adopted by the Arapahoe County Board of County Commissioners (hereinafter called “BOCC”) by resolution in 1986. The previous manual is hereby repealed and replaced by these Standards.

1.2 JURISDICTION

These Standards shall apply to all land within the unincorporated areas of Arapahoe County, except where the County’s jurisdiction is superseded by the State or by another jurisdiction.

1.3 PURPOSE

These Standards present the minimum technical criteria, analysis considerations, submittal requirements, guidance, materials, and specifications for the analysis and design of public improvements and private work which will be dedicated to or accepted by Arapahoe County. All development proposals, land use actions, or any other proposed construction submitted for approval under the provisions of the Regulations shall conform to these Standards. These Standards are not intended as a prescriptive substitute for proper engineering design, nor are these standards intended to limit design innovation or engineering design options. Options that follow standard engineering practice and meet the overall intent and purpose of these design standards may be provided by the applicant for County review. However, it shall be the responsibility of the applicant to demonstrate that the option(s) presented meet or exceed the minimum criteria contained herein and are of equal performance with respect to safety, maintenance, and value.

1.4 ENACTMENT AUTHORITY

The Regulations are adopted pursuant to the authority conferred within: Article 28 of Title 30 (County Planning); Article 2 of Title 43 (State, County and City Highway Systems); Article 11 of Title 30 (County Powers and functions); Article 67 of Title 24 (Planned Unit Development Act); Article 20 of Title 29 (Land Use Control and Conservation); and other applicable sections of Colorado Revised Statutes (C.R.S.), as amended. Pursuant to the above authority statutory, these Standards are adopted by resolution and are incorporated by reference as a part of the Regulations.

1.5 AMENDMENT AND REVISIONS

These Standards may be amended from time to time as to remain current with the County’s use

of technology, current processes and procedures, updating in accordance with new laws, regulations and industry standards and where the experience gained in the use of these Standards indicates a need for revision. The Department of Public Works and Development shall monitor the performance, effectiveness, and consistency with current administrative processes and procedures and may make administrative and technical changes, amendments, or revisions of these standards as approved by the Director of Public Works with notice to the BOCC. Policy Changes within these Standards shall be approved by the BOCC, following the recommendations of the Director of the Department of Public Works and Development (or the Director's named representative), through the adoption process of the periodic updates to these Standards.

Requests for revisions of these standards may also be proposed and submitted to the Engineering Services Division for review. Proposed revisions should include a copy of the text or drawing proposed for revision, a description of the reason for the revision, and the name and contact information of the proponent. Technical Modifications to these Standards shall be approved by the Director of Public Works and Development.

1.6 ENFORCEMENT RESPONSIBILITY

It shall be the duty of the Director of the Department of Public Works and Development, acting on behalf of the BOCC to enforce the provisions of these Standards. The Director and/or Engineering staff may require more stringent design standards where special conditions warrant.

1.7 REVIEW AND APPROVAL

The County shall review all submittals for general compliance to these Standards. Approval by the County does not relieve the owner, developer, engineer, designer, or their designee from responsibility of insuring that the calculations, plans, specifications, construction, and record drawings are in compliance with the Standards as stated in the owner's or developer's and engineer's certifications.

1.8 INTERPRETATION

In the interpretation and application of the provisions of the Standards, the following shall govern:

- 1.8.1** In their interpretation and application, these provisions shall be regarded as the minimum requirements for the protection of the public health, safety, comfort, morals, convenience, prosperity, and welfare of the residents of the County. These Standards shall therefore be regarded as remedial and shall be liberally construed to further their underlying purposes.
- 1.8.2** Whenever a provision of these Standards and any other provisions of the Regulations or any provision in any law, ordinance, resolution, rule, or regulation of any kind, contain any restrictions covering any of the same subject matter, whichever standards are more restrictive or impose higher standards or requirements shall govern.
- 1.8.3** These Standards shall not abrogate or annul any public improvement construction plans or permits which have been filed with and approved prior to the effective date of these Standards, provided that the improvements have been constructed within the two-years

from the date of approval. Public improvement construction plans or permits which have expired approvals (i.e. improvements have not been constructed, within two-years from the approval date) shall be required to be re-submitted in accordance with the requirements of these Standards. The Director shall have final authority to resolve any conflict in the interpretation of these Standards.

1.9 RELATIONSHIP TO OTHER STANDARDS

Since the County is the approval authority for land use changes, these Standards, which stipulate certain minimum conditions for land use changes, shall apply. If another agency or special district imposes more stringent standards, this difference is not considered a conflict, and the more stringent standard shall apply.

Many standards are incorporated by reference throughout this document. When there are references to external documents, or where these Standards do not specifically address relevant engineering technical criteria, specifications, materials, construction standards, or guidance, the County may require the application of other engineering standards. The latest edition, or most current version, of the following standards shall be used as the presumptive standard when specific design and construction criteria, guidance, code, standards, plans, manuals, methods, materials, or procedures are not specifically addressed in these Standards:

- Arapahoe County Land Development Code (LDC)
- Arapahoe County Development Application Manual.
- Americans with Disabilities Act (ADA) Standards for Accessible Design, ADA.gov.
- Public Rights-of-Way Accessibility Guidelines (PROWAG), U.S. Access Board.
- American Association of State Highway and Transportation Officials (AASHTO) “Policies on Geometric Design of Highways and Streets” (aka “Green Book”).
- American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide.
- Colorado Department of Transportation Standard Specifications for Road and Bridge Construction (aka CDOT Standard Specs).
- Colorado Department of Transportation Miscellaneous and Safety Standard Plans (aka CDOT M&S Standards).
- Colorado Department of Transportation Construction Manual.
- Metropolitan Government Pavement Engineering Council (MGPEC) Pavement Design Standards and Construction Specifications Manual.
- Federal Highway Administrations Manual on Uniform Traffic Control Devices (MUTCD).
- Model Traffic Code for Colorado
- Arapahoe County Traffic Operations Policy and Procedures (TOPP’s)
- Arapahoe County Bicycle and Pedestrian Guide
- AASHTO Guide for the Development of Bike Facilities
- Denver Regional Council of Governments (DRCOG), Regional Complete Streets Toolkit
- Arapahoe County Stormwater Management Manual
- State Highway Access Code, State of Colorado
- Occupational Safety and Health Administration (OSHA) Standards

1.10 VARIANCES

Variations from these Standards will be considered on a case-by-case basis in accordance with procedures in the Regulations and Standards (refer to Section 3.2 of the Standards for variance procedure).

1.11 DESIGN PROFESSIONALS

Colorado State Law requires that certain work be performed by or under the direction of a professional licensed to practice engineering and/or land surveying in the State of Colorado.

1.12 REQUIRED PUBLIC IMPROVEMENTS

All new developments and re-developments are required to construct such new public right-of-way infrastructure, and/or replace, retrofit, or upgrade existing infrastructure within the public right of way adjacent to the property, and provide adequate land dedication for the provision of public rights-of-way, easements, or tracts as needed by reason of such development or re-development. These Public Improvements typically include, but may not be limited to, roadways, roadway and intersection widening, sidewalks, curb, gutter, storm drainage, storm facilities, signals, signs, channelization, striping, bike lanes, trails, and other required public utilities and appurtenances. All Public Improvements shall be in Right of Way unless specifically allowed by the County. Land dedication for public Right of Way may include both the Right of Way needed to locate the required Public Improvements, as well as any Right of Way needed to accommodate planned, future public transportation projects outlined in County Transportation Master Plan (TMP), Transportation Improvement Plan (TIP), and other related transportation, open spaces, or parks planning documents or plans for which the development or re-development is expected to contribute traffic, public services, or other capacity needs. The Public Improvements required should be expected to vary by project location and extents and shall be coordinated with all future public improvement projects. For each land development application, the County shall determine the type, size, location, and extent of necessary improvements based on the characteristics of the development proposal, its anticipated impacts, and its relationship with the surrounding area and applicable laws, regulations, and policies. The costs of such Public Improvements and dedications shall be considered a requirement of development approval and the sole expense of the developer. Proportionate or partial funding contributions for public projects by the County may be allowed by separate agreement.

1.13 OUTSIDE AGENCY REVIEW

1.13.1 Utilities and Services - The County does not provide water, sanitation, fire protection, and various other utilities and services. The external agencies that provide these utilities and services are unaffiliated agencies and/or districts with independent and separate approval authority, regulations, required agreements, and processes. The applicant/developer is responsible for contacting all appropriate agencies to obtain their approvals for all land development applications. The design of external agency improvements shall be closely coordinated with the design of all County public improvements and other site improvements to minimize conflicts.

1.13.2 Southeast Metro Stormwater Authority (SEMSWA) – Review, processing, and permitting services related to Stormwater, Water quality, Floodplain, and Grading, Erosion and Sediment Control (GESC) are provided through a partnership between SEMSWA and Arapahoe County for all applications within the SEMSWA service area. Review and permitting services are performed by County staff for all areas outside the SEMSWA service area.

- GESC Program – SEMSWA administers the GESC program on behalf of the County and is the sole review and approval authority related to GESC. SEMSWA reviews GESC reports and plans, collects GESC collateral, issues GESC permits, and provides GESC inspections.
- Approval Recommendation to County – For the review of Drainage studies, drainage components of Construction Drawings, Floodplain studies, O&M Site Plans, and GESC Plans and Reports, SEMSWA provides comprehensive stormwater review and provides approval recommendations to the County. The County is the final approval authority for all drainage related documents not related to the administration of the GESC program.
- Mile High Flood District – When projects include stream work, outfalls to streams, work within floodplains, or that otherwise are located adjacent to MHFD boundaries or that require improvements to be included in MHFD’s maintenance eligibility program (MEP), the project may require review, approval, inspection, and acceptance by MHFD as part of the approval process.

1.13.3 Environmental Permitting and Clearances – The County does not oversee, manage, assess, or determine required environmental permitting and clearance requirements for land use applications. It is the responsibility of the applicant, and their engineer, to perform environmental review for all land use applications to determine permitting and clearance requirements of all applicable regulatory agencies (ex: CDPH&E, Army Corps of Engineers, Colorado Parks and Wildlife, etc.). As a standard practice, the County does perform a courtesy outside referral to many agencies for review and comment. However, conformance with environmental regulations is the sole responsibility of the applicant and their engineer. It is recommended that the applicant perform their due diligence in contacting regulatory agencies for consultation and, if necessary, an assessment for any required permitting and/or clearances.

1.13.4 CDOT and local Cities – In some cases, developments may require or otherwise desire access to either a state highway, state route, or local street or road that is outside the jurisdiction of the County. As part of the land use approval process, the developer will need to obtain access permits through the designated issuing authority (State or other local jurisdiction).

1.14 ABBREVIATIONS

As used in these Standards, the following abbreviations shall apply:

AASHTO	American Society of State Highway & Transportation Officials AASHTO “GREEN” A Policy on Geometric Design of Highways & Streets
ACI	American Concrete Institute

ADA	Americans with Disability Act
APWA	American Public Works Association
ASTM	American Society for Testing and Materials
BOCC	Arapahoe County Board of County Commissioners
CD	Construction Drawings
CDOT	Colorado Department of Transportation
CDOH	Colorado Department of Highways (which name CDOT, CDOH and stay consistent)
CDPH&E	Colorado Department of Public Health and the Environment
ESD	Engineering Services Division
FEMA	Federal Emergency Management Agency
GESC	Grading, Erosion and Sediment Control
IGA	Inter-governmental Agreement
L&I	Landscape and Irrigation
MHFD	Mile High Flood District
MGPEC	Metropolitan Governments Pavement Engineers Council
MUTCD	Manual on Uniform Traffic Control Devices
OSHA	Occupational Safety and Health Administration
O&M	Ownership and Maintenance
PROWAG	Public Rights-of-Way Accessibility Guidelines
PWD	Public Works and Development
ROW	Rights-of-way
SEMSWA	Southeast Metro Stormwater Authority
SIA	Subdivision Improvement Agreement
SMM	Stormwater Management Manual
TSEA	Traffic Signal Escrow Agreement
USDCM	Urban Storm Drainage Criteria Manual
USGS	United States Geological Survey

CHAPTER 2 SUBMITTAL PROCEDURES

2.1 DRAWINGS AND REPORTS SUBMITTAL PROCEDURES

2.1.1 Overview

Consulting engineers and developers seeking approval and acceptance of Construction drawings and engineering reports are required to follow the procedures outlined herein. The use of these procedures helps ensure an efficient review of engineering drawings and reports and facilitate the development review and approval process. Further information related to submittal procedures and requirements for the various County land development processes can be found in the Arapahoe County Land Development Code and Development Application Manual.

2.1.2 Pre-submittal Meetings

The Planning Division routinely conducts pre-submittal meetings prior to formal submittal. The purpose of the pre-submittal meeting is to share information related to the development, land use, or project being proposed and to provide the applicant the opportunity to receive guidance and information from County Staff regarding applicable land use and development processes, procedures, standards, submittals, review costs, and other requirements that may be relevant to the application. These meetings also provide the applicant the opportunity to ask questions of County Staff and discuss site specific issues that may aid the applicant in their development planning and application process.

To schedule a pre-submittal meeting, the applicant should send a pre-submittal application form, letter of intent (narrative and details of the development, land use or project being planned), and a plan/sketch of the proposal to PRESUBMITTALS@ARAPAHOEGOV.COM. After the pre-submittal meeting has been held, the County Planning Case Manager who attended the meeting will send a list of compiled meeting notes, application submittal requirements, and any supporting submittal checklist(s) to the applicant. The information provided is intended to assist the applicant in preparing a complete initial submittal.

The Engineering Services Division will be part of the pre-submittal meeting and will review pre-submittal meeting materials in advance to determine engineering requirements and site-specific issues that may affect the project. In the pre-submittal meeting the applicant may consult with the County Engineering Services Division for general information related to applicable design criteria, processes and procedures, drainage concerns, and submittal requirements.

2.1.3 Submittal of Construction Drawings (CD's) and Engineering Reports

Land use applications submitted to the Planning Division for all subdivisions or developments, whether residential or commercial, shall include Construction Drawings and engineering reports for the proposed development as identified in the pre-application meeting notes. Applicants should email all land use application submittals to LANDUSESUBMITTALS@ARAPAHOEGOV.COM. All engineering

documents received will be reviewed for submittal completeness prior to review as well as design completeness level during review. An application intake meeting may be required.

2.1.4 Completeness Check

The planner, case engineer, mapping staff, and administrative support staff assigned to the application will review the submittal package for all required application documents and fees identified in the pre-submittal notes. This review for application completeness is termed the “Completeness Check” and is generally completed within (3) three working days of application. If the application is determined to be complete, the application will be processed for intake, a case number will be established for the application, and the review of submittals will begin after the three-day Completeness Check period has ended.

Complete submittals are those which include all drawings and supporting engineering reports. Incomplete submittals are those missing one or more items applicable to the review process, as determined by the Engineering Services Division. Incomplete submittals may be returned or held until all required information is submitted. Questions regarding what constitutes a complete engineering submittal for a specific project may be forwarded to the Engineering Services Division of the Public Works and Development Department.

For all submittals that have missing or complete information, or in cases where review fee payment has not yet been received, the application will be determined to be incomplete. Incomplete applications will not be processed for intake and review and will be considered a new application upon resubmittal.

2.1.5 Construction Drawings Completeness Levels

The Construction Drawings (plan sets) provided at time of initial application should be developed to a 90% design completion level (90% design). While it is recognized that some design changes may occur during the process of addressing review comments for approval, the engineer preparing the Construction Drawings should submit technically complete and comprehensive plans so that a meaningful review can be performed and that delays in the review and approval process are minimized to the extent practical. The Construction Drawings shall include all roadway and storm sewer plan views and profiles, accessible pedestrian routes and facilities, detailed grading plans, horizontal control plans, overall utility plan, signage and striping plans, and standard design details at time of submittal.

It should be cautioned that Construction Drawings that are not substantially complete, or that are missing considerable required information for review, may be returned to the applicant with general comments and resubmittal for that review cycle may be required (i.e., the review cycle will not advance).

Construction Drawings shall be developed to a minimum of a 90% design level to accompany the Engineer’s Cost Estimate of Public improvements and the associated Subdivision Improvements Agreement (SIA). See Chapter 12 for further details.

The following are a list of Construction Drawing Design Completeness Level milestones:

- Initial Submittal = 90% Complete
- Engineer's Cost Estimate of Public Improvements / Improvements Agreement (SIA, IGA, etc.) = 90% Complete and all design of public improvements is complete.
- Planning Commission = 95% Complete and all major engineer issues are resolved to the satisfaction of the County. All outside referral comments have been resolved.
- Board of County Commissioners approval = 99% Complete / Check Print prior to Mylars (Clean-up for recording). All engineering issues have been resolved.
- Issuance of Construction Permits = Final Approved Plans (stamped and signed)

2.1.6 Engineering Reports

The engineering reports identified in the pre-submittal meeting notes shall be submitted with the Construction Drawings at initial submittal. Requirements for engineering reports are covered in the respective sections and appendices of these Infrastructure Design and Engineering standards. Unless outlined elsewhere in these or other applicable standards, preliminary reports shall be substantially complete and contain all pertinent information required for review. Two drafts (preliminary and final) of engineering reports are assumed and for each draft one review cycle is anticipated (i.e. review of draft, edits to draft, and finalizing report). The County Engineer may require additional Engineering Reports or information upon further review.

2.1.7 Review of Construction Drawings and Engineering Reports

Once a submittal has been determined to be complete, the review of Construction Drawings and Engineering Reports will proceed with the applicable review cycle. The case engineer reviewing the engineering documents will review the design information for conformance with these Infrastructure Design and Construction Standards (including the applicable engineering standards referenced herein), Stormwater Management Manual, the County comprehensive plan, Drainage Master Plans, Capital Improvement and Open Spaces project information, and any other County, State or Federal regulatory requirements applicable to the submittal. Submittal information may also be sent for review (external referral) to partner and/or external stakeholder agencies to receive comments.

Upon completion of the review, the case engineer and/or case planner will compile all written comments and/or redlines and forward to the applicant for submittal revisions and formal response to comments. The applicant or their representative will be notified by email when comments and redlines have been uploaded to the Arapahoe Customer Access (ACA) portal and are available for download.

If, in the process of reviewing resubmittals, it is determined that the information submitted is materially deficient, has not addressed prior comments, or is found later to be incomplete, these submittals may be returned to the applicant. In these or similar cases, the resubmittals may not advance in the review process.

2.1.8 Developer Revision of Engineering Plans and Reports

The applicant shall make all the requested revisions to the engineering submittals original plans/report and resubmit according to the instructions provided. Engineering plans and reports related to large or complex projects, or those that contain a significant number of issues and/or deficiencies, may require several review cycles prior to approval. Each resubmittal will have a completeness check performed prior to review. The applicant shall review the following requirements related to resubmittal, quality assurance and control review requirements, and written response to comments prior to resubmittal.

2.1.9 Submitting Revised Plans and Engineering Documents

When submitting revised plans or reports to the Engineering Services Division, the resubmittal must contain:

- The revised Construction Drawings and/or Engineering Reports.
- All redlines from previous Staff reviews, and a point-by-point response to comments. The written response to comments should describe the means/manner of how the comments were address with a reference to the location within the documents where the revision or changes were made. Meeting minutes from any comment resolution meetings held should be included.
- Review fees, if applicable.
- Any requested Quality Control/Quality Assurance review documentation.
- In the case of Final Submittals, include a completed Engineering Services Division Transmittal form.

If all the above items are not included with the submittal package submitted, the resubmittal may be returned without further action until such time as they are included.

2.1.10 Quality Control/Quality Assurance (QA/QC) Review Required

Prior to resubmittal, the applicant, and related agents (engineers, surveyors, professional service providers, etc.), shall assure that all documents to be submitted undergo an internal quality control and quality assurance (QA/QC) review prior to each submittal. The QA/QC review is a review for the accuracy of the submittal (ex: how agency comments were addressed, conformance to standards, project requirements have been met, etc.). These reviews are important for the applicant to assure resubmittals do not contain quality issues or deficiencies that may prolong the review process and delay project approval timelines. Internal QA/QC reviews shall be in accordance with the engineering firm's adopted company QA/QC procedures.

In cases where submittal deficiencies and quality issues have been noted in submittals, the County may require a letter certifying that a QA/QC review has been performed in accordance with company QA/QC procedures. In cases of engineering submittals, this letter shall be stamped and signed by the licensed professional

performing the review. Copies of company QA/QC procedures shall be provided to the County upon request prior to review.

2.1.11 Written Response to Comments

The review of revisions to submittals will include a review of the written responses to comments. The applicant is advised to assure that all reasonable and good faith efforts have been made to address the comments provided by County Staff and external agencies. Comments and issues from prior reviews that have not been addressed to the satisfaction of the County and/or applicable outside agencies will be considered non-responsive. Inattention to comment and issue resolution may affect review and approval timelines, may result in additional review cycles and fees, and affect overall project delivery goals and objectives as a result.

To expedite the review and approval process, scheduling a Comment Review Meeting is recommended. This meeting is intended to offer the applicant the opportunity to review comments, ask clarifying questions, and to rectify any conflicts that may exist prior to resubmittal.

2.2 ENGINEERING REVIEW GOALS AND OBJECTIVES

2.2.1 Goal for Number of Review Cycles

For each application, the County has a goal for completing review in a total of four review cycles. Three of these cycles are planned formal review cycles and the fourth is for final edits (final CD's, Mylars, etc.). Engineering fees, level of review effort, and overall estimated review timelines are all based on this underlying review cycle goal.

For each review cycle is assumed to include, but may not be limited to, the following steps:

- 1.) Applicant submittal or re-submittal of application materials
- 2.) County completeness and QA/QC checks
- 3.) County and outside referral reviews and compiling of comments,
- 4.) Comments are returned to the applicant,
- 5.) Applicant revision of engineering documents and reports
- 6.) Applicant scheduling and holding comment review meetings to resolve comments,
- 7.) Applicant development of written response to comments (how comments were resolved in plans, engineering documents, supporting information, etc.)
- 8.) Applicant QA/QC check prior to resubmittal (completeness and accuracy)

2.2.2 Goal for Review Cycle Timelines

While review cycle timelines can vary from time to time, the County has established the following goals related to review timelines for each submittal:

- Initial Application Submittal (Review #1) = 4 weeks
- 1st Resubmittal (Review #2) = 3 weeks
- 2nd Resubmittal (Review #3) = 2 weeks
- 3rd Resubmittal (Review #4) = 1 week
- All subsequent resubmittals/reviews = 1 week

While the County strives to meet these review cycles timelines, these timelines may be adjusted for unusual workload conditions (staffing levels, number of submittals in for review, complexity of submittals, large development proposals, etc.). Additionally, deficient submittals with substantial comments may result in the same review time as previous submittal.

In the event the Construction Drawings are submitted as part of a Land Use Case, the review time shall coincide with the time allowed for the case submittal review as set forth by the Planning Division. The applicant will be advised of the estimated completion date for review of submitted documents.

2.2.3 Review Fee Goals and Assessment of Additional Fees

The County has an established fee schedule for engineering reviews which are based on the above-mentioned number of review cycles, review timelines, conservative level of effort assumptions, and conservative cost estimates. The fees established are set to be in line with other Denver-Metro area local agencies while offering a moderate level of cost recovery to the County. These fees do not cover all County costs associated with the review and approval of development applications. The most recent approved fee schedules can be found on the County's website.

While it is the County's underlying goal to keep review fees to a minimum where possible, there may be cases where the review cycles, staff time and level of effort required to facilitate the review and approval process will be more than what the initial review fee may cover. In cases where the number of review cycles or level of effort exceeds underlying assumptions, where submittals contain numerous deficiencies, or where staff comments have not been addressed and/or resolved during the review process, the County reserves the right to assess additional review fees at their discretion.

2.2.4 Engineering Review Objectives – Planning Commission

Prior to a development application proceeding to the Planning Commission for approval, the following engineering milestones should be met:

- Design should be developed to a 95% Design Completion Level. All major engineering issues should be resolved, and only minor design work should be remaining.
- All outside agency major review comments have been addressed (i.e. SEMSWA, Fire District, etc.)

2.2.5 Engineering Review Objectives – Board of County Commissioners

The following engineering milestones need to be met prior to going to Board of County Commissioners for final approval:

- Engineering Services Division review and acceptance of the final design concept shown on the Construction Drawings. All design work should be complete and only minor clean-up work can be remaining.
- Engineering Services Division concurrence with the Engineer's Cost Estimate of Public Improvements, as defined in Chapter 12.
- Engineering Services Division has final draft of a Subdivision Improvement Agreement (SIA) and/or Inter-governmental Agency Agreement(s) (IGA).
- All Engineering Reports, except for the Final Paving Report and Landscape & Irrigation Construction Drawings should be 99% complete by the applicant.
- All land use rights, easements, permits, and/or maintenance responsibilities should be defined and included as a condition of approval (easements, ROW dedication, O&M Agreements, agency permits, etc.)

2.2.6 Engineering Review Objectives – Recording

After Board of Commissioners approval and prior to recording, the following engineering milestones are required:

- Final Approval of Construction Drawings
- Final Agreements and Exhibits for recording.

2.2.7 Completion of Engineering Review and Final Approval

Once all engineering comments and/or redlines have been addressed, final signed and stamped Construction Drawings and Engineering Reports have been received, all fees are paid, and all other engineering requirements have been satisfied, the case engineer assigned to the project will sign off on the completion of engineering review and recommend approval to the Manager of Engineering Services. A copy of the Engineering Services Transmittal Form (copy of this form available online) will be routed for internal County execution and will be provided to the applicant or their representative. Receipt of an executed Engineering Services Transmittal Form shall be documentation of engineering approval.

2.3 CONDITIONS AFTER ISSUANCE OF FINAL APPROVAL

2.3.1 Plan Expiration and Extensions

The County approval of Construction Drawings and Engineering Reports are valid for a period of twenty-four (24) months from the approval date, after which the issued approval will expire. If the public improvement permit is not issued prior to approval expiration, the applicant must resubmit the plans for re-approval.

2.3.2 Revisions to Approved Construction Drawings

Whenever updates or revisions to previously approved Construction Drawings are determined to be necessary, the applicant will submit updates or revisions through the normal document submittal process. After all the Engineering Services Division

comments and revisions have been incorporated, the revised Construction Drawing sheets may be submitted by the applicant for approval. This approval submittal shall meet requirements of Section 2.1.

Requests for updates and revisions to Construction Drawings will be considered only if there are NO impacts to the original Development Plan(s) and related Engineering Reports. The County will review the Construction Drawing revisions for conformance with the original Development Plan(s) and/or Engineering Reports and with current standards under normal review procedures (requests for updates will be considered resubmittals). If found in conformance with the Development Plan(s) and Engineering Reports, and if found in compliance with current standards, the revisions to the Construction Drawings will be approved. Significant updates to Construction Drawings which necessitate changes to Engineering Reports and or Development Plan(s) will be considered a new submittal and are to be coordinated with the County.

2.3.3 Field Changes

Minor changes to construction drawings can be made in the field provided that the Engineering Services Division approves the changes prior to implementation. Failure to receive approval of field changes from the Engineering Services Division may result in non-acceptance of the improvement and/or facility. All field changes must be accurately depicted on the as-built record drawings as defined in Chapter 7. The applicant shall provide to the Engineering Services Division a letter signed and sealed by the Professional Engineer responsible for the original design, stating that the proposed field change shall not deviate from the intent of the original design.

2.3.4 Review Fees

Engineering Review Fees shall be assessed in accordance with the most recently adopted Engineering Services Division Review Fee Schedule. A copy of the Fee Schedule is available on the County website. The assessment of planning and impact fees may be assessed as part of the land use approval process.

CHAPTER 3 SUBMITTAL REQUIREMENTS

All Construction Drawings, drainage letters & reports/plans, geotechnical reports, pavement designs, GESD report/Plan shall be prepared by or under the direction of a Professional Engineer, registered in the State of Colorado, and shall be reviewed for the minimum requirements set forth herein. The Professional Engineer should be aware that additional information and analysis, beyond the minimum requirements, may be required for a proposed project if unusual conditions or construction challenges are anticipated.

The policy and practice of Arapahoe County is not to accept any liability for facilities designed by others. Arapahoe County does not accept responsibility for the accuracy and adequacy of the design. The County Engineer, through approval of the Engineering Documents, indicates the Engineering Services Division has reviewed the document and found it in general compliance with the Regulations, Standards, and Stormwater Management Manual, or approved variances thereof. Private improvements may be reviewed for public safety. Unless otherwise identified or noted, all construction drawing submittals must to comply with the requirements of these Standards and the Stormwater Management Manual. Variances or waivers of the Standards or requirements of the Stormwater Management Manual shall be formally requested of the Engineering Services Division, as set forth in Section 3.4 of these Standards. Failure to comply with prescribed procedures may result in review delays, additional review fees, or both.

3.1 DRAFTING STANDARDS

3.1.1. General

All plans submitted for approval and recordation shall meet the following minimum standards.

- Full Size Engineering Plans shall be 22" x 34".
- Plan sheets and exhibits to be recorded shall not contain color.
- Double plan and profile sheets will not be allowed.
- Development plans shall meet current Arapahoe County drafting standards, which are available from the Mapping Section of the Engineering Services Division.

3.1.2. Lettering

Letter size shall not be less than one-tenth (0.10) of an inch when printed at half size. All lettering must be in sharp contrast with the background of the original. Letter size and contrast are required for digitalizing engineering drawings for records and security needs.

3.2. CONSTRUCTION DRAWINGS

3.2.1. Certification

Construction Drawings submitted for review shall be prepared by a Professional Engineer, registered in the State of Colorado. The plans must include the following statement on the cover sheet:

"I hereby affirm that these construction drawings for (name of subdivision, development or project) were prepared by me (or under my direct supervision) in

accordance with the requirements of the Infrastructure Design and Construction Standards and the Stormwater Management Manual.”

Name of Engineer
PE Number
Name of Engineering Firm

This statement shall be signed, stamped, and dated by the Registered Professional Engineer who prepared or directed the preparation of the plans.

3.2.2. Site Civil Construction Drawings

Construction Drawings and supporting documents are required for all Public Improvements and improvements within Arapahoe County rights-of-ways, and within easements and tracts. This applies to all land development applications, Metropolitan District improvements, special purpose district public improvements, or other improvements in Arapahoe County Right-of-Way. Approval authority is the Director of Public Works and Development.

When access to a County roadway is proposed and the request is not part of a land use application Construction Drawings of the improvements are required. The Director has the authority for approval.

Refer to Appendix F for minimum information on required sections and information to be included in site civil construction drawings. Additional information may be required depending on project conditions. Appendix F will be amended by the Engineering Services Division from time to time, via administrative amendment.

3.2.2.1. Private Improvements

Private Improvements such as roadways, drainage improvements, utilities, etc. shall be clearly shown and labeled as “Private” on each sheet of the Construction Drawings on which such improvements are shown. Private improvements may be reviewed for public safety.

When a request is made for the County to assume maintenance of any private improvement, it shall be the responsibility of the applicant to satisfactorily demonstrate that the private improvements were constructed in accordance with the Arapahoe County Standards in effect at the time of the original construction of the private improvement. The County will review these requests under normal review procedures as previously outlined in these standards.

3.2.3. Other Plans

3.2.3.1. Utility Construction Plans

Utility installations within the Right-of-Way requires Construction Plans if two or more of the criteria listed below are met:

- Installation is longitudinal to traffic more than 300',
- Installation is transverse to traffic - crosses more than one traffic lane,
- A lane closure, detours, and/or flagging are required,

- The street is a major collector, minor arterial, or major arterial,
- The street is improved (e.g. paved),
- Pavement Patching is required,
- The estimated cost is greater than \$50,000.

For New Utility Installations that meet the above requirements, an Application for Review & Approval shall be submitted. These requirements do not apply to maintenance work or service taps from existing mains to new users. The Director has the authority of approval. Refer to Chapter 9 of these Standards for Permit Bonding and Inspection Requirements for Street Cut and R.O.W Use.

Utility Construction Plans shall conform to the County’s construction drawing requirements as outlined in Appendix F.

3.2.3.2. Landscaping and Irrigation Construction Drawings

Landscaping and Irrigation Plans in conformance with Arapahoe County Streetscape Guidelines and Section 4 of these Standards. Landscape and irrigation Plans for improvements located within County Right-of-Way shall be submitted as a separate document from the Construction drawings and shall conform to section 4-1.3 of the Land Development Code. Irrigation systems shall be designed in conformance with Section 4-1.3J of the Land Development Code. Sight distance shall be designed in accordance with the Streetscape Guidelines, Section 4 of these Standards, and AASHTO requirements. Both sight triangles and sight distance lines shall be labeled and dimensioned on the Landscape Plans. Landscape & Irrigation Plans shall be stamped by a licensed Landscape Architect who is licensed in the State of Colorado and the below certification included on the cover sheet:

“I hereby affirm that these final landscape architectural construction plans within (name of the roadway) right-of-way for (name of subdivision, development or project) were prepared by me (or under my direct supervision) for the owners thereof, in accordance with the Colorado Revised Statute Title 12, Article 45, the Arapahoe County’s Streetscape Guidelines of the Land Development Code and the requirements of the Arapahoe County’s Infrastructure Design and Construction Standards Manual. I understand that Arapahoe County does not and will not assume liability for landscape and irrigation systems designed by others.”

Signature by a Licensed Landscape Architect State of Colorado
 License Number (Affix Seal) Date
 Name of Landscape Architectural Firm

The plans shall also contain the following developer certification on the cover sheet:

“(Name of Developer) hereby certifies that the landscape and irrigation systems for (Name of Subdivision, Development or Project) shall be constructed according to the design presented on the landscape architectural construction plans. I understand that Arapahoe County does not and will not assume liability for the landscape and irrigation systems designed by my landscape architect. I further understand that Arapahoe

County may require additional information if the submitted plan does not function as intended.”

“I have reviewed the information contained herein and accept responsibility for the requirements set forth.”

Name of Developer
Signature Date

When landscaping and/or irrigation are located within the County Right-of-Way, the Project Owner/Developer shall enter into a License Landscape Agreement with Arapahoe County, as a condition of plan approval. Arapahoe County will not be responsible for landscaping and irrigation improvements or related appurtenances within the County Right-of-Way.

The Landscape and Irrigation submittal should also include a one-page exhibit depicting all landscaping to be installed in the right-of-way. This one-page sheet shall be recorded with the Landscape License Agreement as Exhibit A.

3.2.3.3. Ownership and Maintenance Site Plans and Checklist

An Operation and Maintenance Site Plan (O&M Plan) shall be required for all permanent stormwater facilities to ensure that they function as designed. The purpose of the O&M Site Plan is to provide guidance and standard forms for those entities that will be responsible for the long-term inspection and maintenance of the facility. The O&M Site Plan Checklist shall be included with the submittal of the Plans as a separate document.

For detailed information and requirements on the O&M Site Plans and checklist, refer to the Arapahoe County Stormwater Management Manual, latest edition.

3.2.3.4. Trail Plans and Profiles (if applicable)

Regional Trails planned within Arapahoe County can be found in the Arapahoe County Open Spaces Master Plan on the Open Spaces Division’s website. If a development contains a regional trail, Trail Construction Plans are to be submitted to the Engineering Services division under separate cover from the Site Civil Construction Drawings. Trail construction drawings shall meet the requirements in Appendix F and shall be designed in accordance with the Arapahoe County Design Guide for Bicycle and Pedestrian Facilities, most recent edition.

3.2.3.5. Traffic Signal Plans (if applicable)

When construction of a traffic signal is required by a Developer in conjunction with a land use case, Traffic Signal Plans shall be submitted to the Engineering Services Division under separate cover from the Site Civil Construction Drawings.

Traffic signal plans are to conform to the current Capital Projects requirements. Traffic signal standard details will be provided to the applicant if signals are to be designed and/or constructed in conjunction with a development project.

3.3. ENGINEERING REPORTS

3.3.1. Drainage Report

All development applications or land use proposals Arapahoe County shall submit a Drainage Report, or Drainage Conformance Letter. Drainage Report submittal requirements related to the type of development or land use proposal are outlined in the Arapahoe County Stormwater Management Manual. The type of Drainage Report submitted with any development or land use proposal shall be based on the requirements of the Planning Division.

The Drainage Report shall be a stand-alone document. When references are made or assumptions are based on previously submitted studies or reports, the Drainage Report must include the appropriate excerpts, pages, tables, and maps containing the referenced information. Assumptions made in previous reports must be verified and substantiated in all new reports.

3.3.2. Traffic Impact Study (TIS)

The information included in this section is a general overview of when a Traffic Impact Study is required. For detailed information and submittal checklist for Traffic Impact Studies, refer to Appendix B: Guidelines for Traffic Impact Studies, latest edition.

Traffic Impact Studies are generally required for all new land development proposals. TIS requirements for redevelopment or change in use of existing sites will be determined on a case-by-case basis. Mitigation or improvements by the Developer may be required regardless of if a TIS is required.

The need for a TIS should be assessed as early as possible in the development process to ensure maximum flexibility for eliminating traffic-related problems. The TIS is dependent on site-specific characteristics such as location, trip generation, existing road conditions, and type of development proposed; as such, the requirements of a TIS may vary from site to site.

The need for a TIS, TIS update, or TIS waiver will be determined by the Department of Public Works and Development, Engineering Services Division, in accordance with the intent of these guidelines. The County reserves the right to waive or modify the requirements of a TIS as outlined within these guidelines.

The Developer may still be required to mitigate traffic delays or complete roadway improvements necessary to ensure acceptable traffic operations, regardless of whether a TIS is required.

3.3.2.1. Traffic Impact Study Waiver

A TIS requirement may be requested to be waived if all the following conditions are met:

- The average trip generation of the proposed project is less than 250 trips per day and 25 trips in the peak hour.
- The combination of the proposed development traffic plus existing traffic does

not exceed an average of 150 vehicles per day on any unpaved road or road that does not meet the current County standard.

- Access is not being requested to either a State Highway or County arterial roadway.
- There are no current traffic problems or local area concerns, such as an offset intersection or a high accident data.

If the conditions listed above are met, the applicant may submit a waiver request to Engineering Services Division Case Engineer. The TIS waiver request must be prepared by the Developer's Transportation Consultant Engineer (stamped by a Colorado Professional Engineer). The County reserves the right to deny the waiver request if there are extenuating circumstances outside those listed above, which should be evaluated in a Traffic Impact Study as determined by the Case Engineer.

The waiver request shall include the following:

- The trip generation of the development.
- Recent traffic counts along the immediately adjacent roads (less than one year old).
- Conclusion that no adverse transportation impacts are anticipated as a result of the proposed project.

3.3.3. Pavement Design Report

When the pavement design report is not submitted as a part of the Construction drawings, an Application for Review and Approval of the Pavement Design Report shall be submitted. The Director has the authority for approval. The Pavement Design Report (Final) shall be completed prior to paving. All field investigations, sampling, testing, and reports shall be conducted and prepared in accordance with the latest MGPEC Pavement Design Standards.

Refer to Chapter 5 for detailed information regarding the Pavement Design Report.

3.3.4. Grading, Erosion, and Sediment Control (GESC) Plans and Report.

The County is classified by the State as a Municipal Separate Storm Sewer System (MS4) Permittee, and SEMSWA operates the GESC Permit Program for the County in the County's MS4 Permit area within the SEMSWA Service Area. GESC Plans and Reports are required for development to implement erosion and sediment control measures (SCM) as a standard for all land disturbance activities and to reduce increases in erosion and sedimentation over pre-development conditions.

For detailed information on plan and report requirements for GESC, refer to the SEMSWA, Centennial, & Arapahoe County GESC Manual (most recent edition) which can be found on the County's website.

3.3.5. Engineer's Cost Estimate

An Engineer's Cost Estimate is required when a Development will be entering into a Subdivision Improvement Agreement (SIA) with the County and will be used to determine the collateral amount that will be collected by the County to guarantee the Public Improvements within the SIA as well as any private roads which are being constructed with the Development. This cost estimate will be recorded with the SIA as Exhibit A.

Because of the fluctuating nature of construction costs the minimum costs published by the County are to be used only as general guidelines for early estimating; for the Public Improvements Cost Estimate actual construction costs are to be included. The estimate must also include a minimum of 15% contingency.

3.4. VARIANCES, WAIVERS, AND APPEALS

3.4.1. General

If an applicant (developer, special district, contractor, utility, or provider, agency, etc.) responsible for public improvements proposes to design and/or construct improvements in a manner that is not in conformance with the engineering criteria and requirements outlined, or that wishes to obtain approval for a waiver from specific criteria or requirements outlined in these Standards, a "variance request" for each criteria for which a variance or waiver is being requested shall be submitted to the County Engineer and the Technical Review Committee (TRC) for review and consideration. No variance or waiver of these standards shall be granted unless the applicant clearly demonstrates, and the TRC supports, that such variance or waiver complies with the variance criteria and provisions of this section.

It is the responsibility of the design professional preparing and submitting plans and engineering documents to ensure conformance to these standards. The variance process is intended to offer a practical level of design flexibility to address practical difficulties that may arise during the design process. The design engineer shall perform their due diligence in analyzing design alternatives and alternative standards that may be applied to the design prior to submitting a variance request. Variance requests that do not contain sufficient analysis, evaluation, justification, or that are not the best interest of all parties will not be supported or approved.

Variance requests should be submitted as early in the design process as is practical, preferably with the initial plan submittal. Variance requests submitted prior to plan submittal will not be approved. Variances that are submitted late in the review and approval process may not allow sufficient time to evaluate impacts to other design elements and for the resolution of conflicts. It should be recognized that variances that are submitted too early or too late in the review process may not be supported by the County. The County reserves the right to approve or deny variance requests, in full or in part, at their sole discretion.

It is important to note that the County cannot grant variances to Federal or State Regulatory requirements such as Americans with Disabilities Act (ADA) Accessibility Guidelines / Public Right of Way Accessibility Guidelines (PROWAG).

3.4.2. Variance Request Process and Procedures

For a variance to be approved, the applicants engineer shall submit a variance request to the County Engineer for review and consideration. Upon review, if the County Engineer finds that the variance request is in conformance with variance submittal requirements, meets the applicable variance/waiver criteria, and provides sufficient justification and/or information to support the request being evaluated, the Engineer will advance the variance request to the County's Technical Review Committee (TRC) for review and approval. The variance request will be added to the agenda for the next regularly occurring TRC meeting. Request should be submitted by noon at least three (3) business days prior to the scheduled TRC meeting to appear on that TRC agenda.

The County TRC will review the variance request, as presented by the County Engineer and/or applicant's engineer and will consider the County Engineer's recommendation to determine if the variance is supported by the County. For some variances, the County Engineer or TRC may request revisions, evaluation of design alternatives, the evaluation of other standards, external agency consultation, or request additional information or analysis. In these situations, the applicant's engineer shall amend, revise, and resubmit the variance request.

Variance requests that do not meet variance criteria or do not provide adequate justification and supporting information, or that are otherwise not found to be in the best interest of the County and/or the public may be denied. For variance requests that are denied or are otherwise not supported, the applicant has the option of appealing the variance decision in accordance with the appeal process outlined in this Section.

When a variance is approved, it shall be limited to the specific criteria for which the variance has been requested. It shall be explicitly understood that, by way of variance approval, other criteria outlined in these standards are not otherwise waived. The variance criteria being approved shall be considered severable and other variances or waivers shall not be inferred or implied.

3.4.3. Variance Request Submittal Requirements

Variance requests shall be made by the applicants engineer in writing and submitted to the County Engineer. The content of the variance request should include, at a minimum, the following information:

- Project information including project/County Case title and Case Number, design firm company name and address, location, parcel number(s), and address.
- Brief narrative of project and scope of work
- Site plan, profiles, or other graphic information in exhibits or figures.
- Identification of the County standards, criteria, or provision to be varied or waived. References to the standard(s) with the applicable chapter, section, and subsection should be provided.
- A thorough justification of the variance request. Justification should include identifying: existing conditions, proposed conditions, local context, conflicts, constraints, benefits, enhancements, and other evaluated alternatives. The goal of the

justification should be to document the engineering reasoning and rationale for the request and to describe how the proposed alternative design or criteria will produce a comparable result while still providing for adequate protection of the health, safety, and welfare of the public.

- Identification of the alternative design or construction criteria proposed. If alternative design criteria are proposed, cite references to the proposed applicable standard and reference sections.
- A narrative of maintenance requirements, maintenance responsibilities, and associated costs, where applicable.
- A written evaluation of the Variance and Waiver Criteria and description of the ways the proposed alternative will produce an equivalent result.
- The Variance Request shall be stamped and signed by a Professional Engineer licensed in the State of Colorado and shall include the following note:

“This Variance Request from the Arapahoe County Infrastructure Design and Construction Standards, Section (include the section number and title) was prepared for (name of Subdivision, development, or project) by me (or under my direct supervision) and is based on sound engineering judgement and practices”.

Name of Engineer
Engineering Firm

3.4.4. Variance and/or Waiver Criteria

Variance requests will be evaluated based on the information submitted with the variance request in accordance with the following criteria:

- a. The variance or waiver will not compromise or present a risk to the health, safety, and welfare of the public.
- b. The proposed variance or waiver will provide a comparable level of safety, level of service, and quality of design to what would otherwise be present through the application of the criteria outlined in the standards.
- c. The engineer clearly describes, and demonstrates to the satisfaction of the County, the existence of project-specific constraints, conditions, limitations, restrictions, conflicts, or practical difficulties that are present and that warrant additional consideration and flexibility in the application of these standards.
- d. The proposed variance to these standards has considered and seeks to apply other alternative standards, criteria, or practices that will result in an equal or better condition and reflect comparable local and industry standard practices.
- e. The resulting variance or waiver will not create a burden for the County with respect to operations, maintenance, or enforcement.
- f. The variance or waiver will not transfer or have the effect of transferring ownership, obligations, or liability to the County.
- g. The variance will create a benefit to the project that would not otherwise be achievable without the variance.
- h. For waivers, reasonable conditions should exist where the strict application of these standards may provide limited practical benefit or use.
- i. The information and justification provided for review is thorough and comprehensive.

3.4.5. Appeal of Variance Decisions

If a variance or waiver request (see section 3.4.1) is denied, the applicant may appeal the decision. The appeal process is as follows:

A. Appeal to the Director of Public Works and Development

Within six (6) working days of receipt of a written appeal of a TRC variance recommendation, the Director shall respond in writing to the applicant, defining a date, time, and location at which the applicant may present their appeal. The date of the meeting shall not be more than twelve (12) working days from the date of receipt of the written appeal.

At the appeal meeting it shall be the responsibility of the applicant to clearly define and justify the variance or waiver requested. Staff shall be responsible for presenting the reasons and basis for denying the original variance request.

The Director shall provide a written recommendation to the applicant within five (5) working days of the appeal meeting.

B. Appeal to the Board of County Commissioners (BOCC)

If the Director upholds the TRC's recommendation for denial of a variance request, the applicant may make a final administrative appeal to the BOCC.

The appeal should be made directly through the Engineering Case Manager. The Engineering Case Manager will be responsible for scheduling the appeal through the Board of County Commissioners. The appeal should include:

- a. The variance or waiver being requested with a brief justification for the variance or waiver request.
- b. The written recommendations from Staff and the Director for the variance or waiver request, including the variance request from the applicant.
- c. The estimated amount of time required to present the appeal to the BOCC.

It is recommended that the appeal of the variance or waiver request be taken to the BOCC with the land use application(s). If, however, the appeal is taken to the BOCC prior to the public hearing for the land use application(s), the proceedings and record before the BOCC shall be included in the administrative record for such land use applications. However, the BOCC will be limited to consideration of the appeal and is prohibited by quasi-judicial due process considerations from any review or consideration of the underlying land use applications. The presentation on the appeal shall contain no presentation related to the merits of the land use applications, which will be considered independently and in accordance with the applicable procedure and approval criteria for same.

The County Attorney's Office shall schedule a public hearing agenda item at the next available hearing date. The appeal shall be noticed by posting of the meeting agenda with the appeal item in accordance with the Colorado Open Meetings Law and the applicant shall be notified of the hearing date for the appeal within six (6) working

days of receipt of the written appeal. The BOCC may, but need not, allow public comment at such hearing.

The appellant shall make their presentation before the BOCC within the time requested in the written appeal.

The Public Works and Development Department shall have the opportunity to present its position on the appeal to the BOCC and shall have the opportunity to rebut the appeal presentation with a summary of its findings of fact, description of circumstances, and staff judgment used in the initial and appeal decisions.

3.5. ENGINEERING SERVICES REVIEW & APPROVAL FEES

Submittal Fees and Penalties shall be assessed in accordance with the current Engineering Fee Schedule. A copy of the Fee Schedule is available on the County website. The assessment of planning and impact fees may be assessed as part of the land use approval process.

CHAPTER 4 ROADWAY DESIGN AND TECHNICAL CRITERIA

4.1 GENERAL

This Chapter sets forth the minimum design, technical criteria and specifications to be used in the preparation of all roadway plans.

These Roadway Standards are for new construction and modification to existing infrastructure. Modifications and additions to existing infrastructure shall comply with these standards to the maximum extent practicable.

- 4.1.1 Within this chapter, AASHTO “Green Book” refers to “A Policy on Geometric Design of Highways and Streets” most recent revision, as published by the American Association of State Highway and Transportation Officials.
- 4.1.2 Design Speed is the maximum safe speed limit that can be maintained over a specific section of highway when conditions are so favorable that the design features of the highway govern, and is a selected design speed used to determine the various geometric design features of the roadway during roadway design.
- 4.1.3 Posted speed is the maximum lawful speed posted on a section of highway using the regulatory sign. It is based primarily upon the 85th percentile of the design speed on a given alignment.

4.2 ROADWAY DESIGN AND TECHNICAL CRITERIA

Arapahoe County has adopted a Functional Street Classification Plan based on traffic volumes, land use and expected growth. This Functional Street Classification Plan designates streets as local, collector (major and minor) and arterial (major and minor). The following criteria applies to each classification. Standard roadway cross sections are presented in Appendix A.

4.2.1 Planning Principles for Local Circulation Systems.

- 4.2.1.1 A local circulation system is a traffic management method, implemented to convey vehicular, pedestrian and bicycle traffic through developed areas. Basic considerations in the design of local circulation systems must recognize the following factors:
 - Safety – for vehicular, pedestrian and bicycle traffic.
 - Efficiency of Service – for all users.
 - Livability – especially as affected by traffic elements in the circulation system.
 - Economy – These standards take economics into account while providing for the safest roadway progression possible.

4.2.1.2 The following principles are an elaboration on one or more of these four factors. The principles are not intended as absolute criteria, since instances may occur where certain principles conflict. The principles should, therefore, be used as guidelines to proper circulation systems layout.

- **Ensure Vehicular, Pedestrian and Bicycle Access** – The primary function of a local street is to serve the abutting properties. Street widths, placement of sidewalks, patterns of streets and number of intersections are related to the safe and efficient access to abutting lands.
- **Minimize Through Trips** – Through traffic on local and collector streets increases the average speed and volume and thus the accident potential, thereby reducing residential amenities. Through traffic can be discouraged by creating a circuitous route between neighborhoods and higher volume streets and by channeling or controlling median crossings along peripheral routes.
- **Control Access to Arterials** – Local circulation systems and land development patterns should not detract from the efficiency of peripheral arterial facilities. Ideally, land development should occur so that no local streets require direct access to arterial routes. The number of access points between the local circulation system and arterial system should be minimized. Intersections along arterial routes should be properly spaced for efficient signalization and traffic flow. The streets that do intersect the arterial system will tend to have higher volumes since they are the only exit points.
- **Discourage Speeding** – Residential street should be designed to discourage excessive speed (more than 30mph). This can be accomplished through the use of curvilinear alignments and circuitous routes in the street system. Traffic calming measures in residential shall be implemented in accordance with the Arapahoe County Operations Policy and Procedures manual and any associated neighborhood traffic calming program requirements.
- **Minimize Pedestrian – Vehicular Conflicts** – Pedestrian travel from within the area to points outside should require a minimum number of street crossings. Sometimes this can be achieved through proper design of street patterns, land use arrangements and pedestrian routes. Typical methods include use of cul-de-sacs, loop streets, special pedestrian routes or walkways and the proper placement of high pedestrian traffic generators. In general, while vehicular flow must be outward oriented to the peripheral arterials, pedestrian travel should be inward-oriented to avoid these heavier vehicular flows. This is not intended to be used to limit the amount of curb ramps or increase the length of the accessible pedestrian route.
- **Minimize Space Devoted to Street Use** – It is desirable to minimize local street mileage to reduce construction and maintenance costs as well as to permit the most economic land use. Streets should also have an appearance commensurate with their function. They should be in keeping with the residential character.
- **Relate Street to Topography** – Local streets will be more attractive and economical if they are constructed to closely adhere to existing topography. Using the existing topography of the area can enhance the important role that streets play in overall storm drainage system.

- **Layout Street to achieve Optimum Subdivision of Land** – The arrangement of streets should permit economical and practical patterns, shapes and sizes of development parcels. Streets, as a function of land use must not unduly hinder the development of land. Distances between streets, number of streets, and related elements all have a bearing on the efficiency of a subdivision. Access to adjoining properties should also be encouraged.

4.2.2 Urban Local

An urban local street is a general term denoting a residential roadway designed or operating with the following characteristics. No commercial property shall be permitted access to a local street or roadway:

- 4.2.2.1 POSTED SPEED LIMIT – 30 mph maximum
- 4.2.2.2 TRAFFIC VOLUMES – Less than 1,500 vehicles per day for residential roadways with backing driveway access. Less than 2,500 vehicles per day for residential roadways with non-backing driveway access.
- 4.2.2.3 LIMITED CONTINUITY
- 4.2.2.4 SAFETY – Designed for the safety of pedestrians and bicyclists, and the ease of access to adjacent parcels of land.
- 4.2.2.5 TRAFFIC CONTROL – Stop signs, yield signs, or right-of-way rules for uncontrolled intersections.
- 4.2.2.6 FUNCTION – Local streets provide direct access to adjacent property. Traffic carried by local streets should have an origin or a destination within the neighborhood. Utility line easements should be available.
- 4.2.2.7 RIGHT-OF-WAY – In single-family residential areas with monolithic rollover curb, gutter and sidewalk: 50 feet minimum. In single-family residential with 5-foot detached sidewalk: 60 feet minimum. In multiple-family residential areas: 60 feet minimum.
- 4.2.2.8 NUMBER OF MOVING LANES – Two.
- 4.2.2.9 ACCESS CONDITIONS – Intersections at grade with direct access to abutting property permitted.
- 4.2.2.10 PLANNING CHARACTERISTICS – Local streets should be designed to discourage through traffic from moving through the neighborhood. Local streets should not intersect major collectors or arterial streets. Single-Family Residential Local Roadways shall have either monolithic rollover curb, gutter and sidewalk or 5-foot detached sidewalk. Multi-family Residential Local Roadways shall have 5-foot detached sidewalk.

See section 11.2 for intersection spacing criteria.
- 4.2.2.11 TYPE OF CURB AND GUTTER – vertical, Hollywood type and high-speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards) are permissible with attached sidewalk.

4.2.2.12 CUL-DE-SACS and KNUCKLES – Cul-de-sacs shall have a minimum flowline radius of thirty-eight (38) feet, Knuckles shall have a minimum flowline radius of forty-five (45) feet (see detail SP-24, Appendix A). Cul-de-sacs may have a maximum length of 500 feet or a maximum of 15 dwelling units whichever is most restrictive. Extended lengths and/or increased number of dwelling units may be permitted only with written approval from the affected Fire Protection District and approval by the Board of County Commissioners.

4.2.2.13 ROADWAY WIDTHS:

- Single-family residential: 30' paved width plus 2-2' gutter pans (34' flowline – flowline).
- Under the following circumstances, the County and/or Fire District may require a 36-foot, flow line to flow line street width in residential or mixed use areas:
 - Where the gross density is greater than 12 dwelling units per acre
 - However, where buildings are fully equipped with fire sprinklers, the 34-foot minimum flow line to flow line street width shall apply
- Aerial apparatus requirement (42 feet curb line to curb line with parking on both sides):
 - Where building height is greater than 30 feet as measured from grade to bottom of eave. If no eave is present, measurement is taken from grade to top of roof
- Multiple-family residential: 40' paved width plus 2-2' gutter pans (44' flowline – flowline).

4.2.2.14 MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL): See Table 4.1.

4.2.2.15 MINIMUM LENGTH OF TANGENTS BETWEEN CURVES – (Reverse Curves Permissible) Minimum Tangent Length on Local Roadways shall be at least 25 feet.

4.2.2.16 MINIMUM LENGTH OF VERTICAL CURVES: See Table 4.1.

4.2.2.17 STREET GRADES: A minimum longitudinal flowline grade of 1.0% shall be required on all Local streets except at curb returns, knuckles, and bubbles. See Table 4.1 and Section 4.4.2 (inlets). Street grades shall be required to be adjusted at intersections and pedestrian crossings with smooth transitions conforming to normal vertical curve criteria (see Section 4.6 of these Standards).

4.2.2.18 CURB RADII – See Table 4.1 and Table 4.2

4.2.2.19 STREET GRADES – Minimum grade 1% - Maximum grade 5%.

4.2.3 Collector - Minor

A minor collector is a general term denoting a roadway designed or operating with the following characteristics:

- 4.2.3.1 POSTED SPEED LIMIT – Between 30 and 40 mph. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.
- 4.2.3.2 TRAFFIC VOLUMES – Generally less than 7,000 vehicles per day. Designed to handle traffic volumes loading from and onto local, other collector, and arterial roadways.
- 4.2.3.3 CONTINUOUS – For less than 2 miles.
- 4.2.3.4 TRAFFIC CONTROL – on minor collectors provided by stop signs.
- 4.2.3.5 DRIVEWAYS – No back out drives permitted.
- 4.2.3.6 FUNCTION – Collector streets collect and distribute traffic between arterial and local streets and serve as main connectors within communities, linking one neighborhood with another. Traffic carried by minor collector streets should have an origin or a destination within the community. Utility easements should be available.
- 4.2.3.7 RIGHT-OF-WAY WIDTH – 76 feet minimum.
- 4.2.3.8 NUMBER OF MOVING LANES – Two.
- 4.2.3.9 ACCESS CONDITIONS – Intersections at grade with direct access to abutting property permitted.
- 4.2.3.10 TRAFFIC CHARACTERISTICS – Regulation of traffic accomplished through the use of stop signs and channelization. Traffic signals normally used only at intersections with major collectors and arterial streets.
- 4.2.3.11 PLANNING CHARACTERISTICS –Minor Collector streets should have continuity throughout a neighborhood but need not extend beyond the neighborhood. Intersections with minor collectors, major collectors and arterial streets should be at least one-quarter mile apart. Detached 6 feet to 8 feet sidewalks and 5 feet bike lanes are required with a 7 feet landscaped area separating the sidewalk and roadway.
- 4.2.3.12 TYPE OF CURB AND GUTTER – Vertical or high speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards) permitted, detached sidewalk required.
- 4.2.3.13 STREET WIDTHS – 46’ paved with plus 2-2’ gutter pans (50’ flowline – flowline).
- 4.2.3.14 MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL): See Table 4.1.
- 4.2.3.15 MINIMUM LENGTH OF TANGENTS BETWEEN CURVES – (Reverse curves permissible) Minimum Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.
- 4.2.3.16 MINIMUM LENGTH OF VERTICAL CURVES – See Table 4.1.

4.2.3.17 STREET GRADES – Minimum grade 1% - Maximum grade 5%. Street grades shall be required to be adjusted at intersections and pedestrian crossings with smooth transitions conforming to normal vertical curve criteria (see Section 4.6 of these Standards).

4.2.3.18 CURB RADII – See Table 4.1 and Table 4.2.

4.2.4 Collector - Major

A major collector is a general term denoting a roadway designed or operating with the following characteristics:

4.2.4.1 POSTED SPEED LIMIT – Between 35 and 45 mph. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.

4.2.4.2 TRAFFIC VOLUMES – Generally between 7,000 and 12,000 vehicles per day when the land, which the collector serves, is fully developed. Designed to handle traffic volumes loading from and onto local, other collector and arterial roadways.

4.2.4.3 CONTINUOUS – For 2 or more miles.

4.2.4.4 TRAFFIC CONTROL – Provided by traffic signals.

4.2.4.5 DRIVEWAYS – No back-out drives permitted.

4.2.4.6 FUNCTIONS – Major collector streets permit relatively unimpeded traffic movement and are intended for use on those routes where four (4) moving lanes are required but where a larger classified street is not warranted.

4.2.4.7 RIGHT-OF-WAY – 88 feet.

4.2.4.8 NUMBER OF MOVING LANES – four.

4.2.4.9 ACCESS CONDITION:

- Intersection at grade.
- Intersection with other streets will not be restricted.
- Access from street of lower classification will be permitted but in all cases will be controlled by traffic-control devices when warrants are met.
- Normally, all abutting property will be allowed access to the streets and will face the street but perhaps with increased setback requirements.

4.2.4.10 TRAFFIC CHARACTERISTICS

- Regulation of traffic accomplished by signs and channelization.
- Traffic signals will normally be located only at intersection with streets of equal or higher classification.
- Parking shall be prohibited.

4.2.4.11 PLANNING CHARACTERISTICS

- Major collector streets should be employed where traffic demands are high and right-of-way acquisition costs are not prohibitive.
- Detached 6 to 8 feet sidewalk required except at intersections. See Roadway Cross Section for Major Collector at Intersection in the appendix.
- Design elements (Trees, open space, etc.) are recommended.

4.2.4.12 TYPE OF CURB AND GUTTER – Vertical or High speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards), detached sidewalk required except at intersections where attached walk is permitted.

4.2.4.13 STREET WIDTHS – There are two types of Major Collectors one at intersections and one when between intersections. The street widths are as follows for each options:

- At Intersections – 4-12’ travel lanes; 1-14’ center painted median; 2-2’ gutter pans; 2-5’ bike lanes (76’ flowline – flowline).
- Between Intersections – 4-12’ travel lanes, 2-2’ gutter pans and 2-5’ bike lanes (62’ flowline – flowline).

4.2.4.14 MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL); See Table 4.1.

4.2.4.15 MINIMUM LENGTH OF TANGENTS BETWEEN CURVES – Minimum Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.

4.2.4.16 MINIMUM LENGTH OF VERTICAL CURVES. See Table 4.1.

4.2.4.17 STREET GRADES – Minimum grade 1% maximum grade 5%. Street grades shall be required to be adjusted at intersections and pedestrian crossings with smooth transitions conforming to normal vertical curve criteria (see Section 4.6 of these Standards).

4.2.4.18 CURB RADII – See Table 4.1 and Table 4.2

4.2.5 Arterial - Minor

An arterial street is a general term denoting a roadway designed or operating with the following characteristics:

- 4.2.5.1 POSTED SPEED LIMIT** – between 35 and 50 mph. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.
- 4.2.5.2 WIDTH** – 4-lane minimum width, plus additional auxiliary lanes.
- 4.2.5.3 TRAFFIC VOLUMES** – 12,000 TO 30,000 vehicles per day expected traffic volume when the land, which the arterial serves, is fully developed.

- 4.2.5.4** ACCESS – Limited access to adjacent parcels of land.
- 4.2.5.5** CONTINUITY – Several miles, generally connecting with intercity routes.
- 4.2.5.6** TRAFFIC CONTROL – On arterial provided by traffic signals.
- 4.2.5.7** FUNCTION – Arterial routes permit relatively unimpeded traffic movement and are intended for use on these routes where four moving lanes and one left-turn lane are required but where a major arterial cross section would not be warranted.
- 4.2.5.8** RIGHT-OF-WAY WIDTH – 114 feet minimum.
- 4.2.5.9** NUMBER OF MOVING LANES – Four.
- 4.2.5.10** ACCESS CONDITIONS – Intersection at grade. Intersection with other streets will not be restricted. Access from street of lower classification will be permitted but in all cases will be controlled by traffic control devices. Normally, all abutting property will be allowed access to the street if no other access is available and will face the street but perhaps with increased setback requirements.
- 4.2.5.11** TRAFFIC CHARACTERISTICS – Regulation of traffic accomplished by signs and channelization. Traffic signals will normally be located only at intersections with streets of equal or higher classification. Parking shall be prohibited.
- 4.2.5.12** PLANNING CHARACTERISTICS – Arterial should be spaced from ½ to 1 mile apart and should, where possible, be continuous. Arterial should act as boundaries between neighborhood areas. Arterial cross section should be employed where traffic demands are high and right-of-way acquisition costs are not prohibitive. Detached 8 feet (min.) sidewalk with a 10 feet landscaped area separating the sidewalk and roadway required. Separate major land uses.
- 4.2.5.13** TYPE OF CURB AND GUTTER – Vertical or High speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards), detached 8' sidewalk required.
- 4.2.5.14** STREET WIDTHS – 4-12' travel lanes; 1-16' left turn lane/painted or raised median; 2-2' gutter pans 2-5' bike lanes plus acceleration/deceleration lanes at intersections (78' flowline – flowline).
- 4.2.5.15** MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL); See Table 4.1.
- 4.2.5.16** MINIMUM LENGTH OF TANGENTS BETWEEN CURVES – Minimum Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.
- 4.2.5.17** MINIMUM LENGTH OF VERTICAL CURVES – See Table 4.1.
- 4.2.5.18** STREET GRADES – Minimum grade 1% maximum grade 5%. Street grades shall be required to be adjusted at intersections and pedestrian crossings with smooth transitions conforming to normal vertical curve criteria (see Section 4.6 of these Standards).
- 4.2.5.19** CURB RADII- See Table 4.1 and Table 4.2.

4.2.6 Major Arterial

- 4.2.6.1 POSTED SPEED LIMIT** – between 40 and 55 mph. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.
- 4.2.6.2 WIDTH** – 6-lane minimum width, plus additional turn lanes.
- 4.2.6.3 TRAFFIC VOLUMES** – 12,000 to 45,000 vehicles per day expected traffic volume when the land, which the arterial serves, is fully developed.
- 4.2.6.4 ACCESS** – Limited access to adjacent parcels of land.
- 4.2.6.5 CONTINUITY** – Several miles, generally connecting with intercity routes.
- 4.2.6.6 TRAFFIC CONTROL** – On arterial provided by traffic signals.
- 4.2.6.7 FUNCTION** – Major arterial streets permit rapid and relatively unimpeded traffic movement throughout the county, connecting major land use elements as well as communities with one another.
- 4.2.6.8 RIGHT-OF-WAY WIDTH** – 144' minimum.
- 4.2.6.9 NUMBER OF MOVING LANES** – Six.
- 4.2.6.10 ACCESS CONDITIONS** – Intersections will generally be at grade. Intersections will normally be located at one-quarter mile intervals. Access from collector and arterial streets shall be controlled by traffic control devices. Normally, abutting properties and local streets will not be allowed direct access to the street. Abutting properties should not face on the roadway unless separated from it by a frontage road.
- 4.2.6.11 TRAFFIC CHARACTERISTICS** – Movement of traffic will be controlled by signals and channelization. Parking shall be prohibited. Roadways should have a raised median between them.
- 4.2.6.12 PLANNING CHARACTERISTICS** – Major arterial streets should be spaced approximately one mile apart and should traverse the entire city and/or county. Major arterial streets should not bisect neighborhoods but should act as boundaries between them. Detached 10 feet (min.) sidewalk with a 10 feet landscaped area separating the sidewalk and roadway required.
- 4.2.6.13 TYPE OF CURB AND GUTTER** – Vertical or High speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards), detached 10' sidewalk required.
- 4.2.6.14 STREET WIDTHS** – 6-12' travel lanes; 26' raised medians; 2-1' median gutter pans, 2-2' gutter pans, plus necessary left turn and acceleration/deceleration lanes and 4' minimum median at intersections (104' flowline – flowline).
- 4.2.6.15 MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL);** See Table 4.1.
- 4.2.6.16 MINIMUM LENGTH OF TANGENTS BETWEEN CURVES** – Minimum

Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.

4.2.6.17 MINIMUM LENGTH OF VERTICAL CURVES. See Table 4.1.

4.2.6.18 STREET GRADES – Minimum grade 1% maximum grade 5%. Street grades shall be required to be adjusted at intersections and pedestrian crossings with smooth transitions conforming to normal vertical curve criteria (see Section 4.6 of these Standards).

4.2.6.19 CURB RADII – See Table 4.1 and Table 4.2

4.2.7 Urban Expressway (8 Lanes)

4.2.7.1 POSTED SPEED LIMIT – between 45 and 55 mph. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.

4.2.7.2 WIDTH – 8-lane minimum width, plus additional turn lanes.

4.2.7.3 TRAFFIC VOLUMES – 45,000 vehicles per day expected minimum traffic volume when the land, which the expressway serves, is fully developed.

4.2.7.4 ACCESS – Limited access to adjacent parcels of land.

4.2.7.5 CONTINUITY – Several miles, generally connecting with intercity routes.

4.2.7.6 TRAFFIC CONTROL – On expressway provided traffic signals.

4.2.7.7 FUNCTION – Expressway streets permit rapid and relatively unimpeded traffic movement throughout the county, connecting major land use elements as well as communities with one another.

4.2.7.8 RIGHT-OF-WAY WIDTH – 168' minimum.

4.2.7.9 NUMBER OF MOVING LANES – Eight.

4.2.7.10 ACCESS CONDITIONS – ACCESS CONDITIONS – Intersections will either be at grade or grade-separated dependent on traffic volumes. Intersections will normally be located at one-mile intervals. Access from arterial streets shall be controlled by traffic control devices or grade separated interchanges. Abutting properties should not face on the roadway unless separated from it by a frontage road.

4.2.7.11 TRAFFIC CHARACTERISTICS – Movement of traffic will be controlled by signals and channelization. Parking shall be prohibited. Roadways should have a raised median between them.

4.2.7.12 PLANNING CHARACTERISTICS – Expressway streets should only be utilized when traffic projections provide necessity and should traverse the entire city and/or county. Expressway streets should not bisect neighborhoods and should only be accessed by Arterial roadways. Detached 10 feet (min.) sidewalk with a 10 feet landscaped area separating the sidewalk and roadway required. Grade-separated pedestrian crossings only at locations other than intersections.

- 4.2.7.13 TYPE OF CURB AND GUTTER – High speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards), detached 10' sidewalk required.
 - 4.2.7.14 STREET WIDTHS – 8-12' travel lanes; 26' raised median; 2-1 median gutter pans, 2-2' gutter pans plus necessary left turn and acceleration/deceleration lanes and 4' minimum median at intersections (128' flowline – flowline).
 - 4.2.7.15 MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL); See Table 4.1.
 - 4.2.7.16 MINIMUM LENGTH OF TANGENTS BETWEEN CURVES – Minimum Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.
 - 4.2.7.17 MINIMUM LENGTH OF VERTICAL CURVES. See Table 4.1.
 - 4.2.7.18 STREET GRADES – Minimum grade 1% maximum grade 5%. Street grades shall be required to be adjusted at intersections and pedestrian crossings with smooth transitions conforming to normal vertical curve criteria (see Section 4.6 of these Standards).
 - 4.2.7.19 CURB RADII – See Table 4.1 and Table 4.2
- 4.2.8 Rural Arterial (4-Lane)**
- 4.2.8.1 POSTED SPEED LIMIT – between 40 and 55 mph. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.
 - 4.2.8.2 WIDTH – 4-lane including shoulders, painted median/left turn lanes, plus needed drainage swales.
 - 4.2.8.3 TRAFFIC VOLUMES – Generally between 10,000 and 20,000 vehicles per day when the land in which the roadway serves is being fully developed.
 - 4.2.8.4 ACCESS- Limited access to adjacent parcels of land.
 - 4.2.8.5 CONTINUITY – Several miles, generally connecting rural towns.
 - 4.2.8.6 TRAFFIC CONTROL – On Rural Arterial provided by traffic signals and/or signs.
 - 4.2.8.7 FUNCTION – Rural Arterial Roads permit relatively unimpeded traffic movement throughout the rural portion of the County.
 - 4.2.8.8 RIGHT-OF-WAY WIDTH –76' minimum (plus accommodating roadside drainage requirements).
 - 4.2.8.9 NUMBER OF MOVING LANES- four.
 - 4.2.8.10 ACCESS CONDITIONS – Intersections will generally be at grade. Intersections will normally be located at one-quarter mile intervals. Abutting properties, collector and local streets shall normally be allowed acceptable access to the street.

- 4.2.8.11 TRAFFIC CHARACTERISTICS – Movement of traffic will be controlled by signals and channelization. Parking shall be prohibited.
 - 4.2.8.12 PLANNING CHARACTERISTICS – Rural Arterial Roads should be utilized along section lines and where traffic projections warrant the additional lanage and right-of-way.
 - 4.2.8.13 STREET WIDTHS – 4-12’ travel lanes; 2-6’ shoulders plus painted median with necessary left turn and acceleration/deceleration lanes and variable width drainage ditch area (60’ Edge of Shoulder – Edge of Shoulder).
 - 4.2.8.14 MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL); See Table 4.1.
 - 4.2.8.15 MINIMUM LENGTH OF TANGENTS BETWEEN CURVES- Minimum Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.
 - 4.2.8.16 MINIMUM LENGTH OF VERTICAL CURVES. See Table 4.1.
 - 4.2.8.17 STREET GRADES – Minimum grade 1% maximum grade 5%.
 - 4.2.8.18 CURB RADII – See Table 4.1.
- 4.2.9 Rural Secondary (2-Lane)**
- 4.2.9.1 POSTED SPEED LIMIT – between 30 and 40 mph. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.
 - 4.2.9.2 WIDTH – 2-lane width with expansion capability to 4-lanes, including shoulders, plus additional turn lanes.
 - 4.2.9.3 TRAFFIC VOLUMES – Generally between 7,000 and 10,000 vehicles per day when the land in which the roadway serves is fully developed.
 - 4.2.9.4 ACCESS – Direct access to adjacent parcels of land.
 - 4.2.9.5 CONTINUITY – Generally less than 2 miles, generally connecting Rural Primary Roads.
 - 4.2.9.6 TRAFFIC CONTROL – On Rural Secondary provided by traffic control signs.
 - 4.2.9.7 FUNCTION – Rural Secondary Roads collect and distribute traffic between Rural Primary Roads and Rural Local Roads.
 - 4.2.9.8 RIGHT-OF-WAY WIDTH – 76’ minimum (Must be wide enough to accommodate roadside drainage requirements).
 - 4.2.9.9 NUMBER OF MOVING LANES – two to four
 - 4.2.9.10 ACCESS CONDITIONS – Intersections will generally be at grade. Abutting properties and rural local streets will normally be allowed acceptable access to the street.
 - 4.2.9.11 TRAFFIC CHARACTERISTICS – Movement of traffic will be controlled by signage. Parking shall be prohibited.

- 4.2.9.12** PLANNING CHARACTERISTICS – Rural Secondary Roads should be utilized as collector roadways for distribution of Rural Primary Road traffic.
 - 4.2.9.13** STREET WIDTHS – 2-14’ travel lanes; 2-6’ shoulders plus painted median with necessary left turn and acceleration/deceleration lanes and variable width drainage ditch area (40’ Edge of Shoulder – Edge of Shoulder if two lanes).
 - 4.2.9.14** MINIMUM RADIUS OF CURVATURE ON CENTER LINE (HORIZONTAL); See Table 4.1.
 - 4.2.9.15** MINIMUM LENGTH OF TANGENTS BETWEEN CURVES – Minimum Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.
 - 4.2.9.16** MINIMUM LENGTH OF VERTICAL CURVES. See Table 4.1.
 - 4.2.9.17** STREET GRADES – Minimum grade 1% maximum grade 5%.
 - 4.2.9.18** CURB RADII – See Table 4.1.
- 4.2.10** Rural Local (2-Lane)
- 4.2.10.1** POSTED SPEED LIMIT – 30 mph maximum. Posted or prima facie speeds for the various street classifications are normally 5-10 miles per hour less than the design speed of that street.
 - 4.2.10.2** WIDTH – 2-lane width, including shoulders and needed drainage swales.
 - 4.2.10.3** TRAFFIC VOLUMES – Generally less than 1,500 vehicles per day when the land in which the roadway serves is fully developed.
 - 4.2.10.4** ACCESS – Direct access to adjacent parcels of land.
 - 4.2.10.5** LIMITED CONTINUITY.
 - 4.2.10.6** TRAFFIC CONTROL – On Rural Local provided by traffic signs.
 - 4.2.10.7** FUNCTION – Traffic carried by Rural Local Streets should have an origin or destination within the neighborhood.
 - 4.2.10.8** RIGHT-OF-WAY WIDTH – 50’ minimum (Must be wide enough to accommodate roadside drainage requirements).
 - 4.2.10.9** NUMBER OF MOVING LANES – two.
 - 4.2.10.10** ACCESS CONDITIONS – Intersections will generally be at grade. Abutting properties shall normally be allowed acceptable access to the street.
 - 4.2.10.11** TRAFFIC CHARACTERISTICS – Movement of traffic will be controlled by traffic control signs. Parking shall be prohibited.
 - 4.2.10.12** PLANNING CHARACTERISTICS – Rural Local Roads should be designed to discourage through traffic. Access to rural primary roads is discouraged.
 - 4.2.10.13** STREET WIDTHS – 2-14’ travel lanes; 2-6’ shoulders plus variable width drainage ditch area (40’ flowline – flowline).
 - 4.2.10.14** MINIMUM RADIUS OF CURVATURE ON CENTER LINE

(HORIZONTAL); See Table 4.1.

4.2.10.15 MINIMUM LENGTH OF TANGENTS BETWEEN CURVES- Minimum Tangent length shall be equal to or greater than the sum of the Superelevation Runoff Length and the Tangent Runout Length.

4.2.10.16 MINIMUM LENGTH OF VERTICAL CURVES. See Table 4.1.

4.2.10.17 STREET GRADES – Minimum grade 1% maximum grade 5%.

4.2.10.18 CURB RADII – See Table 4.1.

4.2.11 Roadway Specifications

Table 4.1 shows a summary of the minimum roadway construction requirements and other related information.

Table 4.1 Roadway Construction Standards - Urban

	Local	Collector		Arterial		Urban Expressway
		Minor	Major	Minor	Major	
Design Speed (mph)	35	45	50	55	60	60
Posted Speed (mph)	30 max.	30 to 40	35 to 45	35 to 50	40 to 55	45 to 55
Traffic Volume (Vehicles per Day)	< 1,500	7,000	7,000 to 12,000	12,000 to 30,000	12,000 to 45,000	>45,000
Minimum ROW (feet)	50 Single family (SF) 60 Multi family (MF)	76	88	114	144	168
Travel Through Lanes	2	2	4	4	6	8
Sidewalk (feet)	5 attached (SF) or 5 detached (MF)	6 to 8 Detached	6 to 8 Detached	8 detached	10 detached	10 detached
Curb and Gutter	Mountable curb & Vertical & high speed Type 2 (SF), Vertical or High Speed Type 2 (MF)	Vertical or high Speed Type 2	Vertical or high Speed Type 2	Vertical or high Speed Type 2	Vertical or high Speed Type 2	Vertical or high Speed Type 2
Median	N/A	N/A	Painted median	Painted or Raised median	Raised median	Raised median
Street Sections	Roadway Cross Section					
Horizontal Design Criteria						
Curb Return Minimum Radii (feet)						
- Intersect Arterial	Not Permitted	40	40	50	50	
- Intersect Collector	30	40	40	40	40	
- Intersect Local	20	30	30	Not Permitted	Not Permitted	
Minimum Radius of Curve at Centerline per AASHTO (feet)	371	711	926	1190	1500	1500
Minimum Tangent Length (ft) Between Reverse Curves	Superelevation runoff length + tangent runout length, AASHTO Chapter 3					
Vertical Design Criteria						
Minimum K-Value* Crest	29	61	84	114	151	151

Minimum K-value* Sag	49	79	96	115	136	136
Min. VCL Crest (feet)	50	70	70	110	150	150
Min. VCL Sag (feet)	50	80	80	90	100	100
Maximum Grade of Intersection						
- Intersect Arterial	N/A	3%	3%	2%	2%	
- Intersect Collector	4%	3%	3%	3%	3%	
- Intersect Local	4%	4%	4%	N/A	N/A	
Min. - Max. Street Gradient	1% to 5%	1% to 5%	1% to 5%	1% to 5%	1% to 5%	1% to 5%

* K-Values exceeding 125 on curbed streets should be checked for drainage.

Table 4.1 Roadway Construction Standards

	Rural Local	Rural Secondary	Rural Arterial
Design Speed (mph)	35	45	60
Posted Speed (mph)	30 max.	30 to 40	40 to 55
Traffic Volume (Vehicles per Day)	<1,500	7,000 to 10,000	10,000 to 20,000
Minimum ROW (feet)	50	76	76
Travel Through Lanes	2	2 to 4	4
Median	N/A	Painted median	Painted median
Street Sections	Roadway Cross Section		
Horizontal Design Criteria			
Curb Return Minimum Radii (feet)			
- Intersect Arterial	Not Permitted	40	50
- Intersect Collector	30	40	40
- Intersect Local	20	30	Not Permitted
Minimum Radius of Curve at Centerline per AASHTO (feet)	371	711	1500
Minimum Tangent Length (ft) Between Reverse Curves	Superelevation runoff length + tangent runout length, AASHTO Chapter 3		
Vertical Design Criteria			
Minimum K-Value Crest	29	61	151
Minimum K-value Sag	49	79	136
Min. VCL Crest (feet)	50	70	150
Min. VCL Sag (feet)	50	80	100
Maximum Grade of Intersection			
- Intersect Rural Arterial	N/A	3%	2%
- Intersect Rural Secondary	4%	3%	3%
- Intersect Rural Local	4%	4%	N/A
Min. - Max. Street Gradient	1% to 5%	1% to 5%	1% to 5%

4.3 SIDEWALKS, CURB/GUTTER, AND DRIVEWAYS

- 4.3.1** Roadway typical sections shall be as specified by these Standards. Details are located in Appendix A of these Standards.
- 4.3.2** Sidewalks or bicycle paths shall be constructed on both sides of all urban roadways unless specifically deleted by action of the Board of County Commissioners.
- 4.3.3** All sidewalks used in conjunction with vertical or high-speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards) curb and gutter shall have a minimum width of five feet.
- 4.3.4** Combination curb, gutter and walk is approved for use on local roadways only. Vertical or high-speed Type 2 (Sections IM and IIM as defined by CDOT M & S Standards) curb, gutter and detached walk shall be used on all other roadways.
- 4.3.5** State law requires that pedestrian curb ramps be installed at all intersections and at certain mid-block locations for all new construction or reconstruction of curb and sidewalks. (CRS 43-2-107 {2}). Pedestrian curb ramps shall be constructed in accordance with the current Arapahoe County Curb Details in Appendix A. Pedestrian curb ramps may be shown at all curb returns or called out by a general note on the development plans but must be shown (located) at all “T” intersections. Whenever referencing a pedestrian curb ramp call out the specific Arapahoe County Curb Details in Appendix A to be used to construct that ramp. Diagonal or apex style curb ramps are not allowed on Local-To-Collector Roads. Apex Ramps and Diagonal Ramps may be installed on local-to-local Roads for new construction or by variance request through Arapahoe County Public Works and Development.
- 4.3.6** Curb cuts are allowed for commercial/industrial or high-volume residential driveways. In general, when the number of parking spaces serviced by the driveway exceeds ten (10), radius returns are required (See Table 4.2 for flowline radius).
- 4.3.7** Where curb cuts are allowed based on traffic considerations, concentrated storm water runoff must not be discharged across the sidewalk. The Design Engineer is responsible for determining acceptable alternatives to convey flows. Sidewalk Chases will be strongly discouraged in new developments and will only be permitted as a Final Alternative (See Section 4.4.6). If this is not possible due to grading restraints, radius returns and a crossspan must be used.
- 4.3.8** Curb cuts and driveways shall be constructed in accordance with the current Colorado Department of Transportation M Standards.

4.4 DRAINAGE

The minor and major storm drainage systems are designed in accordance with the Arapahoe County Stormwater Management Manual (Manual). Because safe and efficient conveyance of traffic is the primary function of roadways, the storm drainage function of the roadway (such as allowable gutter capacity and street overtopping) will be designed to the limits set forth in the Manual. In the case of conflict caused by requirements of the Manual, drainage requirements shall govern.

- 4.4.1** Crossspans shall be constructed in accordance with the Arapahoe County Standard Details (SP-7, in Appendix A). Crossspans are not permitted across collector or arterial roadways, nor are they allowed on roadways with storm sewer systems. Crossspans shall be a minimum of 8-feet wide, additional width may be required to accommodate drainage flows.

Double Crossspans (Crossspan on both sides of major roadway running parallel to one another) may be used parallel to collector or arterial roadways to convey storm runoff across residential roadways. The use of double Crossspans elsewhere, or the use of any Crossspan on roadways where the vertical grade exceeds four and one-half (4.5) percent at the Crossspan will be considered only after all other alternatives have been exhausted.

Careful considerations shall be given for the locations of Crossspans relative to curb ramps. Crossspans should not be considered part of the accessible route and may not encroach on crosswalks.

- 4.4.2** Inlets shall be located to intercept excess street runoff and convey it into a storm drainage system, therefore reducing or eliminating surface flooding. Refer to Chapters 7 & 9 in the Manual for Street Drainage and Storm Sewers. In general, inlets are placed at all low points (sumps), median breaks, intersections, and along continuous grade curb and gutter. Due to the presence of pedestrian curb ramps, inlets are not allowed in the curb return, but can be located at the tangent points of the curb returns.

4.4.3 Cross Slope

Except at intersections, or where superelevation is required, roadways shall be level from top of curb to top of curb (or flowline to flowline) and shall have a two (2) percent crown. At or within 150' of an intersection, the maximum elevation difference between flowlines is that dictated by the allowable intersection grade and the actual distance between flowlines.

4.4.3.1 Parabolic or curved crowns are not allowed. In no case shall the pavement cross slope at warped intersections exceed the grade of the through street.

4.4.3.2 The rate of change in pavement cross slope, when warping side streets at intersections, shall not exceed one (1) percent every twenty-five (25) feet horizontally on a local roadway, one (1) percent every thirty-seven and one-half (37.5) feet horizontally on a collector roadway, or one (1) percent every fifty-six and one-half (56.5) feet horizontally on arterial roadways. See Section 4.6.6 of these standards.

- 4.4.4** GESC Construction Control Measures are required along and at the ends of all roadways that are not completed due to project phasing, subdivision boundaries, etc., in accordance with the Arapahoe County Grading, Erosion and Sediment Control (GESC) Manual and other applicable Regulations and Standards adopted by Public Works and Development.

- 4.4.5** Permanent Control Measures are required for all new site development as well as redevelopment. All Permanent Control Measures shall be performed in accordance with the Stormwater Management Manual and applicable Regulations and Standards adopted by Public Works and Development

4.4.6 Sidewalk Chases

Where curb cuts are allowed based on traffic considerations, concentrated storm water runoff must not be discharged across the sidewalk. The Design Engineer is responsible for determining acceptable alternatives to convey flows. Sidewalk Chases will be strongly discouraged in new developments and will only be permitted as a Final Alternative through the variance process (See Section 3.4). If this is not possible due to grading restraints, radius returns and a crossspan must be used. In the event a chase section is approved, the chase sections shall not be located within the curb cut or driveway. A hydraulic design shall be in required in accordance with the Manual.

Approved Sidewalk chase sections are to be constructed in accordance with the Arapahoe County Standard Details found in Appendix A of these Standards.

4.5 HORIZONTAL DESIGN

The following criteria for roadway design outline the minimum requirements; however, exceeding the minimum design criteria should be considered.

4.5.1 Horizontal Curves - See Table 4.1 for requirements.

4.5.2 Curb Return Radius - Minimum return radius shall be shown in Table 4.2 below.

Table 4.2 Curb Return Radii (Measured Along Flowline)

Through Street	Intersection Streets		
	Arterial	Collector	Local
Arterial	50'	40'	Not Permitted
Collector	40'	40'	30'*
Local	Not Permitted	30'	20'*

* No parking is allowed within 30-feet of PCR on approaches to all controlled intersections. All other approaches and departures shall have no parking or driveway access within 20-feet of the PCR.

4.5.3 Roadway End Terminus - Whenever roadways terminate due to project phasing, subdivision boundaries, etc., barricades are required. Design and construction shall comply with the requirements of the Manual of Uniform Traffic Control Devices most recent edition. Details shall be shown on the construction drawings, and installation shall be provided by the developer.

4.5.4 Superelevation is required for curves on all roadway classifications of arterial designation or higher and for selected collector roadways that will require superelevation to function properly. Horizontal curve radius and superelevation shall be in accordance with the requirements

detailed within this manual and on the recommendations of the AASHTO “Green Book”.

The use of Superelevation shall be avoided on all roadways with a design speed of 40 mph or less. If superelevation cannot be avoided on a roadway with a design speed of 40 mph or less, all design criteria within these standards and recommendations of the AASHTO “Green Book” shall apply.

- 4.5.5** Reverse Curves - Abrupt reversing curves should be avoided. In cases of reversing curves, a sufficient tangent length between the curves shall be provided. Its length shall accommodate both the required superelevation runoff and tangent runoff.
- 4.5.6** Spiral and compound curves shall be used only on arterial roadways within Arapahoe County (State Highways excluded) and only upon written approval of the Director, Public Works and Development. With approval from the Director, spiral curves shall be designed in accordance with the AASHTO “Green Book”. (Chapter 3 in AASHTO “Green Book” 2018).
- 4.5.7** Cul-de-sacs

The following criteria shall be used for cul-de-sac horizontal geometry.

Minimum property line radius	45’
Minimum Flowline radius	38’
Maximum length of cul-de-sac (measured along & between the radius point, and the ROW line of the abutting street)	500’ length or a maximum of 15 residential dwelling units, whichever is greater.

Longer distances and/or increased number of dwelling units may be permitted with approval from the affected Fire Protection District and the Director of the Department.

4.5.8 Alley

The following criteria shall be used for Alley Design.

- Alleys provide access to the side or rear of individual land parcels. They are characterized by a narrow right of way with width of 20-foot in residential areas.
- Alleys shall be placed in a tract of common ownership (typically a Homeowner’s Association for residential property). The tract owner must demonstrate that perpetual maintenance of the private alleys can be provided for by implementation of a viable maintenance plan.
- Curb return radii at the intersections should be a minimum of 5-foot in residential areas. The longitudinal grade should not be less than 1%.
- Dead-end alleys should include a turning area in accordance with Chapter 5 AASHTO “Green Book”.
- Where the only fire access to a residential use is from a dead-end alley, the length of the alley shall not exceed 150 feet without providing a fire truck turn-around.

4.5.9 Sight Distances

The major considerations in alignment design are safety, grade, profile, road area, design speed, sight distance, topography, drainage, and performance of heavy-duty vehicles.

Alignment should provide for safe and continuous operation at a uniform design speed. Road layout shall bear a logical relationship to existing or platted roads in adjacent properties. The sight distance is needed for stopping, which are applicable on all roadways; and is needed for the passing of overtaken vehicles, applicable only on two-lane roadways.

4.5.9.1 Stopping -Sight Distance. The minimum stopping sight distance is the distance required by the driver of a vehicle traveling at the design speed to bring the vehicle to a stop after an object on the road becomes visible. Stopping sight distance shall be considered and applied in accordance with the recommendations of the AASHTO “Green Book”, Chapter 3.

4.5.9.2 Passing Sight Distance. Passing sight distance is the minimum sight distance that must be available to enable the driver of one vehicle to pass another safely and comfortably without interfering with oncoming traffic traveling at the design speed. Two-lane roads should provide adequate passing zones. Required passing sight distance for given design speeds are given in Table 4.3.

Table 4.3 Stopping and Passing Distance

Design Speed (mph)	Stopping Sight Distance (ft)	Passing Sight Distance (ft)
25	155	450
30	200	500
35	250	550
40	305	600
45	360	700
50	425	800
55	495	900
60	570	1000

4.5.9.3 Intersection and Driveway Sight Distances

Sight Triangle – There shall be an unobstructed line of sight along both sides of all stopped approaches at an intersection within the Right-of-Way to provide the entering vehicle adequate sight distance to enter or cross the roadway. The sight triangle relationship developed for use in Arapahoe County is based upon the dimensions shown in detail SP-26 in Appendix A.

Any object within the sight triangle more than thirty-six (36) inches above the elevation of the adjacent roadway shall constitute a sight obstruction and shall be removed or lowered. Such objects include but not limit to: buildings, cut slopes, wall, fence, sign, hedges, trees, bushes, utility cabinets or tall crops. This design criteria also requires the elimination of parking within the sight triangle and applies whether the intersecting roads are level or on grades. Exceptions to this requirement exist for public facilities such as fire hydrants, utility poles, and traffic control devices. These facilities must be located to minimize visual obstruction and are subject to County approval.

Two types of sight triangles are considered in the intersection design – approach sight triangles and departure sight triangles. The evaluation of the sight triangles at an intersection shall be considered and applied in accordance with the recommendations of the AASHTO “Green Book”, Chapter 9.

All sight-distance triangles must be shown on the street plan/profile and landscape plans.

4.6 VERTICAL DESIGN

4.6.1 Permissible Roadway Grades - The minimum allowable grade for roadways or alleys is one (1) percent. The minimum allowable grade for knuckles and cul-de-sacs is one (1) percent. The **maximum** allowable grade for any roadway is shown in Table 4.1 of these Standards. In areas where a one percent slope is difficult to obtain a variance to this criteria may be granted if deemed appropriate by Staff.

4.6.2 Permissible Intersection Grades (Public Right-of-Way) - The maximum permissible centerline grade at intersections will be four (4%) percent for local roadways intersecting any roadway, three (3%) percent for collector/collector or collector/arterial intersections and two (2%) percent for all arterial/arterial intersections. These grades are maximum instantaneous flowline grades for the stated distances (each side of street) of the minor (intersecting) street (See Detail SP-25 in Appendix A). Desirable intersection grades should be in the range of one (1%) to three (3%) percent for all intersecting streets with the limit of two (2%) percent for arterial.

Table 4.4 Maximum Grades at Intersection

Intersection	Local	Collector	Arterial
Local	4%	4%	N/A
Collector	4%	3%	3%
Arterial	N/A	3%	2%

Roadways intersecting with pedestrian crossings need to account for adequate cross slopes within designated crosswalk areas in accordance with PROWAG and Table 4.5.

Table 4.5 Grades at Pedestrian Street Crossing

Description	Maximum Grade
Intersection With Yield or Stop Control	2.00%
Intersection Without Yield or Stop Control*	5.00%
Mid-Block Pedestrian Crossing	Equal to Street Grade
* Pedestrian street crossings without yield or stop control are crossings where there is no yield or stop sign, or where there is a traffic signal that is designed for the green phase. At pedestrian street crossings without yield or stop control vehicles can proceed through the intersection without slowing or stopping.	

- 4.6.3** Changing Grades at Curb Return - The maximum grade break allowed at the point of tangency at a curb return for local and collector roads shall be two (2) percent and for arterial roadways a maximum of one (1) percent.
- 4.6.4** Cross Fall - Except at intersections, or where superelevation is required, roadways shall be level from top of curb to top of curb (or flowline to flowline). The distance from intersections with which cross fall will be permitted shall be determined by criteria in Section 4.4.3, Cross-Slope.
- 4.6.5** Vertical Curves - When the algebraic difference in grade (A) is at or exceeds 0.005ft/ft (0.5%) and 0.008ft/ft (0.8%) at intersection, a vertical curve shall be used. Design criteria for vertical curves is found in Table 4.1 of these standards. The minimum gradient into and out of a sag (sump) vertical curve is 1% Minimum length of a vertical curve is shown in Table 4.1 of these standards. All vertical curves shall be labeled, in the profile, with length of curve (L) and K (=L/A) values.

4.6.6 Intersections - In addition, the following criteria shall apply at intersections.

- The grade of the “through” street shall take precedence at intersections. At intersections of roadways with the same classification, the more important roadway, as determined by the Arapahoe County Engineering Division, shall have this precedence. The design should warp side streets to match through streets with as short a transition as possible. See below.
- The key criteria for determining the elevation of the curb return on the side street and the amount of warp needed on a side street transitioning to a through street are:
 - Permissible grade in the stop/start lane. (See Section 4.6.2 of these Standards).
 - Pavement cross slope at the P.C.R.’s on the side street and permissible warp in pavement cross slope. (See Section 4.4.3 of these Standards).
 - Normal vertical curve criteria. (See Section 4.6.5 of these Standards).
 - Vertical controls within the curb return itself. (See Section 4.6.8 of these Standards).
 - Cross slope of pedestrian crosswalks.
 - Drainage considerations.
- The elevation at the PCR of the curb return on the through street is always set by the grade of the through street in conjunction with normal pavement cross slope allowances.
- Carrying the crown at a side street into the through street is permitted only when drainage considerations warrant such a design. Refer to Section 4.4.3.2 for street cross slope allowances.
- Dipping the flowline to the extent that the lip of gutter is dipped is not permitted, except as specified by Arapahoe County Standards Details concerning curb opening inlets. Tipping an inlet for the benefit of drainage is also not permitted.
- A more detailed review shall be performed for arterial-arterial intersections to maximize drivability. A few arterial intersections will have a uniform 2% cross slope, the majority of them having one or more sides warped. (See Sections 4.4.3 and 4.6.6 of these standards for rates of pavement warp allowed). A Plan View drawing of all arterial/arterial intersections will be required showing spot elevations on a 10-foot by 10-foot grid.
- Whenever possible, intersections shall be made at right angles or radial to a curve. No intersecting angle of less than seventy-five (75) degrees will be allowed.

4.6.7 Curb Returns - Minimum fall around curb returns for flow along the curb line shall be as follows:

Table 4.6 Minimum Curb Return Fall

Radius (ft)	Minimum Fall (ft)
20	0.4
30	0.6
40	0.8
50	1.0
All others	1.27% around the Curb Return or from the High/Low Point to the PCR

- 4.6.8** Curb return profiles are required for all curb return radii equal to or greater than 30' within the public right-of-way. A midpoint elevation along the arc length of the curb return shall be shown for all curb return radii. All curb return profiles must assure positive drainage.

Curb return design shall be set in accordance with the following design procedure. Curb Return Profiles shall be extended 25' from PCR in each direction to ensure adequate design with impacted roadways. General standards for flowline control and profiles within the curb returns shall be as follows:

- The point of tangency at each curb return shall be determined by the projected tangent grade beginning at the point of intersections (PI) of the flowlines.
- The arc length and external distance of the curb return shall be computed and indicated on the drawing.
- Show the corresponding flowline (or top of curb) grade for 25' on each roadway beyond the PCR.
- Design the flowline of the curb return such that a maximum cross slope between the midpoint of the curve and the PI (tangent intersect) does not exceed +5 percent. Grade breaks at the PCR's will not exceed two (2) percent for local and collector streets and one (1) percent for arterial. The flowline design of the curb return will be accomplished within the return without affecting street grades beyond the PCR. Maximum vertical curves will equal the arc length of the curb return. The elevation and location of the high or low point within the return, if applicable, is to be called out in the profile.
- Scale for the curb return profile shall match the plan and profile scale the curb return is shown on. The scale shall not exceed 1" = 50' horizontally and 1" = 5' vertically.

4.6.9 Connection With Existing Roadways

- Connection with existing roadways shall be smooth transitions conforming to normal vertical curve criteria (see Section 4.6 of these Standards) if the algebraic difference in grade (A) between the existing and proposed grade exceeds 0.005 ft/ft (0.5%) and 0.008 ft/ft (0.8%) at intersection. When a vertical curve is used to make this transition, it shall be fully accomplished prior to the connection with the existing improvement, and also comply with the grade requirements at intersection approaches.
- Existing grade shall be shown for at least three hundred (300) feet with field verified as-built plans showing stations and elevations at twenty-five (25) foot intervals. In the case of connection with an existing intersection, these as-builts are to be shown within a three-hundred (300) foot radius of the intersection. This information will be included in the plan and profile that shows that proposed roadway.
 - Previously approved designs are not acceptable means of establishing existing grades. However, they are to be referenced on the construction plans, where they occur.
 - The basis of the as-built elevations shall be the same as the design elevation (both flowline or both top of curb, etc.) when possible.

4.7 ROADSIDE DESIGN AND CLEAR ZONE

Roadside design requirements apply to all non-traversable terrain and obstacles in the public ROW, the location of which are not critical for transportation safety reasons. Roadside design principles should also be applied by adjacent private property owners to areas outside of ROW that exist within the Clear Zone. Examples of typical objects subject to roadside design standards include but are not necessarily limited to:

- traffic sign supports
- roadside cabinets
- utility poles
- street light poles
- wireless access towers
- irrigation equipment
- fire hydrants
- mail boxes
- Landscaping elements such as trees and boulders
- other objects determined by the County Engineer

Clear Zone is used to designate the unobstructed, traversable area provided beyond the edge of the through traveled way that allows a motorist to stop safely or regain control of a vehicle that leaves the traveled way. The clear zone includes shoulders, bicycle lanes, and auxiliary lanes unless the auxiliary lane functions like a through lane. No obstacles shall be located within the clear zone. See the AASHTO Roadside Design Guide, the latest edition for further guidance.

4.8 OFFSITE DESIGN

The design grade, and existing ground at that design grade, of all roadways that dead end due to project phasing, subdivision boundaries, etc., shall be continued, in the same plan and profile as the proposed design, for at least five hundred (500) feet or to its intersection with an arterial roadway as determined by County Engineering Division Staff. This limit shall be extended to one thousand (1,000) feet when arterial roadways are being designed.

4.8.1 If the offsite roadway, adjacent to the proposed development is not fully improved, the developer is responsible for the design and construction of a transition for the safe conveyance of traffic from their improved section to the existing roadway. The following ratios shall be applied to the taper of lane change necessary for this transition:

	Redirect Taper Ratios								
Posted Speed	30 or	35	40	45	50	55	60	65	70
Taper Ratio	15:1	20:1	30:1	45:1	50:1	55:1	60:1	65:1	70:1

4.8.2 The County Engineering Division Staff should be contacted to establish unusual criteria. This contact is the responsibility of the applicant.

4.9 ACCELERATION AND DECELERATION LANES

The design of street systems depends on the proper control of access to developments. The location and design of access points must minimize traffic hazards and interference to through traffic movements. The need for acceleration or deceleration lanes at site accesses and affected street intersections shall be evaluated based on “State of Colorado State Highway Access Code Volume 2” criteria. The Traffic Impact Study shall identify auxiliary lane improvements.

The access classification should be determined by utilizing the Arapahoe County Transportation Plan roadway designations and then determining the corresponding access classifications. The table below lists the Access Classification for roadways:

Table 4.7 Roadway Classification

Roadway Type	Roadway Classification
Minor Collector	NR-C
Major Collector	NR-C
Minor Arterial	NR-B
Major Arterial	NR-B
Urban Expressway	NR-A
From State of Colorado State Highway Access Code Volume 2, Code of Colorado Regulations 601-1	

4.10 BUS PULLOUT LANES

If recommended by the Regional Transportation District (RTD), bus pullout lanes shall be designed and construction to RTD’s standards. Bus pullout lanes shall be constructed using Portland Cement Concrete using the methodologies described in the MGPEC Pavement Design Standards and Construction Specifications.

4.11 PRIVATE ROAD CRITERIA

The following minimum requirements shall apply to all applications for private roadways.

4.11.1 Definition - Private Road is defined as any roadway, serving two or more residential lots, which will not be maintained by Arapahoe County.

- 4.11.2** County Policy - All roadways shall be built to Arapahoe County public roadway standards. If an Owner / Developer wishes to not build the roadways to County public roadway standards and/or not containing adequate rights-of-way, the Owner / Developer shall submit Private Roadway for review by the County. Although the Private Roadway are acceptable to the County, these roadways shall not be maintained or assumed for ownership and maintenance by the County unless they are brought to County public roadway standards at the Owner / Developer's expense.
- 4.11.3** Use of a Private Roadway - Private Roadway use in subdivision design should follow as present below:
- Common Ownership of the Private Roadway shall be established and the roadway serves as access only to those within the common ownership.
 - Financial Participation from a common ownership can be demonstrated to provide perpetual maintenance of the Private Roadway.
 - The roadway does not interrupt or prelude continuity of present or planned Public Roadway connections.
 - The Roadway carries less than 1,500 vehicles per day
- 4.11.4** Placement - Private Roadways shall be placed in a tract of common ownership (typically a Homeowner's Association for residential property). The roadway tract must contain all appurtenances to the private roadway, including but not limited to; curb, gutter, sidewalk, and associated drainage facilities. Requests for placing detached sidewalk in an easement instead of a tract will be considered on a case-by-case basis.
- 4.11.5** Maintenance - The roadway tract owner must demonstrate that perpetual maintenance of the private roadway can be provided for by implementation of a viable maintenance plan (as described in 4.11.4.3) Submittal Requirements
- 4.11.6** Submittal Requirements
- Pavement Design - Private Roadways must meet the same standards for pavement structural section as a public street in an area of comparable density and traffic volume per Chapter 5 of this Manual and the MGPEG standards.
 - Cost Estimate - Private Roadways, sidewalks, and roadway appurtenances costs shall be included as a necessary improvement within the Subdivision Improvement Agreement (SIA) and subject to collateral in a form accepted by the County.
 - Maintenance Plan/Life Cycle Cost Analysis - Proposals for Private Roadways shall include a plan for perpetual maintenance of the roadway. This plan shall be prepared and certified by a Colorado Licensed Professional Engineer, and shall contain:
 - A life cycle cost analysis with a minimum design life of 20-years and utilizing a 4% rate to account for annual inflation and construction cost increases.
 - Estimated current costs of proposed roadway, curb, gutter and sidewalk construction (installed).
 - Schedule and cost of major maintenance events as chip or fog sealing, resurfacing, etc.
 - Cost of annual and routine maintenance such as crack sealing, pothole repair, etc.
 - Projected future value cost of replacement at the end of the design life.

- If restricted parking sections are proposed, include a plan for no parking enforcement and an estimate for annual enforcement costs.
 - Identify the proposed method of implementation of a funding mechanism for plan (i.e. HOA fees, fees with property sales deposited to escrow, district formation and taxation, etc.).
 - If fees are the selected funding mechanism in G) above, provide an estimated monthly cost, per developed unit, calculated to demonstrate adequate funding to provide perpetual maintenance of the roadway. If district formation is selected, provide a copy of the district service plan and letter of intent to form said district.
 - Certification and statement by a Colorado Licensed Professional Civil Engineer indicating that the report was prepared by, or under direct supervision of said licensed professional.
 - Certification and Statement of owner of intent to implement the plan as a mechanism for perpetual maintenance of roadway.
- Intersections
 - Private intersections with other private roads may require an increase in the roadway pavement width at the approach to accommodate storage, additional language and provide for proper roadway alignment.
 - Private intersections with public roads: Private roads shall meet all public roadway standards at the intersection. Transitions of pavement width and transition distance will be reviewed on a case-by-case basis.
- Private Roadway Attributes – Urban Areas

Pavement widths will vary with the amount of on-street parking proposed. Intersections, drainage crossings or special conditions may require additional pavement width, as determined on a case-by-case basis.

 - No on-street parking - Option is not allowed.
 - Parking One Side (See Appendix for cross section)
 - A 26-foot minimum paved section (two 10-foot drive lanes plus 6-foot parking lane).
 - Approval of the local fire jurisdiction.
 - Posting of one side roadway “NO PARKING”.
 - Enforcement of “NO PARKING” areas by tract owner, by development plan notes, HOA Covenants, etc.
 - On-street Parking shall be adjacent to sidewalk.
 - Parking Both Sides (See Appendix for cross section)
 - A minimum 30-foot paved section (equivalent to Public Local Roadway Section).
 - Private Roadway Attributes – Rural Areas (See Appendix for cross section)
 - A 20-foot minimum paved section (two 10-foot driving lanes).
 - Approval of the local fire district.
 - Posting of Roadway “NO PARKING”.
 - Enforcement of “NO PARKING” by tract owner, development plans, HOA covenants, etc.
 - Curb and gutter not required if determined a rural area by County Staff.
 - A 6-foot gravel shoulder on each side of roadway, consisting of a minimum 6-inch deep aggregate base course.

- A roadside ditch of sufficient drainage capacity (3:1 max side slopes).
- Culverts are required at all driveways (minimum 18-inch CMP but must meet capacity requirements of Arapahoe County Stormwater Management Manual for roadway overtopping).
- Rural areas are not required to place sidewalk but may be required to provide continuity of trail systems and/or pedestrian paths.
- Required signage on all private roadways, privately maintained roadways:
 - will be posted “PRIVATE DRIVE – This road is owned and maintained by Name of Owner of HOA”
 - shall include signage and striping consistent with the Manual on Uniform Traffic Control Devices (MUTCD) latest Edition
- Horizontal and Vertical Geometric Design - All roadway design criteria for both horizontal and vertical geometrics shall conform to the standards detailed for public roadways in this manual.

4.12 RURAL ROADWAY CRITERIA

4.12.1 Drainage

- All rural roadways shall convey storm water flows via roadside ditch (maximum 3:1) side slopes to predetermined roadway drainage crossings.
- Roadway drainage crossings shall consist of reinforced concrete pipe (18” minimum), reinforced concrete box culverts or bridges.
- Access driveways shall convey storm water flows utilizing culverts (18” minimum CMP).

4.12.2 Acceleration and deceleration requirements shall conform to Section 4.9 of this manual.

CHAPTER 5 PAVEMENT DESIGN AND TECHNICAL CRITERIA

5.1 GENERAL

- 5.1.1** This chapter provides the basic criteria and design procedures for roadway pavements. Recommended design methodologies for asphalt and Portland Cement Concrete are addressed and essentially follow the **Metropolitan Government Pavement Engineering Council (MGPEC) “Pavement Design Standards and Construction Specifications” (Most recent revision), hereafter called MGPEC Standards.**
- 5.1.2** The MGPEC Standards shall pertain to all roadway related public improvements including but not limited to new roadways, auxiliary lanes, curb and gutter, sidewalks and medians. Any roadway construction related improvements shall require a Pavement Design Report as detailed in the following section. In an effort to ensure the integrity of all pavement sections, auxiliary lanes shall be designed using the same parameters as the through lanes.

5.2 PAVEMENT DESIGN REPORT SUBMITTAL OPTIONS

There are two acceptable submittal options for Pavement Design Reports related to the -Construction DRAWINGS as referenced by MGPEC:

1. The Preliminary Pavement Design may be completed concurrent with the Final Construction DRAWINGS, with the pavement section dimensions and pavement material and construction specifications included in the - Construction DRAWINGS submittal. A Design Confirmation Report shall be submitted, to confirm the assumptions regarding soil type, expansion or settlement potential, moisture content, density and other engineering properties, prior to issuance of applicable permits.
2. The Final Pavement Design Report may be completed after County approval of the associated Construction DRAWINGS but prior to issuance of paving permits.

- 5.2.1** The Preliminary Design Report shall be prepared per the requirements in the MGPEC Standards, section 1.4.
- 5.2.2** The Design Confirmation Report shall be prepared per the requirements detailed in the MGPEC Standards, Section 1.6.
- 5.2.3** The Final Design Report shall be prepared per the requirements detailed in the MGPEC Standards, Section 1.7

5.3 FIELD INVESTIGATION

- 5.3.1** Preliminary Design and Final Design Reports - Field Investigation for the Preliminary and Final Design Reports shall conform to the MGPEC Standards, Section 2.1

- 5.3.2 Design Confirmation Report - To confirm the assumptions made in the Preliminary Design Report the Design Confirmation Report shall conform to the Field investigation requirements set forth in the MGPEC Standards, Section 2.2.

5.4 LABORATORY TESTING

5.4.1 Preliminary Design Report and Final Design Report

- 5.4.1.1 Soil Classification - Soils shall be classified per the MGPEC Standards, Section 3.1

- 5.4.1.2 Swell Tests - Soils shall be tested per the MGPEC Standards, Section 3.1

- 5.4.1.3 Strength Tests - Soils shall be tested per the MGPEC Standards, Section 3.1

- 5.4.1.4 Life Cycle Cost Analysis - Life Cycle Cost Analysis shall be completed per the MGPEC Standards, Section 5.5 for all Private Roadways that will be owned and maintained in common ownership.

- 5.4.2 Design Confirmation Report - Laboratory Testing Requirements are detailed in the MGPEC Standards, Section 2.2, for a Design Confirmation Report.

5.5 DESIGN REQUIREMENTS

The Design, Costs and Maintenance recommendations shall conform to Chapter 5 of the MGPEC Standards.

5.6 REPORT REQUIREMENTS

- 5.6.1 Preliminary Design Report and Final Design Report - The reports shall be inclusive of all requirements set forth in the MGPEC Standards, Section 6.1.

- 5.6.2 Design Confirmation Report - The report shall be inclusive of all requirements set forth in the MGPEC Standards, Section 6.2.

5.7 MATERIAL SPECIFICATIONS

The Specifications presented in this section are performance oriented. The County's objective in setting forth these Specifications is to achieve an acceptable quality of roadway structures. For purposes of these Standards, public improvements include, but may not be limited to, all roadway improvements, sidewalks, curb ramps, curbs and gutters, appurtenant drainage basins or structures, storm sewers and their access ways, other public works within County right-of-way and County mandated stormwater detention structures built on private property and maintained by the property owner.

5.7.1 Use of Materials not listed in Section 5.7.2

Materials listed in this section and provided with a set of specifications are those deemed by the County to be the primary structural materials commonly or typically used in public improvements. Ancillary public improvement materials such as manufactured paints and coatings, bonding agents, sealers, gaskets, insulating materials, etc. should be in compliance with MGPEC, Colorado Department of Transportation material specifications for the appropriate material employed. Alternate materials for construction may be proposed for use except where expressly prohibited by Subdivision Regulations. The Director, Public Works and Development will make decisions on acceptability of alternate materials.

5.7.2 Material Specifications

5.7.2.1 Hot Mix Asphalt Pavement

The material shall consist of a mixture of aggregate, filler (if required) and asphalt cement. The aggregate mixture shall meet the grading requirements of the job mix formula. Tests on the aggregate for cleanliness, abrasion loss and fractured faces shall meet the Aggregate Properties and Gradation ranges allowed by the MGPEC Standards, Appendix Item 20.

- a. Aggregates shall not contain clay balls, organic matter or other deleterious substances.
- b. After the job mix formula is established, all mix furnished for the project shall conform to it within the tolerances allowed per the MGPEC Standards.
- c. Hydrated Lime shall be added to aggregate per the requirements of the MGPEC Standards, -Item 20
- d. A mix design, including the job mix formula, shall be submitted for review and approval a minimum of seven (7) days prior to placing mix on the project. The mix design shall be performed using the standards and procedures detailed in the MGPEC Standards.

5.7.2.2 Portland Cement Concrete Pavement

This material shall consist of a mixture of coarse and fine aggregates, Portland cement, water and other materials or admixtures as required per MGPEC Standards, - Item 30 except as described below.

- a. Portland Cement shall comply with MGPEC Standards, - Item 30 except as described below.

Concrete shall conform to the following requirements:

Min. 28 day Field Compressive Strength	4000 Psi
Min. Cementitious Materials	610 lbs./cu. yd.
Max. Water/Cement Ratio	0.48 lbs H2O/lbs cement
Air Content % Range	5-8
Maximum Slump	4"
Max. Fine Aggregate % of total Aggregate	50%

- b. Fine aggregates shall meet MGPEC Standards aggregate properties and gradation requirements, - MGPEC Standards, Item 30
- c. Coarse aggregates shall meet MGPEC Standards aggregate properties and gradation requirements, MGPEC Standards, Item 30
- d. Fly Ash properties shall comply with MGPEC Standards, Item 30
- e. Water shall comply with MGPEC Standards, Item 30
- f. Admixtures shall comply with MGPEC Standards, Item 30
- g. Curing materials and method of application shall comply with MGPEC Standards, Item 30
- h. Reinforcement materials and method of placement shall comply with MGPEC Standards, Item 30
- i. Minimum laboratory trial mix strength shall comply with the MGPEC Standards, Item 30

5.7.2.3 Aggregate Base Coarse

This material shall consist of hard, durable particles or fragments of stone or gravel, crushed to required sizes, containing an appropriate quantity of sand or other finely divided mineral matter, which conform to the requirements or MGPEC Standards, - Item 13.

Arapahoe County requires all aggregate base coarse material used for public improvements to meet the design properties and gradation requirements detailed in the MGPEC Standards, Item 13 Aggregate Base Course, Section 13.2 Materials.

- 5.7.2.4** Moisture Treatment - Equipment and Moisture Treatment Methods shall comply with MGPEC Standards,- Item 4.
- 5.7.2.5** Stabilized Subgrade - The materials, mix designs and methods of placement for stabilizing the subgrade soils before paving shall comply with MGPEC Standards, Appendix Item 5. For detached sidewalks and landscaped medians the subgrade stabilization shall end at the back of curb. For attached sidewalks and hardscape medians the subgrade stabilization shall extend to back of walk and under the full width of the median respectively.
- 5.7.2.6** Stabilization Fabric - Where required by design, Stabilization Fabric materials and method of placement shall comply with MGPEC Standards, Appendix Item 8.
- 5.7.2.7** Paving Fabric - Where required by design or County recommendation, Paving Fabric Materials and method of placement shall comply with MGPEC Standards, Appendix Item 22
- 5.7.2.8** Concrete Curbs, Gutters and Sidewalks - Materials, Equipment and Methods for Placement shall comply with MGPEC Standards, Appendix Item 31

5.8 SUBGRADE INVESTIGATION AND PAVEMENT DESIGN REPORT

The report shall be prepared by or under the supervision of, signed and sealed by a Professional Engineer, registered in the State of Colorado and shall include the following information:

- a. Vicinity Map to locate the investigated area.
- b. Scaled drawings showing the locations of all borings.
- c. Scaled drawings showing the estimated extent of subgrade soil types and ESAL for each roadway.
- d. Pavement design alternatives for each street on a scaled drawing.
- e. Tabular listing of sample designation, sample depth, Group Number, Liquid Limit, Plasticity Index, percent passing the no. 200 sieve, AASHTO Classification, Group Index and soil description.
- f. CBR (R-Value) test results for each soil type used in the design.
- g. All design parameters and input data for MGPEC Design Software (if necessary).
- h. All design calculations.
- i. A discussion regarding potential subgrade soil problems including but not limited to:
 1. Heave or settlement prone soils.
 2. Frost susceptible soils.
 3. Ground water.
 4. Drainage considerations (surface and subsurface).
 5. Cold weather construction (if applicable).
 6. Other factors or properties, which could affect the design, performance and/or life span of the pavement system.
- j. Recommendations to alleviate or mitigate the impact problems discussed in Item i above.

CHAPTER 6 BRIDGES AND MAJOR DRAINAGE STRUCTURES

6.1 GENERAL

The developer/owner/applicant shall be responsible to fund an independent review of the design construction plans and all necessary independent field inspections. The independent review and inspection contractor shall be specified by and shall contract with Arapahoe County and the developer/owner/applicant shall be responsible for all associated costs through Final Acceptance.

6.2 PIPE, CULVERT AND BRIDGE CRITERIA

6.2.1 All culvert pipe, box culverts and bridges which will ultimately be maintained by Arapahoe County shall conform to:

- AASHTO (American Association of State Highway Transportation Officials), “LRFD Bridge Design Specifications, U.S.”, latest edition and applicable interims.
- AASHTO, “LRFD Standard Specifications for Transportation Materials and Methods of Sampling and Testing”, latest edition and applicable interims.
- CDOT (Colorado Department of Transportation), “Standard Specifications for Road and Bridge Construction”, latest edition and Standard Special Provisions and Bridge Specific Project Special Provisions.
- CDOT, “Bridge Manual”, latest edition and Bridge Technical Memorandums.
- CDOT, “Bridge Detail Manual”, latest edition.
- CDOT, “Structural Worksheets”, latest edition.
- CDOT, “Construction Manual”, latest edition.
- CDOT, “Field Testing Manual”, latest edition.

6.2.2 Any structure over a 20 ft. span must be designed to an HL-93 vehicular live loading.

6.2.3 All box culverts and bridges shall have the year of construction permanently indented on the downstream headwall face in legible numbers. The numbers shall be 3” high by 1½” deep in the headwall face.

6.2.4 All box culverts and bridge designs shall be certified by a Colorado registered professional engineer who is competent to perform such designs.

6.2.5 Culvert and bridge waterway opening designs shall conform to the parameters set forth in the Arapahoe County “Drainage Criteria Manual”, latest edition.

6.2.6 If pedestrian facilities are installed adjacent to a structure, the facilities shall meet PROWAG requirements.

6.3 CONCRETE STRUCTURE TESTING AND INSPECTIONS

This section delineates the testing, inspection and related documentation requirements for bridges, cast-in-place box culverts and concrete lined channels.

6.3.1 Plan and Specifications Review

It is the owner/developer’s responsibility to familiarize the materials testing firm with the plans and specifications approved by Arapahoe County prior to any construction.

6.3.2 Structural and Inspection Requirements - General

The contents of this paragraph are provided as a convenient reference only because they are anticipated to be the most frequently used provisions of the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction. This section is not the complete requirements and criteria to be used for testing and inspection.

6.3.2.1 The design structural engineer or their representative, familiar with assumptions inherent in the structural design, shall review the construction in sufficient detail to confirm that the construction is appropriate.

6.3.2.1 Inspection of construction shall be provided, as frequently as necessary to confirm that the construction conforms to the plans and specifications, by qualified technical personnel experienced in the inspection of similar structures. A written log or report of all work shall be furnished to Arapahoe County at or prior to the request for probationary acceptance of the bridge or major drainage structure.

6.3.3 Material Testing Requirements - General

Testing of materials shall conform to the requirements of AASHTO “LRFD Bridge Design Specifications, U.S., Division II, Construction”, latest edition and applicable interims, CDOT, “Construction Manual”, latest edition, and CDOT, “Field Testing Manual”, latest edition.

6.3.4 Foundation Testing and Inspection Requirements

Unstable foundation material shall be removed to a minimum of 2 feet below the finish grade elevation and be replaced with a Class 2 structural backfill material. If there is no suitable Class 2 material available on site, Class 1 structural backfill shall be used, which meets the following gradation requirements:

**TABLE 6.1
CLASS 1 STRUCTURAL BACKFILL**

Sieve Size	Mass Percent Passing Square Mesh Sieves
2”	100
No. 4	30-100
No. 50	10-60
No. 200	5-20

In addition this material shall have a liquid limit not exceeding 35 and a plasticity index of not over six when determined in conformity with AASHTO T 89 and T 90 respectively.

Testing of the foundation will be done at random locations with a minimum depth requirement of one-foot (1') and the minimum moisture and density for the foundation material as required by T 99 or T 180. If Class 2 structural backfill material is used, the minimum moisture shall not be lower than two (2) percentage points under optimum moisture at 95% compaction as determined by AASHTO T 180 modified, tested at random through the depth of the fill.

6.3.5 Inspection of Forms and False work

- The inside surfaces of forms shall be clean of all dirt, mortar and foreign material. Forms, which will later be removed, shall be thoroughly coated with approved form oil prior to use.
- Forms shall be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incidental to the concrete operations, including vibration.
- Unless otherwise specified, forms for exposed surfaces shall be constructed with triangular fillets $\frac{3}{4}$ in. x $\frac{3}{4}$ in. at all exterior corners.
- The contractor shall be responsible for designing and constructing false work, which provides the necessary rigidity, supports the loads imposed, and produces in the finished structure the lines and grades indicated on the plans.
- False work shall not be removed until sufficient concrete compressive strengths have been achieved per the CDOT "Standard Specifications for Road and Bridge Construction", latest edition.

6.3.6 Inspection of Reinforcing Steel

- The material grade and size shall be as specified by the Registered Professional Engineer, licensed in the State of Colorado, on the certified construction drawings.
- Placing and Fastening.
 1. Reinforcing steel shall be clean and free of all foreign material before concrete is placed.
 2. The minimum spacing center to center of parallel bars shall be $2\frac{1}{2}$ times the diameter of the bar. However, the clear distance between the bars shall not be less than $1\frac{1}{2}$ times the maximum size of the coarse aggregate or $1\frac{1}{2}$ inches, whichever is greater.
 3. Bundle bars shall be tied together at not more than 6-foot centers.
 4. All reinforcing shall have a clear coverage of 2 inches, except as shown on the plans. Clear coverage shall be measured from the surface of the concrete to the outside of the reinforcement.
 5. All reinforcement shall be tied at all intersections except where spacing is less than 1 foot in each direction, in which case alternate sections shall be tied.

6. In concrete bridge decks the upper mat of bars shall be tied to the lower mat of bars at 4-foot maximum spacing in each direction. Slab bolsters for the bottom mat and high chairs for the top mat shall be placed at a maximum spacing of 4 feet on centers.
7. Precast concrete blocking or other approved blocking material shall be used to support footing bars and bars in slabs on grade. All other reinforcing steel shall be supported with steel chairs or precast mortar blocks. All chairs coming in contact with forms shall be CRSI Class 1 or Class 2, Type B.
8. Minimum splice lengths are as shown on the plans. Where bars of different size are spliced together, the splice length for the smaller bar will govern.

6.3.7 Concrete Testing and Inspection

6.3.7.1 Materials Specifications

- a. Class B or D concrete shall be used on structure as listed on the following tables.

Table 6.2 Concrete Materials Specifications
Table 6.3 Concrete Aggregate Gradation Table

**TABLE 6.2
CONCRETE MATERIAL SPECIFICATIONS***

Concrete Class	Required 28 Day Field Compressive Strength (psi)	(1) Cement Content Minimum or Range (2) (lbs/cu yd)	Air Content % Range (Total)	Additional Requirements
B	3000	565	5 – 8	(2) (4) (6) (7)
D	4500	615 to 660	5 – 8	(3) (5) (6) (7)

(1) The cement content tolerance of + or – 1% specified in AASHTO M 157 will be allowed.
 (2) Class D concrete may be substituted for Class B.
 (3) Class D concrete requires the use of an approved water reducing admixture.
 (4) Class B Concrete shall be used when Standard Plans specify Class A concrete.
 (5) Bridge deck concrete shall have a maximum water /cement (w/c) ratio of 0.44. In determining the w/c ratio, the cement (c) shall be the sum of the weight of the cement and the weight of the fly ash.
 (6) The slump of the delivered concrete shall not exceed the slump of the approved concrete mix design by more than 1½ inches.
 (7) Superstructure concrete shall be made with ¾ inch nominal sized coarse aggregate: 100% passing the 1 inch sieve and 90% to 100% passing the ¾ inch sieve. All other concrete shall have a nominal

NOTE: Concrete mixtures that do not conform to the above table but are required for special uses will be designed for the purpose intended. These include light weight concrete, colored concrete, lean concrete, grouting mixtures, patching mixtures and concrete that require special cements, pozzolans or aggregates not covered in the Standard Specifications.

*From the CDOT Standard Specifications Section 601.02.

**TABLE 6.3
CONCRETE AGGREGATE GRADATION TABLE**
PERCENTAGES PASSING DESIGNATED SIEVES AND NOMINAL SIZE DESIGNATION**

Sieve Size	Coarse Aggregates (From AASHTO M 43)									Fine Aggregate
	No. 3	No. 4	No. 6	No. 7	No. 8	No. 57	No. 67	No. 357	No. 467	AASHTO M 6
	2" to 1"	1 1/2" to 3/4"	3/4" to 3/8"	1/2" to #4	3/8" to #8	1" to #4	3/4" to #4	2" to #4	1 1/2" to #4	#4 to #100
2 1/2"	100							100		
2"	90-100	100						95-100	100	
1 1/2"	35-70	90-100				100			95-100	
1"	0-15	20-55	100			95-100	100	35-70		
3/4"		0-15	90-100	100			90-100		35-70	
1/2"	0-5		20-55	90-100	100	25-60		10-30		
3/8"		0-5	0-15	40-70	85-100		20-55		10-30	100
#4			0-5	0-15	10-30	0-10	0-10	0-5		95-100
#8				0-5	0-10	0-5	0-5		0-5	
#16					0-5					45-80
#50										10-30
#100										2-10

**From the CDOT Standard Specifications Section 703.

- b. The contractor shall submit design mix proportions, laboratory trial mix and aggregate data, for each class of concrete being placed on the project.
- c. The test data shall show the mix design proportions, of all ingredients including cement, fly ash, aggregate, and additives, plus trial mix data including slump, air content, unit weight, yield, water/cement ratio, and 28 day compressive strength results as trialed under laboratory conditions.
- d. The trial mix proportions must produce 28-day compressive strengths at least 115 percent of the required 28-day field compressive strengths.
- e. The contractor shall have the option of substituting approved fly ash for portland cement, up to a maximum of 20 percent by weight, in any class of concrete shown in Table 6.2, except concrete used for bridge decks shall have a maximum substitution of 10 percent.
- f. For concrete aggregate gradation see table 6.3.
- g. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50° F and not more that 90° F at the time of placement.

6.3.7.2 Testing Frequency and Related Inspections

- a. At least one set of five compressive strength cylinders per 100 cubic yards of concrete or fraction thereof shall be taken from the same concrete delivery truck to provide: 2 cylinders for testing at 7 days and 3 cylinders for testing at 28 days.
- b. Slump, air content, unit weight and mix temperature shall be tested for each

set of compressive strength cylinders. Air content and unit weight shall be tested at each batch until three tests are within the specification. Then the testing frequency shall be reduced to one random test every five batches. The slump shall not exceed the mix design by more than 1½ in.

6.3.7.3 Placement (Inspection)

- a. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.
- b. Concrete shall not be dropped more than 5 feet, unless confined by closed chutes or pipes.
- c. Unless otherwise directed, the concrete shall be consolidated with suitable mechanical vibrators operating within the concrete.

6.3.7.4 Drainage and weep holes shall be installed in the structure at the locations shown on the plans or as ordered and the inlet side shall be surrounded with one cubic foot of filter material as shown on Table 6.4 and placed in a burlap sack, securely tied.

6.3.7.5 Filter material shall consist of free draining sand, gravel, slag or crushed stone and conform to Table 6.4.

**TABLE 6.4
GRADATION SPECIFICATION FOR FILTER MATERIAL*****

Sieve Size	Mass Percent Passing Square Mesh		
	Class A	Class B	Class C
3"	100		
1 ½"		100	
¾"	20-90		100
No. 4	0-20	20-60	60-100
No. 16		10-30	
No. 50		0-10	10-30
No. 100			0-10
No. 200	0-3	0-3	0-3

***From CDOT Specifications Section 703.09

6.3.7.6 Construction joints and expansion joints shall be constructed as shown on the plans and specifications.

6.3.7.7 When curing concrete other than bridge decks when the ambient temperature is below 35° F, the contractor shall maintain the concrete surface temperature above 50° F during the curing period. The minimum curing period shall be five days. Methods of curing are to be in conformance with CDOT specifications. Curing of bridge decks shall follow current CDOT specifications.

6.3.7.8 Finishing of Hardened Concrete Surfaces

- a. All formed surfaces shall be given a Class 1 finish immediately following curing.
- b. Class 5 finish shall be the final finish for the following surfaces:

1. All surfaces of bridge superstructure including undersurfaces of deck overhangs, and vertical faces of curbs, but excluding the top of slab and sidewalk, the undersurfaces between girders, inside vertical surfaces of T girders, and undersurfaces of slab and box girder spans and T girders.
 2. All exposed surfaces of bridge piers including cap and debris wall, abutments, wing walls, and retaining walls. The finish shall extend at least 1 foot below finish ground or low water elevation.
 3. All surfaces of pedestrian undercrossings except floors and surfaces to be covered with earth.
- c. Culvert headwall and wing wall surfaces above ground, where visible from a traveled way, shall receive a Class 2 or Class 5 finish at the contractor's option.

6.3.8 Riprap - Riprap material and placement shall be per the approved plans and specifications and the Arapahoe County "Drainage Criteria Manual".

CHAPTER 7 RECORD DRAWINGS

Throughout this document the term “Record Drawing” shall refer to the as-constructed plan set. Record Drawings shall be submitted to the Engineering Division:

- For all improvements constructed under the terms of a Subdivision Improvement Agreement, and;
- Under all conditions specified by the Planning Commission or Board of County Commissioners in approving any land use charges, and;
- Under all terms of a service plan and approved construction drawings for a Metropolitan Improvement District.

A copy of the Record Drawing, signed and sealed by the- Professional Engineer, registered in the State of Colorado, shall accompany the request for Probationary Acceptance of the constructed public improvements. See section 9.12 for the probationary acceptance process.

Record Drawings shall be provided as digital files per Section 7.3 of this Chapter.

7.1 COMPLETENESS

Substantial Compliance Accuracy of the Record Drawings is as follows:

- The Professional Engineer, registered in the State of Colorado, who is responsible for the project, shall submit an Engineer’s Statement of Substantial Compliance (see Figure 7.1) prior to issuance of Probationary Acceptance and reduction of collateral.
- A Professional Land Surveyor, registered in the State of Colorado, shall submit a Surveyor’s Statement of Substantial Compliance (see Figure 7.2) prior to issuance of Probationary Acceptance and reduction of collateral.
- All Record Drawings depicting storm drainage facilities shall comply with all requirements located in the Arapahoe County Storm Water Manual, latest edition.

The Engineering Division will compare the substantially compliant Record Drawing information with the approved construction documents. A certificate or letter of Probationary Acceptance for the public improvements will only be issued if:

- The Record Drawing information demonstrates that the construction is in substantial compliance with the approved drawings, as determined by Engineering Staff.
- The Record Drawings are submitted by the responsible Professional Engineer, a registered Professional Land Surveyor and applicable requirements of the Arapahoe County Storm Water Manual, and Standards are met.

7.2 REQUIRED INFORMATION

The Record Drawings shall be inclusive of the following information:

- Statement of Substantial Compliance by the responsible Professional Engineer.
- Statement of Substantial Compliance by a Professional Land Surveyor

- Sequentially numbered plan sheets.
- Case Number in the lower left corner of all plan sheets.
- Roadway flowline and centerline elevations at 50-foot increments, high points, low points, vertical grade breaks and curves and at all points of curvature, continuous curvature, tangency, and curb returns. Along horizontal curves the flowline and centerline elevations shall be listed at 25-foot increments.
- Pond volume, manhole and inlet surface and sump elevations, pipe invert elevations at flared end sections, manholes, inlets, and outlet structures.
- All additional requirements set forth by the Arapahoe County Storm Water Manual.
- Digital design files as detailed in section 7.3 of these standards.

Record Drawings shall verify the following information including but not limited to:

- Record Drawings shall depict all field changes.
- Record Drawings shall verify the size and elevation of all pipes, inlet and outlet riprap, headwalls, and all other drainage infrastructure shown on the approved Construction Drawings, including the improvements located outside of County right-of-way.
- Record Drawings shall verify all pipe, drainageway, and roadway centerline and flowline grades.
- Record Drawings shall verify all signage and striping has been completed per plan.
- Submit curb ramp as-built information as a GIS shapefile. Shape file should conform to section 7.3.
- Record Drawings shall verify all other information as specifically requested by the Arapahoe County Engineering Division, or as identified within the approved Construction Drawings.
- Record Drawing shall verify all additional information requested by the Arapahoe County Storm Water Manual.

7.3 DIGITAL FILES

Digital Files submitted with the Record Drawings shall meet the following requirements:

- Digital Files shall be in PDF format and AutoCAD Version 14 (or more recent version) or approved equivalent (no fragmented pieces, which are required to be scaled, rotated, and/or assembled to achieve a complete base drawing).
- The "Base" drawing should be related (tied) to at least two (2) monumented horizontal control lines showing a basis of bearings.
- The "Base" drawing should not contain any undefined fonts, ".shp", ".shx", or line references.
- The "Base" drawing should not contain any "xref'd" drawings, which are not compatible with the "base".
- The "Base" drawing should not reference any image files, e.g., ".bmp", ".tif", ".jpeg", etc.
- The "Base" drawing should not contain blocks or nested blocks with attributes, which cannot be "exploded".
- GIS Shapefiles shall be compatible with ESRI applications. The ".zip" file must contain at least the ".shp", ".shx", ".dbf", and ".prj" files components of the shapefile.

Figure 7.1 Engineer's Statement of Substantial Compliance

Based upon review of and reliance on the field survey data and other pertinent data provided by (Name of Firm(s) or Surveyor), on (Date), and a final site investigation conducted on (Date), I hereby state that to the best of my knowledge, information, and belief, it is my professional opinion that the facilities shown in these drawings were constructed in substantial compliance with the approved Drainage Report and/or Construction Drawings and the Engineer's intent. This statement is not based on any direct involvement in the construction process. I did not administer the construction process or perform inspections or observations during construction. This statement is based only on a review of the field survey data and a final site investigation.

(Engineer's Name)
Colorado Professional Engineer No. (SEAL)

Date

Figure 7.2 Surveyor's Statement of Substantial Compliance

A Record Drawing field survey was conducted by (Surveyor), on (Dates). All items noted on these drawings with an "RD" indicate Record Drawing information based on said survey. Record Drawing information is shown only for the items checked below. Unless explicitly marked with an "RD" constructed condition should not be assumed.

- Detention/Retention Pond Volumes
- Pond Structures
- Storm Sewer System
- Open Channel/Structures
- Streets
- Other (Specify)

I, (Surveyor), hereby state that in my professional opinion the Record Drawing information shown on these plans accurately represents the improvements constructed.

(Surveyor's Name)
Colorado Professional Land Surveyor No. _____

Date

(Seal)

Digital Files submitted with the Record Drawings shall meet the following requirements:

- Completely assembled horizontal “base” drawing showing all:

Inlets	Conduits
Manholes	Junctions
Vaults	Diversion structures
Check/drop structures	Revetments
Stilling basins	Plunge pools
Water quality ponds and forebays	Detention ponds
Inlet/outlet structures	Outfall facilities
Channels	Ditches, swales, trickle channels
Rundowns	Bridges
Right-of-ways	Easements
Risers, subdrains, cleanouts, connections, etc.	

- The drawings should be drawn at 1:1 scale.
- Drawing x & y axis should be identical.
- 100-year floodplain should be shown on any FEMA, dFIRM, or FIRM defined drainageway or channel.
- All dimensions (if shown) should be clearly defined and to center of structure, manhole, inlet, etc.

7.4 CERTIFICATIONS AND COUNTY ACTIONS

Summary of certifications and County actions required for Engineering Reports and Plans:

- Drainage Report – Refer to the Arapahoe County Storm Water Manual for further requirements.
- Required Certifications and County Actions:

Document	Certification	County Action
Phase I Drainage Report	None	Review and Comment
Phase II Drainage Report	Engineer/Developer	Review and Comment
Phase III Drainage Report	Engineer/Developer	Approval (Concurrent with Construction Plans)
Construction Drawings	Engineer	Approval
Signing and Striping Plans	Engineer	Approval
Subgrade Investigation and Pavement Design Report	Engineer	Approval

- Required Statements of Substantial Compliance and County Actions:

Document	Statement of Substantial Compliance	County Action
Record Drawings	Civil Engineer/ Surveyor	Probationary Acceptance

CHAPTER 8 - ROADWAY INSPECTION AND TESTING PROCEDURES

8.1 GENERAL

- 8.1.1 Roadway testing and inspection requirements shall conform to the latest edition and revisions of the Colorado Department of Transportation Standard Specification for Road and Bridge Construction (CDOT Standard Specification) as otherwise amended or supplemented by the Arapahoe County Infrastructure Design and Construction Standards and MGPEC standards.
- 8.1.2 All test and inspection results performed by the testing firm in the employment of the owners/developers shall be submitted to the Engineering Division Manager or their field representative at the time of testing or within fifteen working days after the testing or retesting date.
- 8.1.3 Any work performed within Arapahoe County ROW and associated easements shall be tested by a license material testing firm. The materials testing firm must employ a full time registered professional engineer in the State of Colorado who directly supervises work of the firm. All testing reports must be certified by the supervising professional engineer. The costs of testing and associated reporting are paid by the owner/developer.
- 8.1.4 The testing of all materials and construction shall be in conformance with the appropriate AASHTO or ASTM specifications.

8.2 ANCILLARY STRUCTURE TESTING

8.2.1 Utility Trenches and Public Storm Sewer Facilities

- 8.2.1.1 **Materials, Placement and Compaction.** All utility trenches within Arapahoe County ROW shall be placed and compacted in accordance with Table 3.4B-1 in the MGPEC Standards.
- 8.2.1.2 **Test.** Field moisture-density testing shall be performed during backfill operations beginning 1 foot above the top of the pipe & extending to the finished subgrade elevation. A sufficient number of tests shall be taken at various depths to confirm that backfill compaction and moisture content specifications are met. As a minimum, one test shall be taken for each 10 cubic yards of backfill. At least 20 percent of the tests shall be taken within 1 foot of manholes, water valves or other obstacles.
- 8.2.1.3 **Acceptance.** The results of field density tests shall be submitted and reviewed by the Engineering Services Division. Provide all tests are acceptable; the next phase of roadway construction can begin. Any failures must be reworked, retested and resubmitted for review and approval.

8.2.2 Curb, Gutter, Sidewalks, Crosspans, etc.

- 8.2.2.1 This item shall consist of furnishing all materials, equipment, labor and other necessary items for the construction of curbs, gutters, sidewalks, ramps, local depressions and driveways of the form and dimensions prescribed by the plans and/or

County Staff as required per MGPEC Standards, Appendix Item 6.

- 8.2.2.2 A Proof Roll of the subgrade for all curb, gutter, sidewalk, crosspans, etc. shall be required.
- 8.2.2.3 Subgrade compaction tests of all curb, gutter, sidewalk, crosspans, etc. shall be required.
 - MGPEC Item 31 states that subgrade shall be thoroughly moisture conditioned and rolled or hand tamped until the subgrade from the front of curb to back of sidewalk reaches the compaction required for the adjacent roadway.
- 8.2.2.4 Portland Cement Concrete shall conform to the requirements detailed in MGPEC Item 30
- 8.2.2.5 Concrete tests of all curb, gutter, sidewalk, crosspans, etc. shall be required.

8.3 ROADWAY SUBGRADE PREPARATION

- 8.3.1 Excavation construction operations shall be consistent with the requirements detailed in the MGPEC Standards, Appendix Item 2.
- 8.3.2 Embankment construction operations shall be consistent with the requirements detailed in the MGPEC Standards, Appendix Item 3.
- 8.3.3 Treatment construction operations shall be consistent with the requirements detailed in the MGPEC Standards, Appendix Item 4.

8.4 STABILIZED SUBGRADE

- 8.4.1 **Materials** - Treated subgrade shall be used only where a mix design has been previously submitted and approved by the Department of Public Works and Development Division. The requirements of the MGPEC Standards, Appendix Sections 5.2 and 5.5 shall apply.
- 8.4.2 **Construction** - Construction of treated subgrade shall be in accordance with the requirements of MGPEC Standards, Appendix Item 5
- 8.4.3 **Testing** - Treated subgrade shall be observed and tested on a full-time basis and paid for by the owner/developer. The MGPEC Standards, Appendix Sections 5.9, 5.9.A – Thickness, 5.9.B – Grade, 5.9.C – Strength, and Table 5.12-1 are required.
- 8.4.4 **Acceptance** - The test results shall be submitted and reviewed by the Engineering Inspection Section and a proof roll will be scheduled and performed. Provided all tests are acceptable, the subgrade will be approved and the next paving course can be placed. Should these tests fail to meet project specifications see the MGPEC Standards, Appendix Section 5.10, conformity with plans and specifications. MGPEC Standards, Appendix Sections 5.11 – Measurement and 5.13 – Payment
- 8.4.5 **Other** - Other subgrade Materials and treatments not addressed in the MGPEC Standards will

be subject to the approval by the Engineering Division Manager.

8.5 AGGREGATE BASE COURSE

- 8.5.1** The description of the work to be performed shall follow the MGPEC Standards, Appendix Item 13
- 8.5.2 Materials.** Aggregate Base Course materials must be from a currently approved source and conform to the requirements of the MGPEC Standards, Appendix Sections item 13.2 Materials and Table 13.2. MGPEC Standards, Appendix Section 7 item 13.3 Equipment shall not be inclusive as part of the Aggregate Base Course requirements. The owner/developer shall, upon request, provide verification of material properties.
- 8.5.3 Placement and Compaction.** Materials shall be placed on an approved subgrade, which has been proof rolled within the past 24 hours and found to be stable and non-yielding. Should weather conditions change, such as freezing, precipitation, etc., aggregate base materials shall not be placed until the subgrade is reapproved.
- 8.5.3.1** Subgrade shall be prepared in accordance with the MGPEC Standards, Appendix Section Item 13.4A – Subgrade Preparation.
- After proper placement and compaction, a prime coat or “tack coat” shall be applied to the aggregate base material. Prime coat material shall conform with Colorado Department of Transportation’s Colorado Highway Specifications Section 407 and 702 and Appendix Section item 20.5 of these Standards.
- 8.5.3.2** Aggregate base course shall be placed in accordance with the MGPEC Standards, Appendix Sections Item 13.4B – Spreading and Moisture Conditioning and Item 13.4C – Compaction.
- 8.5.3.3** A proof roll shall be completed in accordance with the MGPEC Standards, Appendix Section Item 13.4D – Proof Roll.
- 8.5.4** Acceptable tolerances shall meet or exceed the requirements detailed in the MGPEC Standards, Appendix Section Item 13.5
- 8.5.5** Material properties shall be in accordance with the MGPEC Standards, Appendix Section 7 Item 13.5D and Table 13.5D-1.
- 8.5.6** Testing and inspection shall be in accordance with the MGPEC Standards Appendix Section Item 13.8.

8.6 HOT MIX ASPHALT PAVEMENT (HMAP)

- 8.6.1 General** - MGPEC Standards, Appendix Section Item 20 – This section shall be applicable to all types of plant mixed hot mix asphalt pavements.
- 8.6.2 Materials** - All asphalt, aggregate, fillers and additives shall be combined to form a mix design

in accordance with the MGPEC Standards, Appendix Sections Item 20.1 – General Requirements and 20.2 – Materials. The mix design must be submitted to and approved by the Engineering Division prior to use.

- 8.6.3 Mix Design and Plant Produced Mixture Requirements** - MGPEC Standards, Appendix Section Item 20.3 shall be utilized to enforce Mix Design and Plant Produced Mixture requirements.
- 8.6.4 Mixture Design Submittals** - Mixture Design Submittals shall conform to the requirements set forth within the MGPEC Standards, Appendix Section Item 20.3B – Mixture Design Submittals.
- 8.6.5 Equipment** - Minimum equipment standards shall conform to the requirements set forth in the MGPEC Standards, Appendix Section Item 20.6
- 8.6.6 Manufacture** - Minimum Manufacture standards shall conform to the requirements set forth in the MGPEC Standards, Appendix Section Item 20.7
- 8.6.7 Tack coat** - A Tack Coat shall be applied to all surfaces that the HMAP will come into contact with per the requirements of the MGPEC Standards, Appendix Section Item 20.5
- 8.6.8 Placement** - Hot mix asphalt shall be placed in accordance with the MGPEC Standards, Appendix Section Item 20.7.
- 8.6.9 Longitudinal Joints** - Hot mix asphalt shall be applied in accordance with MGPEC Standards, Appendix Section Item 20.8
- 8.6.10 Transverse Joints** - Hot mix asphalt shall be applied in accordance with MGPEC Standards, Appendix Section Item 20.9
- 8.6.11 Segregation** - Hot mix asphalt shall be placed to ensure segregation is prohibited per MGPEC Standards, Appendix Section Item 20.10
- 8.6.12 Compaction** - Compaction of the hot mix asphalt shall conform with MGPEC Standards, Appendix Section Item 20.11.
- 8.6.13 Production Tolerances** - Production Tolerances shall meet or exceed the requirements of the MGPEC Standards, Appendix Section Item 20.12
- 8.6.14 Conformity with Plans and Specifications** - Materials, Pavement thickness of hot mix asphalt shall conform with MGPEC Standards, Appendix Section Item 20.13 --when the lot is Represented by fewer than three tests, 9.14.3 and tables 9.14.1 and 9.14.2 shall not be inclusive in the requirements for Hot Mix Asphalt. The excluded sections listed above shall be replaced with the requirements detailed in section 8.6.15 of these Standards.
- 8.6.15** After completion of the paving, the final pavement thickness shall be determined using pavement thickness rings, coring or other acceptable methods. Pavement thickness testing shall be made at random locations at intervals of approximately 500 feet in each travel lane. A dated map depicting the core locations along the traveled lanes to include names of roadways, north arrow, lane distances along roadway stations and distances from flowline shall be submitted for approval to County. Charts showing design depths of asphalt, base course, etc., shall be on the map in addition to actual core depths.
 - 8.6.15.1** Criteria used to determine satisfactory work shall include all of the following:
 - a. A minimum of 90% of core tests must meet or exceed design HMAP thickness.
 - b. Average of all core tests must meet or exceed design HMAP thickness.
 - c. All core thicknesses must exceed design HMAP thickness. The pavement

thickness deficiency shall not be more than 0.25 of an inch.

- d. 100% of all cores must pass 95% +/-2% design pavement density.

If all these criteria are not met, additional core tests or approved nondestructive testing at the expense of the owner/developer may be required to further delineate area(s) of unsatisfactory work. This unsatisfactory work will require correction prior to acceptance.

8.6.16 Testing and Inspection-Testing and inspection requirements shall conform to the MGPEC Standards, Appendix Item 20.14, -

8.6.17 Measurement - MGPEC Standards, Appendix Item 20 shall not be inclusive in the requirements for HMAP.

8.6.18 Payment - MGPEC Standards, Appendix Item 20.15 shall not be inclusive in the requirements for HMAP.

8.7 PORTLAND CEMENT CONCRETE PAVEMENT

Portland Cement Concrete construction shall conform to the requirements detailed in the MGPEC Standards, Appendix Item 32 except as described below.

8.7.1 Materials

Concrete shall conform to the following requirements:

Min. 28 day Field Compressive Strength	4000 Psi
Min. Cementitious Materials	610 lbs./cu. yd.
Max. Water/Cement Ratio	0.48 lbs H ₂ O/lbs cement
Air Content % Range	5-8
Maximum Slump	4"
Max. Fine Aggregate % of total Aggregate	50%

8.8 HOT MIX ASPHALT PAVEMENT PLANING/ROTOMILLING

Hot Mix Asphalt Pavement Planing/Rotomilling shall conform to the requirements detailed in the MGPEC Standards, Appendix Item 2.

8.9 JOINT AND CRACK SEALANT

Joint and Crack Sealant operations shall conform to the MGPEC Standards, Appendix Item 23

8.10 FOG SEAL

Fog Seal operations shall conform to the MGPEC Standards, Appendix Item 24

8.11 CHIP SEAL

Chip Seal operations shall conform to the MGPEC Standards, Appendix Item 25.

8.12 SLURRY SEAL

Slurry Seal Operations shall conform to the MGPEC Standards, Appendix Item 26.

8.13 TRENCH BACKFILL COMPACTION

8.13.1 General

No pavement cuts will be permitted for any County roadway granted probationary acceptance or overlaid within the previous 24 months (2 years). Emergency repairs for broken pipes, cables, etc. will be allowed according to the requirements of Chapter 10. If a contractor makes a cut into new pavement as defined in this paragraph which is not an emergency cut, the contractor or owner of the infrastructure shall be liable for additional costs as defined in by Director, Public Works & Development. . The county requires replacing a newly removed asphalt with 1” of extra pavement thickness of the original. T-patching and the use of infra-red are some of the techniques or methods the county requires on case by case situations to achieve a higher quality result in asphalt cut, pothole patching. The County routinely advises all utility companies, at least six (6) months in advance, of impending roadway overlays in the annual reconstruction program.

8.13.1.1 Existing asphalt pavement shall be cut so the joint line (along depth of cut) between existing and replacement pavement is straight and neat – i.e., within 5° of vertical and free from horizontal irregularities. All pavement cuts shall be square or rectangular in appearance with all surface within 5° of a right angle. The cut depth shall be sufficient to permit pavement removal without damage to remaining pavement. T-Patching is required by the county during asphalt cut to smoothen out the asphalt edges to blend well with the existing pavement. Refer to Appendix A, SP 18 of the IDCS.

8.13.1.2 Removed pavement becomes the property of the excavator (unless otherwise specified in a contract document) and shall be hauled away as soon as possible and disposed of in a proper manner (recycle or waste facility).

8.13.1.3 Base course material may be removed and stockpiled for reuse during backfilling if it meets specifications. If not, it is to be hauled away as soon as possible from the ROW and disposed of in a proper manner.

8.13.1.4 Subbase material is to be stockpiled parallel and uphill to the trench alignment; in such a manner that encroachment upon the non-disturbed portion of the roadway and/or pedestrian walkways is kept to a minimum. It shall be removed from the site at the time permanent backfill is placed.

8.13.1.5 Safety standards relating to the shoring and stabilization of trench sidewalls should be maintained as prescribed by appropriate safety regulatory agencies (OSHA, State of Colorado).

8.13.1.6 The trench construction shall not be opened for a distance of more than three hundred (300) feet at any one time, unless specifically authorized by the Director, PWD or their designated representative.

- 8.13.1.7** The trench width shall be confined to those minimum dimensions, which will permit proper installation and acceptable pipe loading, as established by current acceptable engineering practices and all OSHA requirements.
- 8.13.1.8** No cuts shall be left in an open condition overnight, except for the portion necessary to commence work the following morning. This open condition shall be covered with a steel plate, braced and thick enough to withstand a CDOT HS-20 loading at the center of the span. Warning signs, barricades and lights, in conformance with the Manual of Uniform Traffic Control Devices (MUTCD), shall be used in areas where trenching operations are in public roadways. Any trenching remaining open overnight shall have flashing lights used with warning barricades. All such barricades, signs and warning devices shall be installed in accordance with the approved Construction Traffic Control Plan.
- 8.13.1.9** In trenching across the road, no more than one-half (1/2) of the traveled way is to be closed to traffic at one time. The trenched roadway shall be completely backfilled and a suitable driving surface restored before trenching the other half of the road. Final pavement restoration shall be accomplished at one time within a maximum of 7 working days after the installation unless specifically authorized by the Director or their designated representative.
- 8.13.1.10** Closure of any street, road approaches, or other access points will not normally be permitted (in excess of 10 days only by approval of the Arapahoe County Commissioners). Upon trenching across such facilities, steel, running plates, planks or other safe methods shall be used to provide for traffic to enter or leave the road to adjacent property. Refer also to Section 9.6 – Road Closures
- 8.13.1.11** Access to private driveways shall be provided at all times except during working hours when construction operations prohibit provision of such access.
- 8.13.1.12** Unobstructed access must be provided at all times to fire hydrants.
- 8.13.1.13** The contractor shall notify the property owners at least 48 hours in advance of beginning work, or in accordance with right-of-way easements which set forth ingress/egress requirements, prior to any excavation to be made in County easements through private property.
- The Contractor shall take precautions to limit the removal of, or damage to existing pavements, sidewalks, curbs, lawns, shrubbery, trees, hedges, walls, fences, buildings, or other existing improvements and shall replace or restore such improvements to their original location and condition after the excavation has been backfilled and compacted.
- 8.13.1.14** It shall be the responsibility of the contractor to be familiar with all specific conditions contained in private easements. Contractor shall perform all of its work in accordance with the stipulations contained therein.
- 8.13.1.15** Where trenching excavation occurs within the roadway surface, the minimum allowable remaining pavement section shall not be less than four feet (not including the curb and gutter or concrete pavement). All asphalt cuts or trenching within four (4) foot of edge of asphalt shall be extended to the edge of asphalt. See Trench Detail SP-18 in Appendix A.

8.13.2 Backfilling

- 8.13.2.1** The permittee shall advise the Engineering Division of the proposed trench backfill date before commencing work. A minimum of 48 hours advance notification is required. Typically, backfill will take place on the same day of trenching; if this is not the case, the Engineering Division must be given the same 48 hours prior notice as required for commencing trenching.
- 8.13.2.2** The bottom of the trench shall be prepared to provide a firm foundation for the pipe or facility in accordance with the bedding conditions specified by the geotechnical engineer or Special District for the type of pipe or facility to be installed. The subgrade of the trench shall be kept free of standing water. Where the trench subgrade material is found to be unsuitable and does not afford a solid foundation, the contractor shall excavate to such depth as necessary to construct a stable foundation. A stable foundation shall be constructed by placing crushed rock or other CDOT or Arapahoe County approved granular material under the pipe.
- 8.13.2.3** Backfilling shall be placed so that the pipe will not be displaced or damaged. Bedding requirements for utilities shall meet the minimum requirements of the utility provider.
- 8.13.2.4** For trenching within the limits of the roadway including areas of curb, gutter and sidewalks, trench shall be backfilled with approved materials, immediately after the utility authorized by the permit has been placed in the trench. Allowable materials are defined as flowable backfill from 12” above the top of pipe or the upper five-feet of backfill to grade or compacted and tested native backfill. Flashfill or flowfill can also be use as approved by the county. It consists of controlled low-strength self levelling cementitious materials. Flashfill may generally be placed without lift thickness limits. See MGPEC Standards, Appendix Item 19.2 A, 19.2B –CLSM(Controlled low-strength Materials) - backfill material requirements.
- 8.13.2.5** For trenching outside the roadway, the subgrade shall conform to the lines, grades and cross-sections as shown on the approved plans. The subgrade shall be compacted in successive layers not to exceed eight (8”) inches thick and shall be finished and maintained in a smooth compacted condition. The compacted surface shall be free from rutting or other objectionable irregularities.

8.13.3 Base Course

- 8.13.3.1** Base material shall conform to the lines, grades, cross-sections, and thickness shown on the approved plans and shall be finished and maintained in an acceptable condition at least one day in advance of placing prime coat.
- 8.13.3.2** Base material shall consist of hard, durable particles or fragments of stone or gravel crushed to the required size and an AP-filler of sand or other finely divided mineral matter. When produced from gravel, not less than 60% by weight of the aggregate retained on a No. 4 sieve shall consist of particles having at least one fractured face. Base material shall be free from vegetable matter and lumps or balls of clay and which when placed and compacted will result in a firm, dense, unyielding foundation. Base material shall meet the grading requirements set forth in MGPEC Standards, Appendix Item 7.2 and Table 7.2.

- 8.13.3.3** Base material shall be deposited and spread without particle segregation in loose layers not to exceed six inches in depth. Each layer shall be thoroughly and individually compacted to 95% proctor (AASHTO T-180) density. Re-working of the material may be required as necessary following review of all field test results. No base course shall be placed upon a soft, spongy, frozen base, flowable backfill or other subgrade that is determined as unsuitable by an Arapahoe County representative.
- 8.13.3.4** Deviation from the gradation limits may be permitted on unpaved roads provided it can be unequivocally demonstrated that the subbase or base course material is not conducive to rutting, raveling or forming a soft yielding surface in the presence of moisture. Compaction equipment must be on the job site before excavation is started. Compaction equipment must be capable of compacting within the trench width limits to prevent bridging caused by straddling the ditch. Any deviations must have approval from the Director, PWD.
- 8.13.3.5** If the existing base course is untreated, it shall normally be replaced with CDOT Class 6 aggregate base material and compacted in layers not to exceed six inches. The resulting total compacted base thickness shall be eight inches or to the thickness of the removed base plus two inches. If the existing base material is asphalt treated aggregate it shall be replaced by a minimum of 3” of acceptable asphalt base or the existing base thickness plus 1”, whichever is greater. A replacement 2” thick asphalt surface wearing course shall also be used when replacing asphaltic treated aggregate.

NOTE: For the purpose of replacing a full depth asphalt pavement section, the top 2” may be considered the wearing course, with the remainder being the base course.

8.13.4 Trench Cover – Backfill

- 8.13.4.1** All open cut trenches within Arapahoe County Rights-of-Way shall be backfilled with either flowable backfill or native backfill compacted and tested to ensure 95% compaction or with compacted and tested native backfill. Flash fill can be used too. Flash fill which is of a higher strength than flow fill is also acceptable by the county. The flashfill products will allow trench backfill, temporary or permanent pavement restoration and traffic access to occur more quickly than flowfill.
- 8.13.4.2** After the compacted native backfill (compacted to 95%) or flowable backfill have been completed, it shall be cut and trimmed to the required depth and cross section. Flowable fill shall be used under all public improvements, i.e., curb, gutter, sidewalk, crossspan, ramps, etc.
- 8.13.4.3** All excess excavated material shall be removed and disposed of outside the legal limits of the highway as the work progresses, unless the approval from the Director, PWD is obtained to dispose of the material within the legal limits of the highway. All parts of the highway and various structures disturbed shall be restored to a condition equal to that which existed before starting the work.

8.13.5 Trench Cover – Asphalt

8.13.5.1 Temporary

8.13.5.2 All trenches across traffic lanes shall be provided with temporary trench cover.

- A temporary patch of cold-mix shall be placed on all pavement surface cuts immediately after backfill and compaction is completed. On high traffic volume roadways or as directed by Arapahoe County, a temporary hot mix patch of sufficient depth may be required. Temporary patches shall be removed at the time permanent patch is made.
- Minimum requirements for temporary trench cover shall be well-compacted surfacing, arterial conforming to “Road Mix Asphalt Surfacing Material” of the State of Colorado Standard Specifications and shall be a minimum of four inches thick. The mineral aggregate shall, with a tolerance of 5%, conform to the grading specified for 3/8” maximum aggregate. Bituminous binder to be mixed with the mineral aggregate shall be liquid asphalt. Grade MC 250 or MC 800 and shall have enough of a liquid asphalt content to perform the design function.
- Temporary trench cover surfacing material shall be stockpiled on the job site and shall be placed after completion of trench backfill and compaction.
- Temporary trench cover shall be properly maintained until permanent trench cover is placed. At a minimum, the responsible contractor shall evaluate the condition of the temporary patch on a daily basis.
- Trench covered with temporary surfacing will be considered as open to traffic.
- The surface of the temporary patch shall be smooth and at the same level as the adjacent undisturbed paved area.

8.13.5.3 Permanent

Unless otherwise specified, the replacement of pavement shall be as follows:

- In the areas where the wearing surface is hot mix asphalt, replace the pavement with a full depth asphalt paving of a minimum thickness of five (5”) inches but in all cases to a thickness of the old surface plus base course plus one (1”) inch.
- In areas where the wearing surface is Portland cement concrete, pavement replacement shall be at a minimum of same class, and strength as the original pavement, but not less than six inches thick on alleys or residential streets, nor less than eight inches thick on major or secondary streets and highways.
- In areas where the wearing surface is other than hot mix asphalt or Portland cement concrete, the contractor shall replace the pavement and base in kind. Said surface replacement shall be of materials and thickness conforming to the requirements of the governing authority.

8.13.5.4 Permanent Alternative

- Where original surface was Portland cement concrete, Portland cement concrete shall be placed to a thickness of six inches or the thickness of the removed pavement, whichever is greater.
- Where original surface was hot mix asphalt, bituminous treatment or mix, or oilmat, hot mix asphalt shall be compacted in layers not to exceed three (3") inches to a total compacted thickness of five (5") inches or the thickness of the removed pavement plus 1", whichever is greater. On oil mat surfaces or substandard asphalt surfaces, an overlay of Class "SX" asphaltic pavement 1 ½ inches thick shall be placed across the entire traffic lane disturbed by the trench and shall be finished as set forth below.
- Immediately prior to placing the wearing surface, the abutting pavement edges shall be neatly cut.
- The existing pavement shall be cleaned, removing all loose material and coated with hot liquid asphalt (grade AC-10) or asphalt emulsion applied cold (grade CSS-1H) to insure a bond with the new asphalt surfacing.
- The restored pavement shall be finished to a smooth riding surface and to the grade of the surrounding undisturbed pavement.
- Pavement placement shall commence not more than seven (7) calendar days after backfilling, unless the Director PWD or their representative permits otherwise.

8.13.5.5 In the event the trench edges fall in the wheel traveling portion of a traffic lane, existing or proposed, the applicant shall extend the finish surface paving to a point deemed satisfactory by the Director, PWD or their field representative. Finish surface paving shall be performed in such a manner as to provide a crown slope equal to that existing prior to excavation, with no ponding of run-off surface water either over the trench or at the joints between the new and original surfaces.

8.13.5.6 When road surface trench/cut involves more than one traffic lane, a full width paving lift may be required. Individual jobs may require negotiations with the Division of Operations and Maintenance, at the discretion of the Director, of Public Works & Development for partial participation in the cost of a full width overlay.

8.13.6 Repair to Gravel Roads and Shoulders

8.13.6.1 Restoration of Unpaved Areas

- Where the original surface was crushed rock or gravel for the wearing surface and foundation material, Class 6 aggregated base course shall be used as replacement material and shall be placed to a minimum compacted thickness of 8-inches or the thickness of the removed material plus 2-inches whichever is greater.
- Unimproved roads and area between edge of traveled roadway and property line: The trench shall be backfilled with the excavated material and compacted to the specifications provided in this chapter.

Note: Work area shall be restored to original or better condition.

8.13.7 Maintenance Period

- 8.13.7.1** For a period of one year following the acceptance of the backfilling of any trench in the County ROW and/or the permanent patching of the paved surface, the applicant shall be responsible for the condition of said trench backfill and pavement patches. During that time the applicant shall, at their own cost, repair any of the said patches, which become settled, cracked, broken, or otherwise faulty if requested by the Director, PWD or their representative. All work will be done to the satisfaction of the Director, PWD or their representative. Settlement of the replaced road surface of three-sixteenths inch (3/16") or more as measured with a ten foot (10') foot straight edge shall constitute evidence of improper backfill material, and shall be cause for repairs by the contractor.
- 8.13.7.2** The Director, PWD shall make such inspections as they may deem necessary of all work authorized by a permit. They are empowered to provide a full-time inspector if necessary to ensure compliance with the provisions of these standards.
- 8.13.7.3** All inspection costs shall be borne by the permittee. Such costs shall be based on a schedule of charges on file in the office of the Director, PWD.
- 8.13.7.4** The permittee shall notify the Director, PWD in writing upon completion of work accomplished under the provisions of the permit.

CHAPTER 9 PERMIT, BONDING AND ACCEPTANCE REQUIREMENTS

9.1 PERMIT APPLICATION REQUIREMENTS AND PROCEDURES

9.1.1 Overview

A permit is required for any construction, including any new installations, modifications, repairs, removals, or maintenance of existing improvements, within the public right-of-way, public easements, and/or floodplains, for earthmoving activities, or otherwise for use of the public right-of-way as provided herein. Application for such permits shall be made at the Department of Public Works and Development, Engineering Services Division, located at 6924 S Lima Street, Centennial, CO 80112, either in person or via online permit submission.

After applying for the permit, the application will be reviewed by the appointed County Staff. Upon completion of review the applicant will be notified by Arapahoe County of the status of the permit.

Upon approval of the permit, the permit holder must call to schedule a preconstruction meeting and/or County inspection by notifying the Engineering Inspections Section at 720-874-6500. Required preconstruction meetings and inspections shall be scheduled a minimum of 48 hours prior to planned commencing work. County Inspections are considered a condition of all County permits.

No work shall take place prior to notification of, and approval by, County staff. Stop work orders and monetary fines/penalties may be assessed in cases where work has commenced without County notification and scheduling. For more information regarding Stop Work Orders see Section 9.3.11 of this Chapter.

If an inspection is scheduled with the Engineering Division Inspections Section, and for some reason the work is not performed as scheduled, the permit holder shall call and cancel the inspection as soon as possible. Failure to cancel the inspection in a timely manner may result in a re-inspection fee, which shall be assessed to the Permit Holder. Multiple missed inspections, or work without scheduling required inspections, may result in permit revocation by the County. All permit fees paid to date on permits revoked shall be considered forfeited by the permit holder due to non-conformance with standards and permit conditions.

Inspection, re-inspection, and penalty fees shall be assessed in accordance with the current Engineering Permit Fee Schedule. Permit Applications shall only be accepted at the Arapahoe County Public Works and Development - Engineering Services Division during normal business hours (8 a.m. to 4:30 P.M.).

9.1.2 Permit Types

The types of permits issued by Arapahoe County Public Works are as follows:

9.1.2.1 **Street Cut Right-of-Way Use Permit**, which governs the following:

- Construction, removal, repair or maintenance of utilities and other facilities in the public right-of-way.
- Maintenance of facilities which do not necessitate a cut but will otherwise affect, impact, or restrict vehicle or pedestrian traffic operations, facilities, and/or channelization and therefore require development of a traffic control plan and review and approval by Arapahoe County.
- Construction of, or modifications to, access points from private property to County roadways.
- Road Closures for any purpose including, but not limited to, community or other special events. A road closure request form shall be included in as an attachment accompanying the permit application. For road closures that are anticipated to exceed the limits outlined in the Land Development Code, Board of County Commissioners Approval is also required. The permittee is advised to submit all road closure requests at least six (6) weeks prior to planned closure to allow for Board of County Commissioner approval.
- Access from Public Right-of-Way to private property or utility easements.

9.1.2.2 **Public Improvement Permit**, which is used for permitting any construction required by a Subdivision Improvement Agreement with Arapahoe County. In general, required improvements are described in the Engineering Cost Estimate, “Exhibit A” attached to the Subdivision Improvement Agreement (SIA) or Intergovernmental Agreement (IGA), as described in Chapter 12.

9.1.2.3 **Grading, Erosion and Sediment Control (GESC) Permit**, which govern the movement of any earth, either by excavation (cut) or placement of embankment (fill), Stockpiling of materials, or other land disturbing activity of any kind on either public or private property. The requirements for this permit include prior approval and an acceptable Erosion Control and Sedimentation Report and Plan that meets the minimum standards within the “Arapahoe County Grading, Erosion and Sediment Control Manual” (GESC). Contact the Arapahoe County Public Works and Development Department, Engineering SERVICES Division for current Administrative Procedures relating to the GESC Permit.

9.1.2.4 **Oversize/Overweight Vehicle Permit**, which governs the use of Arapahoe County Roadways where vehicle by which exceeds size or weight limitations as established by the State of Colorado or by Arapahoe County.

9.1.2.5 Traffic Signing, Striping and Signalization Permit, which governs the placement, removal or modification of any traffic signs, striping, or signals to be owned, operated, and/or maintained by Arapahoe County.

9.1.2.6 Floodplain Development Permit, which governs any construction grading, excavation, boring, or installation of facilities within any floodplain area. In the event there is no defined floodplain the applicant will be required to submit documentation defining the floodplain boundaries based on direction from County Staff.

9.1.2.7 Low Impact GESD Permit, which is required for projects with a disturbed area less than one acre where minor impacts can be adequately demonstrated to the Engineering Services Division. Streamlined submittal requirements may apply.

9.1.2.8 Annual Utility Maintenance Permits, which are used by public and private utilities to perform routine maintenance of existing utilities and/or facilities located within public ROW.

9.1.3 Permit applications and permit information is available through the County Website www.arapahoegov.com. Go to Departments/Public Works and Development/Engineering Services Division/Permitting and Inspections.

9.1.4 Special Circumstances

The following section describes special circumstances relating to permitting of construction in Arapahoe County.

9.1.4.1 Emergency Repairs

Emergency repairs shall require a “Street Cut ROW Use Permit”, however, a delay of up to 72 hours (3 business days excluding weekends and holidays) is granted to submit the permit for the Emergency Cut. Permit applications for emergency cuts, which have not been applied for within 72 hours of the cut, shall be subject to a penalty. All provisions of Bonding and Insurance as defined in Section 9.5 shall apply to agencies performing the emergency cut.

An emergency cut shall be defined as a roadway excavation required to restore an essential service which has been disrupted or failed, or where delay of a repair would require further damage to the public right-of-way. An essential service is defined as electric, telephone, gas, water, sanitary sewer, storm sewer or other service needed to ensure the health and safety of the public.

9.1.4.2 Relocations and Adjustments to Existing Facilities by County Order

The work of relocating existing facilities to facilitate Capital Works Projects, or other minor work ordered to be performed within County right-of-way to adjust or maintain existing facilities (such as installation, repair, or adjustment of range boxes, survey monuments, manhole rings, service boxes, or similar appurtenances located within

County Right-of Way) work undertaken for the convenience of, and at the order of, Arapahoe County shall require a permit. However, the permit will be issued on a “no fee” basis if the permit is obtained prior to commencing with work.

9.1.4.3 Utility Repairs and Maintenance Operations

All utilities shall obtain a street cut permit or construction permit (as applicable) prior to beginning work in Arapahoe County right-of-way, except as allowed under Section 9.1.3.1. The practice of utilities using their own work order or job order to proceed with work in the right-of-way, in lieu of obtaining County Permits is expressly prohibited. After obtaining a permit, the utility shall notify the Engineering Division – Inspections Section at least 48 hours, but not more than 96 hours prior to commencing work.

All utility work shall conform to Arapahoe County Utility Clearance Policy and Procedures (see Resolution #21-317) and the latest version of County Standard Operating Procedures (SOP's) related to the policy.

9.1.4.4 Permit Transference

The permit, the privileges granted herein and the obligations of the applicant created thereby shall be binding upon successors and assigns of the applicant.

9.1.5 Extensions to Permits

If the applicant fails to complete installation of the facility covered by the permit within the period specified in the permit, said permit shall be deemed null and void and all privileges and fees will be forfeited, unless an extension of time is obtained from the Engineering Division Manager or their designated representative.

9.2 GENERAL SPECIFICATIONS

Work done under a permit shall result in a repair being made to the street or other County Property involved. Said repair shall cause the street or other property to be returned to a condition equal to or better than original, within the limits of careful, diligent workmanship, good planning and quality materials. Said repair shall be accomplished in the least possible time and with the least disturbance to the normal functioning property.

9.3 PERMIT CONDITIONS

This section describes the requirements for plans and other information necessary for approval of a permit application.

9.3.1 Duration of Permits

The Public Improvements Permit shall be effective for a period of Two (2) years from the date of approval of Construction Plan Approval. For consideration of an extension the applicant shall make an extension request not less than 20 working days prior to expiration of the permit.

Unless otherwise provided in the special provisions, a Street Cut Right-of-Way Use Permit shall be in effect for one-hundred and twenty (120) days from the date of issuance unless sooner revoked by the Director, Public Works and Development, or their designated representative for failure to abide by the terms and conditions of the permit, or by operation of the law, or at the time the utility for which the permit is issued ceases operation. For consideration of an extension the applicant shall make an extension request not less than 15 working days prior to expiration of the permit.

The Oversize/Overweight Moving Permit shall be effective for a maximum of 30 days from the date of permit issuance. If an annual Oversize/Overweight moving permit has been issued, then the permit shall be in effect for a period of 1-year, with each individual oversize/overweight move being approved on a permit form.

The Traffic Signing, Striping and Signalization Permit shall remain effective for a period of two (2) years from the date of approval of construction plan.

The Floodplain Development Permit is issued by the Engineering Services Division- - and shall meet all requirements and time restrictions set forth by the Engineering Services Division Manager. Time restrictions are generally based on scope of project.

9.3.2 Permitted Areas

Any permit issued shall pertain only to excavating or constructing within the County right-of-way or County drainage easements and is in no way to be considered a permit to enter any private property adjacent to such right-of-way or easement, or to alter or disturb any facilities or installations existing within the right-of-way which may have been installed and are owned by others.

9.3.3 Inter-Jurisdiction Permit Limitations

Permits are issued subject to the approval of City, State, or other governmental agencies having either joint jurisdiction over the section of right-of-way or jurisdiction to regulate land use by means of zoning and/or building regulations. It shall be the applicant's responsibility to determine the necessity of and to obtain any such easements and approvals, which may be required.

9.3.4 Restoration

Granting of a permit is conditioned upon replacement or restoration of the road and right-of-way to a satisfactory condition by the applicant. Satisfactory condition shall be deemed a repair made in conformance to Chapters 8 and 9 of these Standards as determined by the County.

9.3.5 Owner/Developer Responsibility

The owner/developer of the site adjacent to the area, for which the permitted work is being completed, agrees to be responsible for maintenance of landscaped areas between the property line and the adjacent public roadway.

9.3.6 Utility Relocation Responsibility

The applicant shall be responsible for relocating or adjusting any utility facilities located within the road right-of-way as required to accommodate the road approach or other facility applied for. Construction of the utility, road approach or other facility by the applicant, his/her agent, or contractor, may be denied if the Director, Public Works and Development, or his/her representative believe that satisfactory arrangements for said relocation or adjustment has not been made with the owner of the affected utility facility. Unless specifically stated by agreement or contract, all cost of the utility relocation shall be the responsibility of the developer/owner.

9.3.7 Plan Requirements

Permit applicants shall be notified within seventy-two (72) hours of submitting their permit application if Construction Plans will be required. When Construction Plans and Specifications are required, they shall be submitted in accordance with the requirements of Chapters 2 and 3 of these Standards prior to issuance of any permit. For maintenance projects involving minor street cuts, the applicant shall submit a request in the form of the Street Cut Right-of-Way Use Permit with a sketch plan showing type, size and location of the proposed installation or repair and a traffic control plan compliant with the Manual on Uniform Traffic Control Devices (MUTCD).

9.3.8 Fees, Insurance and Bonding

Applicant must pay all required fees, obtain all necessary plan approvals and provide insurance and bonding, as required in Section 9.5 prior to approval of the permit application. A current fee schedule is available by contacting Arapahoe County Public Works and Development, Engineering Services Division at (720) 874-6500.

9.3.9 Repairs of Damage Caused by Construction

Repairs of damage caused to existing facilities as a result of work carried out by a valid permit shall be the responsibility of the permittee.

9.3.10 Failure to Abide by Terms and Conditions

Failure of the applicant to comply with any of the terms and conditions of the permit shall be sufficient cause for cancellation of the permit and may result in removal of the utilities, approaches or other facilities by the County at the applicant's expense.

9.3.11 Stop Work Orders

Failure to obtain adequate permits and/or failure to comply with approved plans and County Standards could result in a Stop Work Order until the adequate permits have been issued and/or the improvements have been reconstructed to comply with all plans and County Standards. No further permits will be issued until the repairs and/or corrective work has been completed or the County has been reimbursed for expenses required to complete the repairs.

9.3.12 Permittee Qualifications

Permits to perform work on Arapahoe County Public Improvements shall be issued only to a person (or authorized agent representative) who meets the requirements in Section 9.5, "Bonds and Insurance".

9.4 REFUNDS

No refunds shall be issued on any permit fee.

9.5 BONDS AND INSURANCE

9.5.1 A non-cancelable permit bond in the amount of \$20,000, or the estimated cost of public improvements currently permitted or under warranty, payable to the Board of County Commissioners, Arapahoe County, shall be required in the name of the permittee prior to issuance of any permit. This bond shall assure that the permittee will comply with all County Standards and Specifications and shall assure recovery by the County of any expense incurred, within a period of 365 days (1 year), following the expiration date of a permit, to the amount of said bond, due to failure of the permittee to comply with the provisions of these Standards or to otherwise cause expense to the County as a result of work performed. Bonding is not required in the following cases:

9.5.1.1 The proposed work is included in the scope of an approved, current Development Agreement (SIA, TSEA, IGA, etc.) for which collateral has previously been established.

9.5.1.2 The proposed work is to be performed by a Local Improvement District, Metropolitan District or other entity for which a valid letter of responsibility is in place.

9.5.1.3 The proposed work is performed for Arapahoe County and the contractor has provided the County with a performance/payment bond.

9.5.2 Failure to Obtain Bond

Any permit determined to be without adequate bond as required, shall be subject to immediate revocation by the County. Contractors performing work without such bond shall be denied all future permits in Arapahoe County until such bonding requirements are met.

9.5.3 Eligibility for Letter of Responsibility

Municipalities, quasi-governmental agencies, special districts, mutual companies, electric, gas and communications utilities may provide a Letter of Responsibility in lieu of posting the required bond. Subject Letter of Responsibility shall be in the format of Figure 9.1.

9.5.4 Substitution for Bond

Arapahoe County shall not accept cash deposits, certified checks or similar security in lieu of a bond. Bonds and Letters of Responsibility shall be filed in the office of the Engineering Services Division Manager.

9.5.5 Insurance

The applicant shall obtain and carry a liability and property damage insurance policy or policies, for the period of time required to complete installation of facilities and improvements authorized by the permit. Completion of installation of facilities and improvements includes repair and restoration of the road or other facilities affected by construction. Coverage shall be provided against any claim, demand, suit or action for property damage, personal injury or death resulting from any activities of the applicant, its officers, employees, agents, or contractors in connection with the construction, installation, repair or removal of said facilities authorized by the permit.

The said policy or policies shall include as named additional insured: Arapahoe County Board of County Commissioners, Arapahoe County Officers, agents and employees except as to claims against the applicant, for personal injury to any members of the Board or its officers, agents and employees, or damage to any of its or their property.

Said insurance shall provide coverage of Property Damage, Public Liability Insurance and Bodily Injury Insurance in an amount of not less than Four Hundred Thousand (\$400,000) Dollars each, or such other maximum amount as may be specified in the Colorado Governmental Immunity Act, and protecting the County against any and all claims for damages to persons or property resulting from construction and/or installation of any required improvements pursuant to this requirement.

The policy will provide that the County shall be notified at least thirty (30) days in advance of any reduction in coverage, termination, or cancellation of the policies. Such notice shall be sent to the Engineering Division Manager by Certified Mail, Return Receipt Requested. Contractor agrees that any subcontractors engaged by or for the permitted contractor, to construct the required improvements shall maintain public liability coverage in limits not less than those mentioned above. Failure to comply with Insurance Requirements shall result in suspension and/or revocation of permits.

Figure 9.1

INSERT LETTER OF RESPONSIBILITY

9.6 ROAD CLOSURE

- 9.6.1** Preferably only one side of a roadway shall be blocked at any given time. When alternatives to road closure are not possible or when maintaining open roads would pose a safety threat, a street closure request may be submitted (See Chapter 13 – Forms). Any plan for traffic control during construction that indicates a complete closure must show vehicular and pedestrian detour routes, and must be approved by the Engineering Division Manager or their authorized representative at least one week prior to issuance of the permit.
- 9.6.2** Road Closures exceeding twenty (20) days shall require Board of County Commissioner Approval and must be submitted a minimum of twenty-one (21) days prior to the proposed road closure.
- 9.6.3** The Engineering Services Division shall notify the appropriate school district, fire protection district, the County Sheriff's Office and the Colorado State Patrol Office concerning the exact location of street barricades and dates traffic will be impeded.
- 9.6.4** The contractor shall maintain barricades, in accordance with the approved traffic control plan and MUTCD.

9.7 STOP WORK ORDER

Any person, corporation, quasi-governmental agency, special district, company, electric, gas or communication utility purveyor, who, without first having obtained a permit, and/or who, having made a cut in public right-of-way which has settled, failed or which has not been replaced in conformance with established County Standards, shall be subject to a "Stop Work Order" issued by the County. Whereupon that person, entity, or utility shall, except in the cases of emergency repair work, shall discontinue all work within public right-of-way within Arapahoe County until such time as the required repair has been satisfactorily completed. No further permits will be issued until the repair has been made, or the County has been reimbursed for their expenses. Arapahoe County may, on its own initiative, make required repairs and bill the responsible contractor. Charge shall include a minimum \$300.00 administrative charge and all County incurred costs for labor, time, materials, and equipment. All costs shall be assessed on a portal-to-portal basis.

9.8 UTILITY INSTALLATIONS

- 9.8.1** Underground Within Roadway

All utility lines shall be installed a minimum of the depths shown in detail SP-22 in Appendix A from the proposed roadway finished grade. This requirement is applicable throughout the County right-of-way, in roadway sections, including curb, gutter, sidewalk or other public improvements. Exceptions may be granted by the Director, Public Works and Development, or their representative where warranted. All utilities crossing into County right-of-way shall be as near to perpendicular as feasible. Storm Sewer systems are excluded from these requirements, all storm sewer design shall conform with the requirements of the Arapahoe County Storm Water Management Manual. The use of microtrenching for utility installation is not allowed in County Rights-of-Way.

9.8.2 Underground Outside of Roadway

Utility lines subject to freeze/thaw damage (sanitary sewer and water) shall be installed at a minimum depth of the depths shown in detail SP-22 in Appendix A when located outside of the roadway. Utility lines not subject to freeze/thaw damage may be installed at a minimum depth of 36 inches when outside of the roadway section. Exceptions may be granted by the Director, Public Works and Development, or their representative where warranted. Storm sewer depths shall conform to the Arapahoe County Stormwater Management Manual.

9.8.3 Overhead

A minimum ground clearance of 18'-0", from finished grade, shall be provided where overhead utility lines cross public roads and streets. The clearance shall be measured at the lowest point (sag point) where the line crosses the traveled portion of the roadway.

9.8.4 Potholing Locates

Exploratory test holes made to determine location of existing utilities in an intersection or crossing and to be cored shall be charged a fee as set forth in the fee schedule. A maximum of five (5) test holes, at a maximum diameter of 10", per intersection or crossing may be permitted by a single fee. It is the responsibility and at the cost of the permittee to locate all utilities including County owned public improvements (storm sewer, traffic signal inter-connects, traffic loop detectors, etc.) prior to the commencement of work. The party performing the potholing or excavation shall contact Colorado 811 in accordance with C.R.S.

9.8.5 Utility Clearances

Water and sanitary utility clearances from storm sewer (outer wall of pipe) shall meet the minimum requirements set forth in the Arapahoe County Stormwater Management Manual. All other Utility clearances from storm sewer shall maintain a minimum of 18-inch separation (Horizontal and vertical) and/or conform to the requirements of other individual districts whichever is more stringent.

9.8.6 See Appendix E for utility locate pothole repair procedure policy.

9.9 APPLICABILITY

The requirements of this chapter shall apply to any person, corporation, municipality, quasi municipal agency, company, electric, gas, cable television or telecommunication utility, who for any reason cuts, disturbs or otherwise defaces any county road for the purpose of installing or repairing, or for any reason pertaining to the presence of, an underground utility or structure.

9.10 FORMS

The various application forms required to perform work in County right-of-way can be found in Chapter 13 – Forms.

9.11 FEES

9.11.1 Fee Schedule

Fees shall be assessed for permits and inspection at the time of issuance of the permit in accordance with the current County fee schedule. A copy of this fee schedule may be obtained free of charge from the Arapahoe County Public Works and Development Department.

9.11.2 Penalty Fees

Any person or corporation commencing any work without valid, prior written authorization shall be required to pay a penalty fee.

The GESC Permit shall require penalty fees for re-inspections and for reinstatement after issuance of a stop work order. The re-inspection penalty shall be assessed when a specific issue requires more than two inspections prior to conformance. The reinstatement penalty shall be assessed prior to commencing with work following issuance of a stop work order for any reason.

9.11.3 Fees for Non-Business Hour Inspections

Permit fees include any and all charges necessary for permit administration and all required inspections (when applicable). Permit fees include the normal inspection fee provided that required inspections are performed during normal County business hours (8:00 am – 4:30 pm, Monday through Friday, holidays excluded), and are based upon proper notification to and scheduling with County inspection staff. Additional fees apply to all inspections required outside of the normal County business Hours. Contact Arapahoe County Engineering Inspections at 720-874-6500 for details on availability, procedures, and requirements for non-business hour inspections.

9.11.4 No Fee Permits

For projects in which it is determined that no permit fees are required, the permittee shall not begin construction of any improvements or repairs until the County has issued a “No Fee Permit”. In the event the permittee begins construction prior to the issuance of a permit all applicable permit fees and penalties shall apply.

9.12 ACCEPTANCE

This section sets forth the uniform policy, procedures, and requirements related to the acceptance of Public Improvements in Arapahoe County.

9.12.1 Standards for Acceptance

The requirements for Arapahoe County Acceptance of Public Improvements include, but not limited to, the construction and installation of improvements located within County right-of-way, tracts, or easements. The County shall perform required inspections for work, and/or any corrective work, associated with the Public Improvements identified in Subdivision Improvement Agreement (SIA), as are identified and itemized in Exhibit A therein, and that are located within County right-of-way for maintenance in accordance with County regulations and in accordance with the following terms and conditions:

- 9.12.1.1** As soon as all the Public Improvements which are covered by the Agreement are installed in accordance with the approved Construction Drawings, the terms and conditions of the SIA, Developers Agreement, and other development approval conditions, and in accordance with the County Infrastructure Design and Construction Standards, the Developer shall send a letter to the Public Works and Development, Engineering Services Division requesting probationary acceptance. When the Engineering Services Division has determined that the Improvements have conformed to these requirements, and that all required inspections have been performed and all construction documentation has been received, the County will send a letter to the Developer granting probationary acceptance of the Public Improvements. The probation period will be stated in this letter and will normally terminate one year from the date of probationary acceptance. The County will submit its statement allowing a reduction of the Collateral to not less than 10% of the original value of the Public Improvements, as defined in Exhibit A.
- 9.12.1.2** Once the Public Improvements have been completed and the designated warranty period as outlined in the Probationary Acceptance documents have been met, the owner/developer may request Final Acceptance. Requests for final acceptance may be received by Arapahoe County no sooner than nine (9) months following the probationary acceptance date. After inspection, the County will identify and provide a written list of deficiencies, and any required corrective work needed, based on a physical inspection of the Public Improvements. The Developer shall correct the deficiencies noted in the written list, to the County's satisfaction, within six (6) months from the date of issuance. When all of said deficiencies have been corrected, including application of a final seal coat to streets and traffic striping, when necessary, the County will grant a final acceptance to the Developer.
- 9.12.1.3** The County shall not release the remaining or final ten percent (10%) of the total amount of the Collateral until the Public Improvements have been granted final acceptance by the County.
- 9.12.1.4** Once the County has granted final acceptance and released all remaining collateral, the Developer can then request release from the Subdivision Improvement Agreement recorded on title. The developer shall prepare all legal descriptions and provide all

additional information required by the County for processing release.

9.12.2 Construction Tolerances

For the County to accept Public Improvements, the work will need to be constructed in an accurate manner that is both in conformance with the Construction Drawings and within acceptable tolerances for the work being performed. Acceptable construction tolerances shall be those specified those specified in Appendix D, Arapahoe County Construction Specification Tolerances. Work performed that falls outside these specified tolerances shall be considered defective and require corrective work, which may include removal, reconstruction, or other modification deemed acceptable by the County.

9.12.3 Stop Work Orders

These Requirements may be enforced by work stoppage injunctions issued by the District Court pursuant to law; or suit may be filed by County Attorney on behalf of the Board of County Commissioners for damages resulting to County right-of-way due to non-compliance with these requirements.

9.12.4 Ownership of Improvements

Subject to the provisions of the Arapahoe County Land Development Code or other applicable County standards, rules or regulations relating to County's acceptance of improvements for maintenance purposes, upon completion of construction of the Public Improvements located within County right-of-way identified in Exhibit A, all such Improvements shall become the sole property of Arapahoe County, free and clear of all liens, encumbrances, and restrictions. Developer shall furnish to County lien waivers and/or satisfactory proof that all claims and payments to be made in connection with construction of said Improvements have been satisfied. All other Public Improvements referenced in the Agreement shall be owned and maintained by Developers and their successors and assigns.

Where road improvements are required for a subdivision, the initial capital cost shall be funded by the developer/owner. After acceptance of the roads for maintenance, the County shall then provide a normal level of maintenance as available funds, manpower and equipment permit. The County will maintain only those roads specifically accepted for maintenance by the Director of Public Works and Development.

A normal level of maintenance includes street sweeping, snow plowing, repair and cleaning of drainage structures and general maintenance of the roadway in a condition deemed safe by the Director of Public Works and Development.

9.12.5 Improvements to Existing Roadways

Where new development impacts an existing roadway by accessing onto the road or increasing storm runoff onto or along the road, the developer(s) will be responsible for upgrading the roadway to the minimum standards required by these Design Standards. The construction of new roadways for the purpose of providing access to a development is the responsibility of the developer(s).

9.12.6 Traffic Control Acceptance Requirements

The following traffic control aspects shall apply to acceptance procedures:

9.12.6.1 Roadways shall not be opened to public traffic until necessary traffic control devices have been installed. Before a new roadway is accepted by Arapahoe County, it shall be properly signed and striped according to the approved plans.

9.12.6.2 If, during acceptance inspection of the new subdivision, it becomes evident that additional signage is needed, the County shall inform the owner/developer in writing. These additional signs shall be the responsibility of the owner/developer to install such signs and to show them on a revised signing and striping plan.

9.12.7 Probationary Acceptance Process

9.12.7.1 Probationary Acceptance Package Submittal

Upon completion of improvement construction, the owner, or their representative, shall submit a Probationary Acceptance request package to the Engineering Services Division. The probationary request package must include, but not be limited to, the following:

- A written request letter for Probationary Acceptance (PA) that fully describes the improvements to be accepted by Arapahoe County. This request should be submitted to the County inspector by email. The letter shall acknowledge that the developer/owner has fulfilled the Subdivision Improvement Agreement requirements for Public Improvements including testing documentation showing the quality and structural integrity of the roadway improvements.
- The letter shall acknowledge the following Terms of Maintenance Responsibility:
 - The County will be responsible for snow plowing within the guidelines of the “Snow and Ice Control Plan”. The County will not plow any streets that have manholes, valve boxes or any other obstructions projecting above the pavement surface. The County will not be responsible for ice buildup at inlets where the final lift of asphalt paving has been deferred and the asphalt surface does not drain into the gutter.
 - The County will accept responsibility for damage to curb and gutter because of the County’s snow plowing operations PROVIDED that they are notified of such damages in a timely manner (within 30 days), so that the County can check the circumstances. The County will not accept all curb and gutter damage, only that which can be directly attributed to its operations.
 - The County will not be responsible for installation or maintenance of any barricades or warning signs required to protect the public because of phased roadway construction.
- Copies of all materials testing reports for acceptance. Reports shall include testing of concrete, asphalt, soil backfill, subgrade compaction tests, etc. performed during the construction of the improvements. Testing requirements shall be as outlined within these Infrastructure Design and Construction Standards and/or other Standards incorporated by reference (see Chapter 1, Relationship to Other Standards).
- A complete set of Record (aka “As-Built”) Drawings, including all public

improvements to be accepted by Arapahoe County. The Record Drawings must be signed and stamped by a Colorado registered professional engineer. The Record Drawings must include a statement verifying the public improvements for the associated subdivision or projects were constructed in substantial compliance with the Arapahoe County approved construction drawings. Refer to Chapter 7 of Arapahoe County's Infrastructure Design & Construction Standards for record drawing requirements.

- A statement from a Colorado registered land surveyor certifying the "as-built" detention or retention pond volumes as well as the construction of all drainage structures. This statement is also in Chapter 7 of Arapahoe County's Infrastructure Design & Construction Standards. The statement should be included on the Record Drawings.
- All new roadway construction or reconstruction work must have a letter from a Colorado registered professional engineer, agent from a material testing firm or the asphalt paving supplier certifying the roadway pavement materials used were from a County approved source and met specifications defined in Chapter 5 of the Infrastructure Design and Construction Standards.
- A map, preferably a copy of the original subdivision plat, showing the location and all pertinent surveying information.
- Core test results for thickness and density must be submitted for new pavement. Arapahoe County's Construction Standards refers to MGPEC Standards for core testing requirements.
- The letter shall acknowledge that the developer/owner has fulfilled the Subdivision Improvement Agreement requirements for Public Improvements including testing documentation showing the quality and structural integrity of the roadway improvements.

9.12.7.2 Prior to submitting the Probationary Acceptance package, the owner shall also assure that the following requirements and/or conditions have been satisfied per County requirements:

- All constructed improvements for which acceptance is being sought have been covered by a valid County public improvement construction permit.
- All necessary traffic control devices, signing, and striping must be permitted and installed according to the approved plans prior to granting acceptance.

9.12.7.3 Probationary Acceptance Inspections

Upon receiving the Probationary Acceptance request, an on-site inspection of the Public Improvements can be scheduled with the Inspection section of the Engineering Services Division. The owner/developer is responsible for assuring that the Public Improvements associated with the Subdivision Improvement Agreement are in good repair and acceptable condition, are clean and free of dirt and debris, and are accessible and ready for visual inspection. In the case where the public improvements are either inaccessible or unprepared for visual inspection shall require re-inspection. Additional re-inspection fees may apply.

All acceptance inspections, Probationary or Final, shall not be scheduled nor conducted for the Public Improvements, as specified in the Subdivision Improvement Agreement, if sufficient collateral is not posted, valid, and in force. The owner/developer shall take corrective action to correct all deficiencies in collateral requirements after receiving notice from the County. It is the sole responsibility of the developer to maintain proper collateral for the improvements as is required by the Subdivision Improvement Agreement.

Any changes, modifications, or cancellations to the scheduled time/date of the inspection shall be made with the County inspector at least 24 hours in advance. Re-inspection fees may be assessed when cancellations and/or modifications to inspection times/dates are not made prior to the deadline.

Ten (10) working days following the inspection, the owner/developer will receive a written deficiency list (aka punch list) indicating the deficiencies and/or corrective work noted during the Probationary Acceptance inspection. It is the responsibility of the owner/developer to notify Arapahoe County, via email or phone, when the repairs have been completed so that a re-inspection may be scheduled. The re-inspection shall occur within three (3) weeks of notification. After reinspection the County will provide the owner/developer with written notice either granting or withholding Probationary Acceptance within 10 working days.

9.12.7.4 Granting Probationary Acceptance

The County Engineering Inspector shall grant or deny probationary acceptance based on re-inspection and compliance with the required corrective work outlined in the deficiency/punch list as was previously provided to the owner/developer. If new deficiencies are found, either in quality, extent of work, or conformance with standards, the owner/developer shall be notified in writing that these new deficiencies shall be corrected as a condition of Final Acceptance. Probationary Acceptance will not be delayed by discovery of new deficiencies provided the deficiencies do not pose an immediate risk to the health, safety, or welfare of the public.

The County shall issue written notice of either granting or withholding Probationary Acceptance within ten (10) working days of the acceptance re-inspection. If acceptance is denied, cause(s) shall be explicitly disclosed. The Probationary Acceptance letter shall specify the date on which the owner/developer is eligible to request Final Acceptance. The Probationary Acceptance period will normally be a minimum of one calendar year. The time may be extended under unusual circumstances at the discretion of the County.

9.12.7.5 Denial of Probationary Acceptance

A request for Probationary Acceptance of a Subdivision's public improvements, for which such acceptance has been previously denied by Arapahoe County, shall be treated as a new request for acceptance.

9.12.7.6 Reduction in Collateral

Upon receipt of the Probationary Acceptance Letter from Arapahoe County, the owner/developer is eligible to have the subdivision agreement collateral reduced to 10% of the original value provided the County does not have sufficient reasoning, as determined by County Engineering Staff, to withhold a greater amount due to known deficiencies or potential problem areas. If probationary acceptance is only partial or only for a portion of the Public Improvements, the reduction in collateral shall correspond to the line-item value of the accepted improvements and not exceed more than 30% of the original collateral amount. The County may require the owner/developer to provide an itemized estimate for the partial improvements. For probationary periods greater than one year, an additional 10% of the original collateral amount shall remain in force for each additional year, or fraction thereof, of probation.

9.12.8 Final Acceptance Process

Once the Public Improvements required in the Subdivision Improvement Agreement have been completed, and the designated warranty period outlined in the Probationary Acceptance documents has been met, the owner/developer may request Final Acceptance. The owner/developer may apply to proceed with the final acceptance process nine months after the date of probationary acceptance. Final acceptance cannot be granted until one year after the probationary acceptance. The final acceptance request package shall be submitted to the Engineering Services Division.

The letter/correspondence requesting Final Acceptance shall identify the County project number and the Public Improvements to be accepted. Reference shall be made to the date of Probationary Acceptance. A contact person, address, email, and phone number shall be listed. The letter shall specifically request a Final Acceptance inspection.

Upon receipt of the Final Acceptance request, the owner/developer may schedule Final Inspection with the Inspection section of the Engineering Services Division. The owner/developer is responsible for assuring that the Public Improvements associated with the Subdivision Improvement Agreement are in good repair and acceptable condition, are clean and free of dirt and debris, and are accessible and ready for visual inspection. In the case where the public improvements are either inaccessible or unprepared for visual inspection shall require re-inspection. Additional re-inspection fees may apply.

Ten (10) days after the Final Inspection has been completed, the County inspector will issue a deficiencies list (aka punch list) of all repairs and/or corrective work to be completed prior to Final Acceptance. The owner/developer shall obtain the necessary permits needed to perform corrective work and repairs prior to the commencement of work and operations. Such permits shall be issued on a "no fee" basis unless the repairs commence prior to the issuance of the required permits, otherwise normal permitting fees and all applicable penalty fees shall apply. Said permits are required so that the County is aware of all work being performed in County Rights-of-Way.

Upon completion of all corrective and repair work, the owner/developer shall request a re-inspection in writing. After scheduling the re-inspection, the Inspector will either recommend

Final Acceptance of the Improvements or issue an additional deficiency list (punchlist) outlining the remaining corrective work. For cases where the Inspector recommends Final Acceptance, the County will issue a Final Acceptance Letter and process the release of all remaining collateral. The County may also prepare and file a Termination and Release of Subdivision Improvement Agreement with an owner/developer provided legal description of the property at the owner/developer's request.

CHAPTER 10 UTILITY LOCATIONS

10.1 PLANS REQUIRED

Any utility or other facility constructed in County ROW and/or Utility Easement requires construction plans submitted and approved in accordance with requirements of Chapter 3 in these standards. No Street Cut Right-of-Way permit shall be issued for construction of new utilities or extension of existing utilities without prior construction plans approved by Arapahoe County.

To avoid delays and redesigns on large projects and in areas where future road improvements are expected, plan and profile sheets are required at street crossings. Additional plan and profile sheets may be required due to the complexity of a project or possible utility conflicts and will be determined on a case-by-case basis by the Staff Engineer. A pre-design meeting should be held with the Staff Engineer or authorized representative to discuss the requirements of the plan submittal. The County will assist the utility company in determining what future roadway profiles and improvements are expected to minimize future utility relocations.

Utility layout and design shall conform to the requirements listed within Chapter 10 and in Section 9.8 of these Standards.

Exceptions:

1. Service taps or laterals to individual properties when not installed with main line.
2. Minor maintenance projects may be exempt from submitting construction plans. In such cases however, a sketch and traffic control plans must accompany the permit application. The plans shall address pedestrian traffic as required. Utility companies may be exempt from the requirement of a professional engineer's signature and stamp on the construction plans if the project is of a nature that would not warrant design by a registered professional engineer, as determined by the County Engineer.

10.1.1 A guide to determine if a project will require formal plans is shown below. If two or more of the criteria are checked **yes** then construction plans are required.

	No	Yes
1. Longitudinal to traffic more than 300'	<input type="checkbox"/>	<input type="checkbox"/>
2. Transverse to traffic - crosses more than one traffic lane, requires lane closure, detours, flagging	<input type="checkbox"/>	<input type="checkbox"/>
3. Is the street-major collector, minor arterial or major arterial	<input type="checkbox"/>	<input type="checkbox"/>
4. Is street improved, i.e., paved	<input type="checkbox"/>	<input type="checkbox"/>
5. Is pavement patching required	<input type="checkbox"/>	<input type="checkbox"/>
6. Is estimated cost greater than \$50,000	<input type="checkbox"/>	<input type="checkbox"/>

10.1.2 If construction plans are required, Arapahoe County will notify the applicant within 48 normal business hours of receiving the permit application.

- 10.1.3** The applicant's construction of the facility shall be in conformance with the drawings or sketches referred to above unless a variance has been requested and approved by Arapahoe County.
- 10.1.4** When plans are required and the proposed facility involves pressure pipe lines, the following additional data is required:
- Design pressure of pipe.
 - Normal operating pressure.
 - Maximum operating pressure.
 - material composition of the pipeline.

10.2 DESIGN STANDARDS

- 10.2.1** All work in connection with the utility authorized by the permit shall be done in a neat and workmanlike manner to the satisfaction of the Public Works and Development Department. The details of construction of the same shall conform to the requirements in effect at the time of permit issuance.
- 10.2.2** Potholing efforts for utility conflicts shall be in compliance with SB18-167. All utilities from mains including service laterals shall be located prior to any boring installations. If water and sewer lines are not found during potholing efforts, confirmation with the local water and sanitation districts is required indicating that the water and sewer piping is not in conflict with the bore alignment.
- 10.2.3** All utilities including water, sanitary sewer and storm sewer shall be stubbed out to the ROW at all locations that are planned for future tie-ins. Other reasonable stub-outs may be requested by the County based on sound engineering judgment and knowledge of adjacent development.
- 10.2.4** All manhole lids, utility access covers and range box access covers shall be depressed below the adjacent finished street surface in accordance with these standards.
- 10.2.5** During initial construction, utility companies may be required to install all utilities within a Schedule 40 PVC sleeve across all public streets to accommodate future repairs without street cuts. Sleeves shall be installed at a minimum depth of 48" to the top of the pipe from the top of the curb. Sleeve location shall be determined on a case-by-case basis.

The Developer shall be required to install additional utility sleeving at all arterial and collector intersections as determined by the County Engineering Staff, including at any intersection along a collector or arterial, which may warrant signalization, Sleeving shall be installed across all streets of the intersection.

10.3 LOCATION (See also Standard Details SP. 20 – SP. 22 in the Appendix)

For the following, potholing should be done prior to submitting construction plans. Any person or company who will be excavating or boring in the county right of way will have to call Colorado 811. The Utility Notification Center of Colorado will contact the utility operators in the right-of-way to do locate. This is done in order to assess the location(s) of other utilities. The Construction Documents

shall satisfy the requirements of the individual Water and Sanitation District prior to approval by Arapahoe County. When Water and Sanitation District requirements differ from these Roadway Standards the more restrictive shall apply unless a variance is approved by the County that is supported by the Water and Sanitation District.

10.2.6 Water

Water mains should be located on the Northerly and Easterly sides of the streets when possible. Deviations from these criteria will be acceptable where conditions dictate.

Provide a minimum 10' horizontal separation from existing or proposed sanitary sewer lines and storm sewer line. Fire hydrants shall be located in accordance with the local utility provider's requirement or as determined by the fire district.

10.2.7 Sanitary Sewer

Sanitary sewer lines should be located on the southerly and westerly sides of the street when possible. Deviations from these criteria will be acceptable where conditions dictate. Sanitary Sewer should be offset five (5) feet from centerline.

10.2.8 Storm Sewer

Storm sewer lines should be located on either side of street, beneath curb, gutter and walk to provide direct access to storm inlets when possible. Deviations from these criteria will be acceptable where conditions dictate. Utility clearances (except water and sanitary) from storm sewer outer pipe wall shall be a minimum of 2 feet. Manhole rims and covers shall have a minimum one (1) foot clear distance from any gutter pan.

10.2.9 Natural Gas

Gas mains should be located either within the right-of-way or in an adjacent easement on the southerly and westerly sides of the street when possible. Deviations from these criteria will be acceptable where conditions dictate. For utility companies that wish to run double mains (a main on each side of the street), the requirement of north and east/south and west may be waived by the Director, PWD.

10.2.10 Power

Generally, power lines should be located in the northerly and easterly sides of the street either within the right-of-way or in an adjacent easement when possible. Deviations from these criteria will be acceptable where conditions dictate.

10.2.11 Telecommunications

Telecommunication lines should be located in the northerly and easterly sides of the street either within the right-of-way or in an adjacent easement when possible.

Deviations from these criteria will be acceptable where conditions dictate. It is the preference of the Public Works and Development Department to bore fiber optic line beneath conflicting utilities.

10.2.12 Landscaping within public easements and ROW.

Generally, all poles, signs, trees and shrubbery shall conform to Arapahoe County “Streetscape Guidelines”. Streetscape Guidelines can be found in the Land Development Code, Section 4-2.9.

CHAPTER 11 ACCESS REQUIREMENTS AND CRITERIA

11.1 GENERAL

Access to County Streets and Roadways is approved through one of two mechanisms. (1) For new developments, the Board of County Commissioners grants access through the approval of a Development or Site Plan. (2) Access from an existing developed property onto County streets is dependent on the zoning for the property in question, below details the mechanism based on the zoning.

- For Planned Unit Developments (PUD), new or altered access must be obtained through the County Administrative Amendment Process. This involves applying through the Planning Division to amend the property's Development or Site Plan. The application should be accompanied by appropriate plans detailing the proposed access location and technical justification supporting the proposed location as acceptable. The justification provided shall include the extent of improvements necessary at the proposed location.
- For straight-zoned property, application for access shall be made using Form 581 (Review and Approval). This application shall be accompanied by plans detailing the proposed access and technical justification supporting the proposed location and detailing the necessary public improvements.

11.2 CRITERIA FOR ACCESS ONTO ARAPAHOE COUNTY ROADWAYS

11.2.1 Access onto State Highways

11.2.1.1 The State Highway Access Code governs access onto State Highways.

11.2.1.2 All access onto State Highways is controlled by the State of Colorado. Arapahoe County takes no jurisdictional authority over access onto a State Highway. Arapahoe County reserves the right to deny any proposed access location.

11.2.1.3 Arapahoe County has the authority to administer the State Highway Access Code, published by the Colorado Department of Transportation (CDOT), prior to referral to the State for comments and/or issuance of access permits onto State Highways in Arapahoe County.

11.2.2 Freeways

11.2.2.1 The Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA) rules and regulations shall apply to all new freeway accesses.

11.2.2.2 The State of Colorado and the Federal Highway Administration control all accesses onto freeways and interstates. Arapahoe County takes no jurisdictional authority over access onto a freeway or interstate. Arapahoe County reserves the right to deny any proposed access location.

11.2.3 Major Arterials

11.2.3.1 An access permit must be obtained from the Public Works and Development Department, Engineering Division for any public or private access constructed to a major arterial. A detailed Traffic Impact Analysis shall be completed for any proposed access point on a major arterial to ensure adequate levels of service prior to issuance of an access permit.

11.2.3.2 Generally, no private direct access onto major arterials shall be permitted unless a signal progression plan has been approved and it is determined that the proposed access will cause no significant impacts to traffic operations. Private direct access to a major arterial may be permitted only when the property in question has no other reasonable access to the general roadway network, or when denial of a direct access to a major arterial will cause unacceptable traffic conditions and/or safety problems on an alternative lower classified roadway. When direct private access must be provided on a major arterial roadway, the following shall be considered prior to approval of the proposed access location:

- Such access shall continue only until such time that some other reasonable access to a lower classification roadway is available and permitted. The access permit should specify the future reasonable access location, if known, and under what circumstances the modifications will be triggered and what changes will be required.
- No more than one access shall be provided to an individual parcel or to contiguous parcels under the same ownership unless it can be shown that; (1) allowing only one access conflicts with safety regulations (i.e. Fire District requirements), or (2) additional access would significantly benefit safety and operation of the major arterial and is necessary to the safe and efficient use of the property.
- An access shall be limited to right turn only movements, unless (1) it has the potential for future signalization, (2) left turns would not create unreasonable congestion or safety problems and lower the overall intersection level of service, and (3) alternatives to the left turn movements would cause unacceptable traffic conditions and safety problems to the general roadway network.

11.2.3.3 Direct public access onto a major arterial roadway, where left turns are permitted, shall meet the signalization spacing criteria in Section 11.2.3.4. Those that do not meet these requirements shall be limited to right turn only movements unless they meet the requirements in Section 11.2.3.2.C. No local streets shall be permitted to intersect with major arterials.

11.2.3.4 Spacing and Signalization Criteria:(major arterial)

- In general terms, full access to major arterials shall be limited to one- half mile intervals plus or minus 200-feet, in order to achieve good speed, capacity and optional signal progression.
- However, to provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be completed to properly locate any proposed access that may require signalization. The specifics of this analysis are detailed in the “Guidelines for Traffic Impact Studies”.

11.2.4 Minor Arterials

11.2.4.1 An access permit must be obtained from Arapahoe County Public Works and Development for any public or private access constructed to a minor arterial. A detailed Traffic Impact Analysis shall be completed for any new proposed access point on a minor arterial to ensure adequate levels of service prior to issuance of an access permit.

11.2.4.2 Generally, no private direct access onto a minor arterial shall be permitted unless a signal progression plan has been approved and it is determined that the proposed access will cause no significant impacts to traffic conditions. Private direct access to a minor arterial may be permitted only when the property in question has no other reasonable access to the general roadway network, or when denial of a direct access to a minor arterial will cause unacceptable traffic operations and/or safety problems on an alternative lower classified roadway. When direct private access must be provided on a minor arterial roadway, the following shall be considered prior to approval of the proposed access location:

- Does not have the potential for signalization as per the requirements of Sections 11.2.3.2.B and 11.2.3.2.C.
- Does have the potential for signalization, if it meets signal spacing requirements for intersecting public roadways stated below and does not interfere with the location, planning, and operations of the general roadway network and access to nearby properties.

11.2.4.3 Public direct access onto a minor arterial roadway, where left turns are permitted, shall meet the signalization spacing criteria in Section 11.2.4.4. Those that do not meet these requirements shall be limited to right turn only movements, unless they meet the requirements in Section 11.2.3.2.C. No local streets shall be permitted to intersect with minor arterials.

11.2.4.4 Spacing and Signalization

- In general terms, full access onto minor arterials shall be limited to one-quarter (1/4) mile intervals, plus or minus approximately 100- feet, in order to achieve good speed, capacity and optimum signal progression.
- However, to provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be completed to properly locate any proposed access that may require signalization. The specifics of this analysis are detailed in the “Guidelines for Traffic Impact Studies.”

11.2.5 Major and Minor Collectors

11.2.5.1 The following curb apron and driveway criteria shall govern private access onto minor collectors. Single-family residential access onto collectors is not permitted within new developments and shall only be considered on existing residences if no other roadway of lower classification can be accessed.

- 11.2.5.2** Public roadway access separation onto major and minor collectors shall be determined by the traffic conditions and level of service evaluation in the Traffic Impact Analysis. Intersections shall not be spaced at any distance that will hinder traffic operations during the AM or PM peak hour in Design Year 2 of the proposed development area.
- 11.2.5.3** Public streets shall intersect minor collectors no closer than 330 feet from each other (centerline to centerline), and shall intersect major collectors no closer than 660 feet from each other (centerline-centerline). On minor collectors, the closest local street intersection to an arterial shall be 330 feet (ROW line of arterial to centerline of local street) and on major collectors shall be 660 feet from the arterial (ROW line of arterial to centerline of local street). On minor collectors with an ultimate projected traffic volume of less than 2500 V.P.D., intersection spacing may be 250 feet (centerline to centerline) for the first intersection from an arterial and 210' from centerline to ROW of arterial.

11.2.6 Local Streets

- 11.2.6.1** The curb apron and driveway criteria in this Section shall govern access to local roadways.
- 11.2.6.2** Residential driveway locations shall be no closer than 20-feet from the Point of Curb Return (PCR) on any adjacent roadway.
- 11.2.6.3** Public roadway access separation on local roadways shall be determined based on the traffic conditions and level of service evaluation in the Traffic Impact Analysis. Intersections shall not be spaced at any distance that will hinder traffic operations during the AM or PM peak hour in Design Year 2 of the proposed development area. On local roadways, the intersection-to- intersection distance from arterial and collector roadway shall be evaluated for adequate traffic conditions in the Traffic Impact Analysis or subsequent addendum, prior to issuance of any access permits.
- 11.2.6.4** Public streets should not intersect local roadways closer than 150 feet from each other (centerline to centerline). On a local street, the closest intersection to a collector street shall be at least 200 feet (centerline to centerline), and to an arterial street the closest intersection shall be 200 feet (arterial ROW line to local street centerline). Further study may be required at the discretion of County Staff regarding access location and spacing.

11.3 BASIC PRINCIPLES FOR CURB CUTS AND DRIVEWAYS

- 11.3.1** Certain design criteria for curb cuts and driveways require minimum dimensions in some instances and maximum dimensions in others. The design of curb openings and driveways within the range of these dimensions will provide for good service on the part of the motorist using the driveway while at the same time minimizing the interference to the traffic using the street. By controlling the location and width of openings or driveways along the street, it will be possible to avoid or eliminate long open stretches where motorists can indiscriminately access onto the street. The width of opening established in these Standards is based on studies, which indicate that the various width openings will accommodate vehicles of maximum size authorized on our County roadways. In case of conflict between requirements in the various sections of this chapter, the more restrictive condition shall normally apply.
- 11.3.2** The curb cuts or driveway width should be adequate to properly handle the anticipated traffic

volume and traffic characteristics, as well as being within the limits specified for the type of property development. The controls established for curb cuts and driveways shall apply to existing streets as well as new streets that may be developed in the future.

11.3.3 To the greatest extent possible, all openings for driveways shall be located at the point of optimum sight distance along the street. For openings and driveways to commercial establishments and service stations there shall be sufficient space reasonably cleared of any obstructions such that drivers entering the property will have sufficient sight distance to enable them to make proper and safe movements. The profile of a driveway approach and the grading of the adjacent area shall be such that when a vehicle is located on the driveway outside the traveled portion of street the driver can see a sufficient distance in both directions so as to enable him to enter the street without creating a hazardous traffic situation. The driveway profile grade within public right-of-way should not exceed four (4%) percent. Driveways with a pedestrian route crossing shall have a five (5) feet minimum path with a cross slope of less than two (2.0%) percent.

11.3.4 Any adjustments which must be made to utility poles, street light standards, fire hydrants, catch basins or intakes, traffic signs and signals, or other public improvements or installations which are necessary as the result of the curb cuts or driveways shall be accomplished without any cost to Arapahoe County. Also, any curb cuts or driveway, which has been abandoned, shall be restored by the property owner except where such abandonment has been made at the request of, or for the convenience of, the County. Driveways shall not interfere with operations or locations of any drainage appurtenances or curb ramps.

11.3.5 Driveway approaches, where the driveway is to serve as an entrance only or as an exit only, shall be appropriately signed by, and at the expense of, the property owner. The property owner will be required to provide some means of ensuring that the motorists will use the driveway either as an entrance only or an exit only, but not both.

11.3.6 Driveway locations shall be maintain a minimum of 20-feet of separation from the Point of Curb Return on any adjacent public or private roadway to the edge of driveway.

11.3.7 Rural Road Access from Private Property

New driveway accesses from private property to an existing graveled County road shall be required to install a minimum of six (6) inches, compacted Class 6 aggregate base course or equivalent material from the ROW line to the edge of the traveled roadway. The width of the driveway within the ROW shall be 24 feet and shall have a minimum 18" diameter corrugated metal pipe (CMP) culvert (design shall be provided for review and approval prior to access location) at the established ditch flow line. A sketch plan of the installation must be submitted with the access permit application. No construction permit will be issued until Public Works and Development, Engineering Division approves the access and its construction plans.

11.3.8 Access to Roadways with No Curb and Gutter

11.3.8.1 Driveway apron shall extend from ROW line to edge of existing paved driving surface and shall be constructed of either:

- An 8" thick compacted Class 6 aggregate base material.

- A minimum of 3” thick asphalt pavement over 6” thick Class 6 aggregate base material.

11.3.8.2 The drive shall be a minimum of 20-feet wide or a maximum of 24-feet wide in the County ROW.

11.3.8.3 A minimum 18” diameter corrugated metal pipe (CMP) culvert shall be installed at the established roadside ditch flowline beneath the private drive access. The applicant is responsible for providing adequate design sizing for the CMP culvert with the Phase III Drainage Study or as a separate document.

11.3.9 Maintenance of Private Access onto County ROW

Maintenance of the private driveway access and drainage improvements within the County right-of-way described in Sections 11.3.6 and 11.3.7 shall be the responsibility of the adjacent property owner.

11.4 DEFINITION OF TERMS

Several terms are used herein, which have a somewhat distinct meaning. For the purpose of clarity, the definition of some of these terms are listed below:

Width of Curb Apron (W) – The width of curb apron is the distance measured along the curb line from access flowline extended to access flowline extended.

Edge Clearance (E) – The distance measured along the curb line from the nearest edge of the curb apron to a point where the property line extended intersects the curb.

Corner Clearance (C) – At an intersecting street, the distance measured along the curb line from the projection of the intersection street right-of-way line to the nearest edge of the curb apron.

Distance Between Double Drives (D) – The distance measured along the curb line between the inside edges of two adjacent curb openings.

Setback (S) – The lateral distance measured perpendicular to the street right-of-way line and extending from the right-of-way line to the closest point on a gasoline service pump island.

Frontage – The distance along the street right-of-way line of a single property or development within the property lines. Corner property at an intersection would have separate frontage along each street.

Residential – Property used primarily for residential purposes such as single family, two family and multi-family units.

- **Single Family (SF) Residential** – Single, detached family dwelling units or double bungalows or duplexes.

- **Multi Family (MF) Residential** – Three or more attached dwelling units including townhouses, condominiums and apartments.

Commercial – Establishments where buying and selling of commodities, entertainment or services is carried on, excluding service stations. Included are such uses as office building, restaurants, hotels, motels, banks, grocery stores, theaters, parking lots, trailer courts and public buildings.

Service Stations – Any property where flammable liquids used as motor vehicle fuel are stored and dispensed from fixed equipment into fuel tanks of motor vehicles.

Industrial or Warehouse – Any establishment that manufactures or stores an article or product.

11.5 GENERAL REQUIREMENTS

11.5.1 Number of Openings

SF Residential – In general, each SF residential property shall be limited to one access point.

MF Residential – In general, access shall be determined by information provided by owner/developer in the Traffic Impact Study and by comments generated during Arapahoe County’s review and acceptance of the study.

Commercial – In general, commercial properties having less than 150-feet of frontage and located mid-block shall be limited to one access point to County roadways. An exception to this rule may be where a building is constructed in the middle of the lot and parking is provided for on each side of the building. A second access point may be allowed for commercial property located on a corner or for properties having greater than 150-feet of frontage, if the additional proposed access is determined by County Staff to be acceptable and the proposal is justified in the Traffic Impact Study.

Service Stations – Where there is a minimum of 150-feet of frontage, two access points to a County roadway may be permitted if the accesses are justified as acceptable within a Traffic Impact Study.

Industrial – Access shall be determined on a case-by-case basis. The County shall consider good traffic engineering practice and the information provided by the applicant in the Traffic Impact Study accompanying the submittal.

11.5.2 Amount of Curb Apron Permitted - The total length of curb apron on a roadway for access to a commercial property or service station shall not exceed 40% of the property frontage. This requirement does not apply to residential type curb aprons.

11.5.3 Entrance Angle - In general, the entrance angle for all driveways shall be as near 90° to the centerline as possible. The minimum angle that will be permitted is 90° plus or minus 10°.

11.5.4 Joint Entrances - Whenever possible and feasible, joint entrances shall be provided to serve two adjacent properties. Joint entrances are to be centered on the common property line. Joint entrances shall require the execution of a Joint Access Easement Agreement between the adjacent property owners.

11.5.5 Access Approaches for Areas Requiring Backing Maneuvers - Access approaches shall not be permitted for parking or loading that requires backing maneuvers within County right-of-way. All off-street parking areas must include on-site maneuvering areas and aisles to permit user vehicles to enter and exit the site in forward drive without hesitation.

11.5.6 Minimum Throat Length for Access Roadways and Drive Aisles - The minimum throat length for an access drives shall meet the requirements for the following conditions:

- For parking areas with unsignalized access – 75-feet.
- For distance to minor intersection with unsignalized major intersection – 50-feet. For distance from any signalized major intersection – 200-feet.
- The distance shown above is measured from the edge of the major roadway’s right-of- way to the nearest edge of the parking space or access aisle.

11.5.7 Un-utilized Access Points - If a parcel of land with direct access has been in a state of non-use for more than four years, recommendation of access use shall be considered a change in use. If the use of the access exceeds the design limitations of the access point or is non-conforming to present design criteria, a new permit shall be required.

11.5.8 Changes in Access Use - If the use of existing access to County right-of-way changes, or there is a change in the use of the property, a new access permit may be required. Change in access or property use may include, but is not limited to, change in volume or type of traffic, structural modifications to the building, remodeling of the structure, change in type of business, expansion in an existing business, change in zoning or change in property division creating new parcels.

11.6 CONTROL DIMENSIONS

To accomplish the objectives of the basic principles stated earlier, certain control dimensions are necessary. There are many variables that affect these control dimensions. Some of the variables are as follows: type of roadway classification, type of property development, volume of traffic and width of right-of-way.

11.6.1 Width of Curb Apron (W)

The total width of curb apron for properties on various function roadway classifications shall be in conformance with Table 13.1.

TABLE 13.1 WIDTH OF CURB APRON (W)					
	RESIDENTIAL		SERVICE		INDUSTRIAL
	SF	MF	COMMERCIAL	STATION	
FREEWAY	N/A	N/A	N/A	N/A	N/A
MAJOR ARTERIAL	IF ALLOWED UNDER 11.2.3.2.C, DESIGN AS A				
MINOR ARTERIAL	IF ALLOWED UNDER 11.2.3.2.C, DESIGN AS A				
MAJOR COLLECTOR	N/A	35-40'	35-40'	35-40'	35-40'
MINOR COLLECTOR	N/A	35-40'	35-40'	35-40'	35-40'
LOCAL	(**)	35-40'	35-40'	35-40'	35-40'

Notes: (1) Curb aprons of 30-feet or more must be constructed with radius curb returns

** For Single Family Residential access to local streets

Local Suburban (with Curb, gutter and sidewalk) = 16-30-feet

Local Urban (without curb, gutter and sidewalk) = 20-30-feet

Local Rural (Agriculture Zoning) = 20-30-feet

11.6.2 Edge Clearance (E)

Residential

Arterial – None (may not be exceed the property line extended).

Local – None (may not exceed the property line extended).

Commercial and Service Stations

Arterial – 75-foot minimum Local – 75-foot minimum

Traffic operations shall be evaluated in the Traffic Impact Study to ensure adequate levels of service with the minimum edge clearance distances prior to approval.

Note: Joint accesses with adjoining property are encouraged. Joint access shall be the only justification for reducing the minimum edge clearance dimension. Joint access points will require the two adjacent property owners to dedicate joint access easements to one another.

11.6.3 Corner Clearance

It is important to locate driveways away from major intersections. This constraint is as much for the ability to enter and exit the property as for the benefit of intersection safety and operations. Exiting a driveway during peak hour conditions at a signalized intersection is difficult because the queue of standing or slow moving vehicles may not allow a sufficient gap for entry from the driveway. Corner clearances shall be determined through evaluation of the intersection conditions in the Traffic Impact Study. Residential driveways shall be located a distance of 20-feet from the point of curb return of the intersection.

11.6.4 Sight Distance

Sight distance for curb openings to private property shall meet all sight triangle and sight line requirements detailed in Section 4.5.9.3. This does not apply to single-family residential projects using mountable curb, gutter and sidewalks.

11.7 UNPERMITTED ACCESS

Any access, driveway or curb cut that is constructed within public ROW without an access permit issued by Arapahoe County Public Works and Development shall be subject to a stop work order and shall be removed immediately upon demand from the Director, Department of PWD. Failure to remove the unpermitted access may result in removal of said access by the County (at the property owner's expense). Failure to comply with the "Stop Work Order" may result in County legal action and prosecution of violators.

CHAPTER 12 PUBLIC IMPROVEMENT COST ESTIMATE

12.1 GENERAL

Any applicant seeking Final Plat and/or Final Site Development Plan approval (subdivider) shall provide the Department of Public Works and Development (PWD) with an itemized cost estimate of Public Improvements associated with the subdivision. The Exhibit A is to establish the amount of collateral that shall be secured by PWD guaranteeing that the Public Improvements are completed and accepted by Arapahoe County in conformance with the Subdivision Improvement Agreement (SIA) that shall be executed prior to completion of the subdivision or other development or re-development process. Arapahoe County reserves the right to require the inclusion of maintenance costs in the engineer's cost estimate.

PWD will determine whether the proposed scope of improvements, phasing, timing, means of providing collateral, and the estimated costs of improvements are acceptable to the County. Following this determination, PWD and the County Attorney's Office (CAO) will complete a draft of the applicable agreement(s) using County standard agreements. The engineer's cost estimate will be included as Exhibit A in the SIA. Once these agreements have been reviewed and deemed acceptable by the County Attorney's Office, the agreements will be forwarded to the applicant for execution. Upon the applicant's review and execution, the agreements shall be returned to PWD for further processing and signature by either the Board of County Commissioners or an authorized representative as named by Board Resolution. Once the agreements have been fully executed, by the Board of County Commissioners or authorized representative, they will be forwarded to the Arapahoe County Clerk and Recorders Office for recording. Recording is a condition of final approval.

The applicant shall understand that the standard agreement(s), as developed, have been prepared to protect the Board of County Commissioners and their interests; therefore, modification of the standard agreement is generally not allowed. Modifications to standard agreements may be rejected, in whole or in part, at the sole discretion of the County. Should the applicant object to any of the terms or conditions of the agreement(s), or wish to modify the standard agreement in any way, all proposed changes must be reviewed and approved by the CAO and PWD. It is the applicant's sole responsibility to identify, in writing, all objections and/or proposed modifications and to provide all supporting information to PWD and the CAO for review, consideration, negotiation, and/or resolution. All proposed changes, modifications, and/or edits should be submitted to PWD well in advance of any desired or anticipated dates of final approval(s) or legislative body meetings. Should an impasse be reached with PWD and/or the CAO in the drafting of these agreements, or in negotiating the proposed changes thereto, the impasse shall be presented to the Board of County Commissioners for final decision.

Should any information, as previously described, not be provided by the applicant, the Department of Public Works and Development shall reserve the right of recommending the postponement of any

scheduled public hearing or provide an unfavorable recommendation during any public hearing due to lack of information.

12.2 PUBLIC IMPROVEMENTS

The scope of public improvements normally provided in subdivision development or other development or re-development is discussed in this section.

12.2.1 Roadways

Developments shall provide all new public and private roadways, and associated land dedication, needed to adequately serve the development, improve the frontage of all roadways abutting the development, and make improvements to existing roadways needed to mitigate the impacts of the development on the local transportation system and transition to existing conditions. Participation in the improvement of local roadways typically includes, but may not be limited to, intersection or roadway widening, signalization, roadway transitions, tapers, turning/acceleration/deceleration lanes, medians, traffic islands, parking, bike lanes, curb returns and ramps, curb, gutter, gutter/drainage pans, sidewalks, pathways, and roadway drainage. Other improvements needed to mitigate traffic impacts, accommodate drainage, and transition to existing improvements may be required based on engineering review of existing conditions and site constraints.

The design of roadways shall conform to Arapahoe County Typical Public and Private Roadway Cross Sections based on classification. All curb, gutter, curb ramps, and sidewalk improvements required in the public Right-of-Way, tract, or within Public Use Easements adjacent to a proposed subdivision, shall be designed and constructed by the developer in accordance with County Standards and Public Right-of-Way Accessibility Guidelines (PROWAG).

All new local and collector roadways, and private roadways, within and/or adjacent to the subdivision or other development or re-development shall be designed and constructed in conformance with County Standards. The scope, extent, and required participation in the design and construction of new arterials and improvements to existing arterials in the development or re-development vicinity shall be determined by based on County Standards and Codes. Traffic studies submitted for engineering review shall identify all traffic mitigation measures needed to meet relative impacts identified in the Traffic Impact Study submitted with the land use actions pertaining to the subdivision.

The requirements for new roadways, required Right-of-Way, and improvements to existing roadways shall be in conformance with County, State, and Local Comprehensive Plans and Transportation Plans. Developments abutting roadways that are identified in either the County's Transportation Master Plan (TPM) shall be required to provided Right-of-Way dedication, based on the ultimate planned roadway lanes and widths, and roadway widening required as identified in the earliest planned phase of the widening or improvement identified within the TPM. This may also include construction of, or contribution to by escrow agreement, to any

planned signal locations. Required Right-of-Way dedication shall be that of the widest width required for the largest planned section, such that it will not conflict with the County's planned improvements. The developer shall coordinate all design, and confirm design requirements with, the Arapahoe County Transportation Division and Capital Projects group.

The development or re-development shall also contribute to the improvement of the regional transportation system roadway network through assessment of urban or rural transportation impact fees (TIF / RuTIF) as a condition of development approval.

12.2.2 Private Roadways

All pavement, curb, gutter, ramps, and sidewalk within a private roadway shall be located within a tract and have a public access easement located thereon. Roadways and tracts shall privately maintained upon final acceptance by the County. These private roadway improvements shall be designed and constructed to County Standards, including the requirements for pavement design. All private roadways shall be considered the same as public improvements for the purpose of design, construction, and inspection and shall be included in the Exhibit A and shall be guaranteed as part of the Improvement Agreement.

12.2.3 Drainage Improvements

Drainage improvements are required to be included in the Subdivision Improvement Agreement and include the following:

- the drainage collection and conveyance storm system within the drainage easements, tracts, and the County right-of-way for the on-site platted improvements
- the connection of the local on-site drainage system within the drainage easements, tracts, and County right-of-way to an outlet and/or discharge to the major drainageway.
- Improvements to the major drainageway within or serving the development as defined by the adopted Master Plan and/or as required by Arapahoe County in the absence of a Master Plan.
- Permanent Water Quality Control Measures and/or Detention Facilities, whether publicly or privately maintained, shall be considered public improvements due to the potential impacts to downstream property owners. As such the cost of constructing these types of facilities as well as the outlet structure and all applicable connections to the major drainage system shall be inclusive in the Exhibit A and guaranteed through execution of the Improvement Agreement.

12.3 UTILITIES

Arapahoe County Engineering Division does not consider utilities (such as water, sanitation, gas, power, fiber, communications, etc.) as public improvements, and therefore does not specifically review the plans of these utilities unless there is sufficient reason for the County to be concerned with the installation and/or location with respect to public improvements. Water and sanitation improvements are the jurisdictional authority of special purpose districts, which may require separate design of utilities, in accordance with their district's standards, and posting of collateral guaranteeing the improvements.

12.4 TRAFFIC SIGNS AND SIGNALS

12.4.1 Traffic Signals

If the subdivision Traffic Impact Study identifies the need for traffic signals as a result of subdivision approval, whether the need is immediate or in the future, the subdivider shall be required to participate in the design and installation of the traffic signals including pedestrian signals and pushbuttons as required. The extent of participation shall be determined by the Department of Public Works and Development. The estimated cost of participation shall be included in the public improvement cost estimate and shall become part of the Exhibit A when signal construction is required for the development. The traffic signal contribution shall trigger the requirement of a Traffic Signal Escrow Agreement (TSEA) when signals are not yet warranted or where they are to be constructed at a future date.

12.4.2 Traffic Signage and Striping

The cost of striping for the subdivision shall be included in the Exhibit A, based on the requirements set forth by the Signage and Striping Plans. Traffic signage costs may be determined as a lump sum cost -for TSEA at the discretion of the Department of Public Works and Development. The subdivision streets shall not be opened for public use until all signage and striping has been installed and accepted.

12.5 COLLATERAL

Collateral for public improvements securing the Improvement Agreement, for any subdivision or other development or redevelopment application, shall be in the form of an irrevocable Letter of Credit (LOC) or Cash Escrow in the total amount detailed in Exhibit A of the Subdivision Improvement Agreement (SIA). If the subdivider prefers not to provide collateral, a building permit restriction form of SIA shall be utilized. In some instances, a Cash Escrow payment may be required by the County for certain public improvements.

12.5.1 Collateral Letter of Intent

The collateral letter of intent is a letter prepared by the applicant with the initial application submittal that indicates the method by which the applicant will guarantee public improvements that are necessitated by the project. County Staff will prepare the SIA based on the information provided in the Collateral Letter of Intent. It is the applicant's responsibility to communicate changes to the form of collateral in advance of SIA draft preparation by Staff. Delayed notification or changes to the form of Agreement may result in additional review fees.

The latest version of the Collateral Letter of Intent is available on the Arapahoe County Website at www.arapahoco.gov.

The collateral letter of intent shall specify, but not be limited to, the following:

- A description of the intended method for guaranteeing the construction of public improvements, i.e. letter of credit, restriction, cash escrow, etc.
- The applicant's intent to guarantee public improvements.

- The cost of each major category according to the Engineer's Cost Estimate if the information is available at the time. The Engineer's Cost Estimate is described in Section 12.5.3.
- A statement as to whether the public improvements will be constructed in phases and whether the applicant expects to request the Department of Public Works and Development to accept facilities as they are completed in each phase of work. If such information is not specified, the Department of Public Works and Development will assume that all public improvements will be constructed during the first phase. Projects to be phased shall prepare the Engineer's Cost Estimate to reflect project phasing and phasing of acceptance of public improvements.
- The name, title, and address of any applicant party to the agreement, i.e. owners, developers, etc.

12.5.2 Monetary Collateral

If the applicant has chosen an agreement that requires monetary collateral, there are two(2 ea.) forms of financial collateral acceptable to the Board of County Commissioners. These acceptable forms of collateral are:

12.5.2.1 Irrevocable Letter of Credit

An irrevocable letter of credit from a Colorado financial institution, or other out-of-state financial institution subject to Public Works and Development staff and County Attorney's Office approval, shall be provided in a form acceptable to the Board of County Commissioners. The letter of credit shall be valid for one full calendar year. After one year the letter of credit shall be extended a minimum of six months. Failure to extend the Letter of Credit at least 15 days prior to expiration will trigger the County to begin collection procedures including notification to the applicant of such occurrence.

The latest versions of the form of agreement for the Irrevocable Letter of Credit, as they apply to securities provided by either in-state and out-of-state financial institutions, are available on the Arapahoe County Website at www.arapahoco.gov.

12.5.2.2 Cash Escrow

This method of collateralization may be used separately or in combination with the Improvement Agreements available to guarantee public improvements. If a combined method is used to guarantee public improvements, the collateral letter of intent must explicitly outline and detail the improvements that will be guaranteed through the provision of monetary collateral and those that will be subject to permitting restrictions. It is important that the applicant understand that if multiple guarantee mechanisms are utilized, the preparation of multiple agreements may be required and may result in additional review fees.

12.5.3 Engineer's Cost Estimate

The Engineer's Cost Estimate shall be provided by the applicant's Engineer who shall be

licensed in the State of Colorado. This Engineer's cost estimate will, upon review and approval, become Exhibit A of the applicable Improvement Agreement, with the exception of the Traffic Signal Escrow Agreement (TSEA). The Engineer's Cost Estimate shall specify, but not be limited to, the cost and quantity of items described below:

- 12.5.3.1 Roadway improvements and related appurtenances for both public and private roadways.
 - 12.5.3.2 Drainage improvements and appurtenances within Arapahoe County right-of-way, easements, and tracts. These improvements include, but are not limited to, permanent stormwater detention and water quality control measures and/or facilities, storm drainage collection and conveyance systems, open channel conveyance systems (i.e. ditches, swales, etc.), or other pertinent stormwater systems located on the project for both onsite and offsite improvements.
 - 12.5.3.3 Regional facilities which include, but are not limited, to identified regional roadway and storm drainage facilities.
 - 12.5.3.4 Federal Emergency Management Agency (FEMA) Letter of Map Revision (CLOMR/LOMR) processing and/or review fees, if applicable.
 - 12.5.3.5 Drainage Basin Fees, if applicable.
- 12.5.4 Other improvements or mitigation deemed necessary by the Department of Public Works and Development.
- 12.5.5 The Engineer's estimate shall apply a 15% contingency to the total cost of public improvements. If the Engineer's Cost Estimate (aka Exhibit A) includes separated bid schedules, the 15% contingency shall be applied to each individual bid schedule.

The Engineer of Record shall prepare the Engineer's Cost Estimate based on an itemized breakdown of costs for the public improvements in bid schedule format. The summary of quantities for the individual bid items shall be in accordance with the extent and scope of the improvements shown on the Construction Drawings. The Engineer shall make all best and reasonable efforts to itemize bid items to the extent practicable.

Items which cannot be reasonably itemized shall be included in a bid item titled "Non-itemized improvements" and shall be placed at the end of the bid schedule. A description of the work items that constitute the non-itemized improvements shall accompany the estimate when forwarded to the Engineering Services for review. A narrative containing the scope, justification, and rationale for estimated bid items (i.e. bid items that have estimated bid units, typically labelled as "EST.") shall also be provided if applicable.

Cost information used for preparation of the Estimate shall be based on recent and accurate bid-tab information for the Denver-Metro area. Cost data used shall be based on information no later than the prior year, unless the information is adjusted for inflation based on Colorado Department of Transportation (CDOT) Construction Cost Index (CCI). Adjustments for inflation shall be based on the CCI for the most recent quarter of the most recent year.

Unit costs shall include be based on complete, installed complete unit costs for the respective item of work. All indirect project costs shall be incorporated and/or distributed amongst the various bid items within the Engineers estimate. These indirect project costs shall include, but may not be limited to, indirect project costs such as mobilization, traffic control, materials, construction management and administration, testing and acceptance, traffic control, and other indirect construction labor, handling, and material costs.

The Engineer preparing, or overseeing the preparation of, the estimate shall review all itemized costs schedules for completeness and accuracy prior to submittal to the County (i.e. shall perform a quality control/quality assurance check of the information provided) and shall sign, date, and stamp the estimates with their professional engineering seal. The County shall not be responsible for any errors or omissions related to the preparation of Engineering Cost Estimates and reserves the right to all means and methods of costs recovery from the applicant / developer associated with insufficient collateral posted based on inaccurate or incomplete Engineering Estimates. No disclaimers to alleviate engineers responsibility for providing true and accurate costs estimates and information shall be allowed.

The Engineering Services Division keeps lists of minimum unit costs on the County website, which is updated from time to time. Minimum unit costs shall conform to recent bid item, unit, and material costs for the Denver-Metro area but shall be no lower than those shown on Arapahoe Counties minimum unit cost list. In cases where unit cost information is limited, or specific unit cost information is unknown, County staff may require the use of Colorado Department of Transportation (CDOT) Cost Data (See CDOT Cost Data Books at www.cdot.gov), or other approved cost sources, for unit cost information. The extent to which these minimum unit costs shall be required shall be up to the discretion of the case review engineer for the County.

Should a special improvement district be responsible for providing all or a portion of the required public improvements necessitated by the proposed land use, the type of improvements and associated costs shall be contained in a separate schedule within the estimate and clearly labeled to identify and delineate those the extent of improvements to be being provided by the special improvement district.

All Engineering Estimates will be reviewed and approved by the County's Engineering Services Division prior to being included as Exhibit A within the applicable Improvement Agreement.

12.5.6 Contingency and Non-Itemized Improvements

The Engineer's estimate shall apply a minimum 15% contingency to the total cost of public improvements to account for variability in actual costs, cost contingencies for inflation over the term of the Improvement Agreement, and to account for unanticipated changes and/or uncertainties in the cost of construction labor, shipping, materials, etc. The Department of Public Works and Development reserves the right to require contingencies greater than 15% in cases where there are larger project risks, for estimates that are prepared based on Construction Drawings that may be subject to change, when uncertainties exist in the proposed design or conceptual proposals for which the estimate is based, when the scope and extent of the

improvements are limited and may be subject to increased volatility and/or change in costs, or as required based on the sole discretion of Engineering Services staff.

Once all required information and documentation described has been prepared by the applicant, submitted to the Department of Public Works and Development, and has been approved by the Board of County Commissioners, in the form of an Improvement Agreement, the applicant is responsible for keeping the Improvement Agreement valid and enforced. It is the responsibility of the applicant to track the terms of the Improvement Agreements and apply for extensions prior to the expiration date of the Agreement. It is also incumbent upon the applicant to maintain collateral for the duration of the Agreement. Failure on behalf of the applicant to manage obligations outlined in the Agreements, or as otherwise contained within these standards, may result in Agreement termination, forfeiture of approval and vested rights, collection proceedings for collateral, assessment fines/fees, stop work orders, or other corrective actions taken or required by the County.

Should it be determined that the agreed public improvements will not be constructed within the term of the Improvement Agreement, the applicant should pursue a formal extension to the Improvement Agreement. The Department of Public Works and Development is available for further direction regarding the formal Improvement Agreement extension.

12.6 PUBLIC IMPROVEMENTS FOR OTHER LAND USE ACTIONS

Improvement Agreements, public improvements, and collateral for public improvements are essential parts of the Final Plat approval process. Because policies regarding responsibility for public improvements have changed over time, there are County land use change processes other than the Final Platting Process for subdivision that may require public improvements as a condition of BOCC or Planning Commission approval. These include the Final Site Development Plan process, the Location and Extent process, the Engineering Case process, the Master Development Plan process, the Administrative Site Plan process, the Subdivision Exemption process, the Right-of-Way Vacation process, and such other land use and development processes as are authorized under the Arapahoe County Land Development Code. If the County requires public improvements to be completed as a condition of BOCC or Planning Commission approval for any of the above referenced projects, a Subdivision Improvement Agreement and collateral shall be provided as described in Section 12.5 and other applicable regulations.

CHAPTER 13 FORMS



13.1 GENERAL

This chapter outlines the various forms and permits along with fees required. All forms shown herein are subject to alteration and update upon approval of the Director of Public Works and Development. Fees are subject to revision by resolution of the Arapahoe County Board of County Commissioners. A current fee schedule is available by contacting the Engineering Division at 720-874-6500.

13.2 STREET CUT AND ROW USE PERMIT

The following procedure applies to the preparation of this form.

13.2.1 Fill out blue spaces for the contact and project information section and questionnaire section.

 ARAPAHOE COUNTY		PUBLIC WORKS AND DEVELOPMENT			
STREET CUT ROW USE/POTHOLE PERMIT		BRYAN D. WEIMER, PWLF Director			
Date _____	STREET CUT PERMIT # _____	Lima Plaza 6924 South Lima Street Centennial, Colorado 80112-3853 720-874-6500 arapahoe.gov			
Parcel # _____	AC Reference # _____				
AC Project # _____	AC Project Name _____				
1. CONTACT INFORMATION					
Owner/Developer _____	Contractor _____				
Contact Name _____	Contact Name _____				
Address _____	Address _____				
City _____ State _____ Zip _____	City _____ State _____ Zip _____				
Phone _____	Phone _____				
Email _____	Email _____				
Bond <input type="checkbox"/> Yes <input type="checkbox"/> No	Bond Exp. Date _____	Certificate of Liability Ins. <input type="checkbox"/> Yes <input type="checkbox"/> No	Certificate of Liability Exp. Date _____		
2. PROJECT INFORMATION - ADDRESS/LOCATION/INTERSECTION					
General description of work to be done _____					
Asphalt (LF)	Concrete (LF)	# Potholes	# Manholes	# Handholds	# Vaults
Pipe Size (diameter)	Pipe Length (LF)	# Conduits	# Pedestals	Other _____	
<small>3. Required Attachments - Permits will not be processed without all of the required information - a) Attach Location or Construction Plans (If formal plans are required you will be notified by Arapahoe County) b) Attach Traffic Control Plan in conformance with the Manual of Uniform Traffic Control Devices. c) Open Space Tax Form must be filled out completely.</small>					
<small>4. Contractor Acceptance of Terms & Conditions - I understand that this permit is granted under the terms and conditions listed herein and the special terms and conditions of this permit. I understand that approved construction plans and the Arapahoe County Infrastructure Design and Construction Standards shall be the basis for acceptance of facilities built or repaired under this permit. I understand that upon completion of the work described herein, we shall notify the County by phone, e-mail, or mail. The work will be inspected and approved if acceptable. The permit will be assigned a date which will begin a one-year warranty period. If the work is not approved a repair list will be issued.</small>					
Contractor Signature _____			Date _____		

13.2.2 Sign and submit to County.

13.2.2.1 Requires developer to co-sign application if Final Acceptance of Subdivision has not been granted by the County.

13.2.2.2 Attach a location or construction plan.

13.2.2.3 Attach a traffic control plan compliant to MUTCD Part 6 “Temporary Traffic Control,” for traffic control during construction.

13.2.2.4 If a “road closure” is needed attach a road closure request form.

13.2.3 County will review application, calculate fees, and approve if all conditions are met. Upon approval the County will contact the applicant.


13.2.4 Fees must be paid to obtain permit.

- 13.2.5 Permit must have a bond and a certificate of liability insurance before a permit can be issued.
- 13.2.6 Permittee shall notify County Inspectors prior to commencement of work in accordance with permit terms and conditions (typically 48 hours prior to starting work).
- 13.2.7 The permittee shall return copy to Arapahoe County upon completion of work. The one-year warranty period for the permitted work shall not commence until the copy is received by Arapahoe County Public Works and Development and approved by the Engineering Inspector for the project.

13.3 PUBLIC IMPROVEMENTS CONSTRUCTION - PERMIT

The following procedure applies to the preparation of this form.

- 13.3.1 Fill out blue spaces in the application and contact information section.



ARAPAHOE COUNTY

PUBLIC WORKS AND DEVELOPMENT

BRYAN D. WEIMER, PWLF
Director

Lima Plaza
6924 South Lima Street
Centennial, Colorado 80112-3853
720-874-6500
arapahoe.gov.com

PUBLIC IMPROVEMENTS CONSTRUCTION PERMIT

Date _____ PUBLIC IMPROVEMENT PERMIT # _____

AC Project No. _____ Parcel # _____

AC Project Name _____

Project Address/Intersection _____

CONTACT INFORMATION

Owner/Developer _____	Contractor _____
Contact Name _____	Contact Name _____
Address _____	Address _____
City _____ State _____ Zip _____	City _____ State _____ Zip _____
Phone _____	Phone _____
Email _____	Email _____

Scope of work to be completed.

STREET IMPROVEMENTS					CONCRETE WORK					PIPELINE OR CABLE					DRAINAGE IMPROVEMENTS				
<input type="checkbox"/> Lime Treated Subgrade Prep					<input type="checkbox"/> Combination					<input type="checkbox"/> Unpaved Road					<input type="checkbox"/> Detention Ponds				
<input type="checkbox"/> Cement Treated A.B.C. Base					<input type="checkbox"/> Sidewalks					<input type="checkbox"/> Paved Road					<input type="checkbox"/> Rip Rap Placement				
<input type="checkbox"/> Asphalt Surfacing					<input type="checkbox"/> Curb & Gutter					<input type="checkbox"/> Stormy Sewer					<input type="checkbox"/> Concrete Trickle Channel				
<input type="checkbox"/> Concrete Paving					<input type="checkbox"/> Cross Pans/Valley Pans					<input type="checkbox"/> Water Main					<input type="checkbox"/> Conveyance Swale				
<input type="checkbox"/> Patching					<input type="checkbox"/> Curb Ramps					<input type="checkbox"/> Service Line					<input type="checkbox"/> Permanent BMP				
<input type="checkbox"/> Base Course					<input type="checkbox"/> Inlets/Manholes/Vaults					<input type="checkbox"/> Storm Sewer					<input type="checkbox"/> Bridge or Cast in Place Culverts				
<input type="checkbox"/> Overlay					<input type="checkbox"/> Pipe or Pre-Cast Box Culverts					<input type="checkbox"/> Utilities					<input type="checkbox"/> Storm Vaults, Inlets				

STREET IMPROVEMENTS					PIPE OR CABLE				
DESCRIPTION	QTY.	Unit Fee (\$/SY)	Base Fee	Subtotal	Pipe Line or Cable Size	QTY.	Unit Fee (\$/LF)	Base Fee	Subtotal
Asphalt Surfacing/Overlay/Paving	SY	.15	\$100		1/2" - 8"	LF	.28	\$100	
Cement treated A. B. C. Base	SY	.15	\$100		9" - 16"	LF	.39	\$100	
Concrete Paving	SY	.15	\$100		17" - 24"	LF	.55	\$100	
Lime Treated/Subgrade Prep	SY	.15	\$100		25" - 42"	LF	.77	\$100	
Patching	SY	.15	\$100		Over 43"	LF	.93	\$100	

Material Source Approvals - Special terms and conditions Traffic Control must comply with MUTCD

CONCRETE IMPROVEMENTS					DRAINAGE IMPROVEMENTS				
DESCRIPTION	QTY.	Unit Fee (\$/LF)	Base Fee	Subtotal	DESCRIPTION	QTY.	Unit Fee (\$/Unit)	Base Fee	Subtotal
Combination	LF	.25	\$100		Concrete Trickle Channel	EA		\$100	
Sidewalk	LF	.25	\$100		Conveyance Swale	EA		\$100	
Curb & Gutter	LF	.25	\$100		Permanent BMP	EA		\$100	
Cross Pans/Valley Pans	EA		\$100		Pond Construction	EA		\$100	
Curb Ramps	EA		\$100		Rip Rap Placement	CY	.28	\$100	
Inlets/Manholes/Vaults	EA		\$100		Storm Vaults (1 to 6')	EA		\$100	
Head Wall Toe Wall	EA		\$100		Storm Vaults (7 to 6')	EA		\$100	
Pipe or Precast Box Culvert (36")	LF	.77	\$100		Det. Pond (1 Ac. Ft.)	EA		\$100	
Pipe or Precast Box Culvert (36")	LF	.94	\$100		Det. Pond (10 Ac. Ft.)	EA		\$150	
Inlets or Junction Boxes (1 to 6')	EA		\$110		Det. Pond (10 Ac. Ft.)	EA		\$200	
Inlets or Junction Boxes (7 to 6')	EA		\$165		Det. Pond (100 Ac. Ft.)			Case by Case	
Other:					Bridges or Culvert Cast in Place			% of ECO	

Contractor Acceptance of Terms & Conditions. This information provided on this application is factual to the best of my knowledge. I understand that this permit is granted under terms and conditions and special provisions as noted above. I also understand that the approved construction plans and Infrastructure Design and Construction Standards shall provide the basis for County acceptance of facilities built or repaired under this permit. I further understand that the public improvements shall be constructed in substantial compliance with the construction plans approved by Arapahoe County Engineering Services on _____ or revised on _____

Contractor Signature _____ Date _____

Engineering Services Inspector Approval _____ Date _____

This permit expires on _____, OR 2 years from plan approval date.

ARAPAHOE COUNTY OPEN SPACE SALES & USE TAX FEE - List invoice costs for construction and building material used with this permit

Value of Materials \$ _____ Open Space Tax (0.0025%) Fee Due \$ _____ Tax Exempt Yes No Tax I.D. Number _____

TOTAL AMOUNT DUE \$ _____ Invoice and Issued by _____

- 13.3.2 Sign and submit to County with appropriate enclosures and attachments.
- 13.3.3 County will review application, calculate fees, and approve if all conditions are met.
- 13.3.4 Fees must be paid to obtain permit.

13.3.5 Permittee shall notify County Inspectors prior to Commencement of work in accordance with permit terms and conditions.

13.4 **GESC (GRADING, EROSION AND SEDIMENT CONTROL) PERMIT**

The following procedure applies to the preparation of this form.

13.4.1 Fill out blue spaces in the permit form.

 ARAPAHOE COUNTY		PUBLIC WORKS AND DEVELOPMENT	
STANDARD GRADING EROSION & SEDIMENT CONTROL PERMIT		BRYAN D. WEIMER, P.WLF Director	
Date _____	GESC PERMIT # _____	Lima Plaza 6924 South Lima Street Centennial, Colorado 80112-3853 720-874-6500 arapahoegov.com	
AC Project No. _____	Parcel # _____		
AC Project Name _____			
Project Address/Intersection _____			
CONTACT INFORMATION			
Owner/Developer _____		Contractor _____	
Contact Name _____		Contact Name _____	
Address _____		Address _____	
City _____	State _____	City _____	State _____
Zip _____		Zip _____	
Phone _____		Phone _____	
Email _____		Email _____	
ACRES (including grading/excavation/fill) _____		Estimated Material Volume (CY) _____	
By signing below, both applicants hereby apply for an Arapahoe County GESC Permit for the aforementioned property and certify as follows:			
1. To the best of my/our knowledge, the information provided herein is correct, and is consistent with the approved engineering plans.			
2. A GESC Plan for the disturbed area on this site was prepared in accordance with the GESC Manual, as amended and the Arapahoe County Stormwater Manual.			
3. I certify I am legally authorized to sign on behalf of and bind the above listed entity.			
The GESC Permit is granted with the explicit understanding that it is the permittee's responsibility to:			
1. Comply with all requirements in accordance with the Arapahoe County GESC Manual, Arapahoe County Stormwater Manual, GESC Plan and Report, and GESC Permit.			
2. Allow Arapahoe County, or its designee, unrestricted access to the site to conduct regular site inspections and to perform corrective actions in the event the Permittee fails to provide sufficient remedies to correct site deficiencies.			
3. Immediately cease land disturbing activities upon receipt of a written Stop Work Order from authorized representative of Arapahoe County. A Stop Work Order shall be issued and this permit revoked if the permittees are not in compliance with the Arapahoe County Stormwater Manual, GESC Permit, GESC Plan & Report and GESC Manual or the permittees fail to take corrective action within the time specified on the written notification of such non-compliance.			
4. Understand that in addition to other remedies, a violation of the GESC Permit shall constitute a violation of the Arapahoe County Zoning Resolution; and			
5. Understand any approval obtained from Arapahoe County does not absolve the need to comply with the requirements of Sections 7 and 9 of the Endangered Species Act of 1973, 16 U.S.C. 1531, et seq., as amended, or with any other applicable federal, state, or local laws or regulations.			
6. Eliminate designated hazards whenever an Arapahoe County representative determines that an excavation or embankment of fill on private property jeopardizes life and limb, or endangers property, or adversely affects the safety, use, or stability of a public way or drainage channel. Failure to eliminate a designated hazard within 48 hours will result in issuance of a Stop Work Order.			
Owner/Developer Signature _____		Print Name _____	
		Date _____	
Contractor Signature _____		Print Name _____	
		Date _____	


13.4.2 No grading, excavating or filling is allowed until permit is approved and issued by the County.

13.4.3 The County shall notify applicant when permit has been approved.

13.5 TRAFFIC SIGNING, STRIPING AND SIGNALIZATION PERMIT

The following procedure applies to the preparation of this form.

- 13.5.1 Fill out the blue spaces on contact information section, along with the traffic signals and sign inventory and the inclusion of traffic control plans and/or the marked signing/stripping plan. Be sure to sign and date the permit.



ARAPAHOE COUNTY

TRAFFIC SIGNING, STRIPING AND SIGNALIZATION PERMIT

PUBLIC WORKS AND DEVELOPMENT

BRYAN D. WEIMER, PWLF
Director

Lima Plaza
6924 South Lima Street
Centennial, Colorado 80112-3853
720-874-6500
arapahoe.gov

Date _____ TRAFFIC PERMIT # _____

AC Project No. _____ Parcel # _____

AC Project Name _____

AC Project Location _____

CONTACT INFORMATION

Owner/Developer _____

Contact Name _____

Address _____

City _____ State _____ Zip _____

Phone _____

Email _____

Contractor _____

Contact Name _____

Address _____

City _____ State _____ Zip _____

Phone _____

Email _____

The contractor is responsible for acquiring permits for any traffic devices required by plans or specifications. All devices must be in conformance with Arapahoe County material specifications and the Manual on Uniform Traffic Control Devices

TRAFFIC SIGNALS						
INTERSECTION:				Quantity	Unit Fee	Subtotal
				EA	\$1,000	
				EA	\$1,000	

TRAFFIC SIGNS							
Description	Quantity	Unit Fee	Subtotal	Description	Quantity	Unit Fee	Subtotal
Chevron Alignment	EA	\$75		Pavement Ends	EA	\$75	
Cross Road	EA	\$75		Reverse Sign	EA	\$75	
Crossing Signs (All)	EA	\$75		School Crossing	EA	\$75	
Curve Sign	EA	\$75		Speed Limit	EA	\$75	
Dead End / No Outlet	EA	\$75		Stop	EA	\$75	
Dip	EA	\$75		Stop / Yield / Signal Ahead	EA	\$75	
Keep Right	EA	\$75		Striping	EA	\$75	
Lane Reduction / Transition	EA	\$75		T-Symbol	EA	\$75	
Lane Use Control (All)	EA	\$75		Turn Sign	EA	\$75	
Large Arrow	EA	\$75		Yield	EA	\$75	
New Signals	EA	\$75		Other:			
No Parking Anytime	EA	\$75					
No Parking Fire Lane	EA	\$75					
No Trucks	EA	\$75					

Traffic Control Plan Attached Yes No

Marked Signing / Striping Plan Attached Yes No

CONTRACTOR SIGNATURE BLOCK: The information provided on this application is factual to the best of my knowledge. I understand that this permit is granted under the terms and condition enclosed and special provisions as noted above. I also understand that the approved construction plans and Infrastructure Design and Construction Standards shall provide the basis for County acceptance of facilities built or repaired under this permit. I further understand that the public improvements shall be constructed in substantial compliance with the construction plans approved by ARAPAHOE COUNTY ENGINEERING SERVICES on _____, or revised on _____, 20____.

Contractor Signature _____

Date _____



- 13.5.2 Attach approved plans or sketch of work to be performed.

- 13.5.3 Attach traffic control plan during construction compliant with MUTCD, Part 6 and PROWAG.

13.6 FLOODPLAIN DEVELOPMENT PERMIT

The following procedure applies to the preparation of this form.

13.6.1 Fill out blue spaces in the contact information, project information, and flood hazard data information sections.

 ARAPAHOE COUNTY		PUBLIC WORKS AND DEVELOPMENT	
FLOODPLAIN DEVELOPMENT PERMIT		BRYAN D. WEIMER, PWLF Director	
Date _____	FLOODPLAIN DEVELOPMENT PERMIT # _____	Lima Plaza 6924 South Lima Street Centennial, Colorado 80112-3853 720-874-6500 arapahoegov.com	
Parcel # _____	AC Project No. _____		
AC Project Name _____			
Project Address/Intersection _____			
			
CONTACT INFORMATION			
Owner/Developer _____		Contractor _____	
Contact Name _____		Contact Name _____	
Address _____		Address _____	
City _____ State _____ Zip _____	City _____ State _____ Zip _____		
Phone _____	Phone _____		
Email _____	Email _____		
PROJECT INFORMATION			
Permit Type: <input type="checkbox"/> Major <input type="checkbox"/> Minor	Project Size (acres) _____	Project Size (LF) _____	
Watercourse _____	Is Floodplain Impacted? Yes <input type="checkbox"/> No <input type="checkbox"/>		
Base (100YR) Flood Elevation _____	Does This Activity Impact BFE? Yes <input type="checkbox"/> No <input type="checkbox"/>		
CHANNEL IMPROVEMENTS <input type="checkbox"/> Bank Stabilization <input type="checkbox"/> Grade Control <input type="checkbox"/> Drop Structure <input type="checkbox"/> Outfall <input type="checkbox"/> Fill <input type="checkbox"/> Other _____	RECREATIONAL ACTIVITY <input type="checkbox"/> Trail Construction <input type="checkbox"/> Park <input type="checkbox"/> Pedestrian Bridge <input type="checkbox"/> Tot Lot <input type="checkbox"/> Common Area <input type="checkbox"/> Ball Field <input type="checkbox"/> Other _____	MISCELLANEOUS <input type="checkbox"/> Bridge <input type="checkbox"/> Parking Lot <input type="checkbox"/> Low Water Crossing <input type="checkbox"/> Pipe Install/Utility <input type="checkbox"/> Substantial Res Improvement (>50%) <input type="checkbox"/> Other _____	TYPE <input type="checkbox"/> Temporary <input type="checkbox"/> Permanent <input type="checkbox"/> Rehabilitation <input type="checkbox"/> Emergency Repair <input type="checkbox"/> Maintenance <input type="checkbox"/> Other _____
REQUIRED ATTACHMENTS (IF PREVIOUSLY PROVIDED, REFERENCE PROJECT NUMBER & NAME) - Supply 2 copies of each <input type="checkbox"/> Vicinity/Location Map <input type="checkbox"/> Description of Activity, including supporting documentation, i.e. Drainage Report, Floodplain Analysis, etc. <input type="checkbox"/> Construction Plans <input type="checkbox"/> GESC Permit <input type="checkbox"/> Engineer's Certification of Floodplain Impact Note: Other information may be required depending on requested activity			
Applicants Acceptance of Terms & Conditions. I have read this permit and I accept the terms and conditions listed on the attached page. I understand that this permit is granted under the terms and conditions listed therein, and the special terms and conditions listed in Section below. I understand that approved construction plans and the Arapahoe County Stormwater Management Manual shall be the basis for acceptance of development in the floodplain under this permit.			
Applicant Signature _____		Company Name _____	Date _____

13.6.2 Attach supporting documentation or reference for flood hazard data.

13.7 ROAD CLOSURE FORM

Fill out blue spaces on the applicant information and justification for request. This request comes from the County's Engineering Inspector.

SUBJECT: ROAD CLOSURE

Company/Contact Person Requesting Closure _____

Phone _____

Email _____

I am requesting permission to close _____ from _____
_____ to _____.

The dates of the closure will be from _____, 20__ to _____, 20__.


This closure is needed for: _____

A detour plan is attached.

13.8 APPLICATION FOR REVIEW AND APPROVAL

The following procedure applies to the preparation of this form.

13.8.1 Fill out all information.


 ARAPAHOE COUNTY		PUBLIC WORKS AND DEVELOPMENT	
ENGINEERING SERVICES TRANSMITTAL FORM		BRYAN D. WEIMER, PWLF Director	
Date Submitted	AC Project No.	Lima Plaza 6924 South Lima Street Centennial, Colorado 80112-3853 720-874-6500 arapahoegov.com	
AC Project Name		Project Address/Location	
CONTACT INFORMATION			
Owner/Developer		Applicant	
Contact Name		Contact Name	
Address		Address	
City	State	Zip	City
Phone			Phone
Email			Email
ITEMS SUBMITTED			
<input type="checkbox"/> Agreements <input type="checkbox"/> Collateralized <input type="checkbox"/> Restriction <input type="checkbox"/> Changes to Approved Construction Plans <input type="checkbox"/> Construction Plans <input type="checkbox"/> Drainage Conformance Letter <input type="checkbox"/> Drainage Report Phases 1, 2, 3 <input type="checkbox"/> Engineers Cost Estimate <input type="checkbox"/> Floodplain Documents <input type="checkbox"/> GESC Disturbed Acres <input type="checkbox"/> Standard <input type="checkbox"/> Low Impact <input type="checkbox"/> Small Site		<input type="checkbox"/> Landscape & Irrigation Plans <input type="checkbox"/> Operation & Maintenance Manual <input type="checkbox"/> Pavement Design <input type="checkbox"/> Soils Report <input type="checkbox"/> Traffic Impact Study <input type="checkbox"/> Utility Plans <input type="checkbox"/> Waiver Requests <input type="checkbox"/> Other	
This Application is (check one) <input type="checkbox"/> 1 st Submittal <input type="checkbox"/> 2 nd Submittal <input type="checkbox"/> 3 rd Submittal <input type="checkbox"/> Additional Submittal <input type="checkbox"/> Final Submittal			
Submitted By		Date	

13.8.2 Sign and submit to County with appropriate submittals.

13.8.3 County will review the submittals and notify the applicant when the review is done.

13.9 **OVERSIZE/OVERWEIGHT VEHICLE PERMIT**

Fill out all information requested in the blue spaces and description of the route.



ARAPAHOE COUNTY

OVERSIZE/OVERWEIGHT MOVING PERMIT

PUBLIC WORKS AND DEVELOPMENT

BRYAN D. WEIMER, PWLF
Director

Lima Plaza
6924 South Lima Street
Centennial, Colorado 80112-3853
720-874-6500
arapahoegov.com

Date _____ OVERSIZE PERMIT # _____

Parcel # _____

CONTACT INFORMATION

Company Name _____

Billing Contact Information _____

Address _____ City _____ State _____ Zip _____

Phone _____ Email _____

Certificate of Liability Insurance- Yes No Certification of Liability Expiration Date _____


Moving Date(s) (between daylight and dark) _____ Times(s) _____

Estimated Weight of Vehicle and load _____ Number of Axles _____ Pilot Vehicles Required- Yes No

Type of Load - Structure; Frames, Tanks, Beams, etc.; Brick Building; Oil Drilling Rig; Water Drilling Rig; Working Rig;
 Other _____

Origin _____ Destination _____

Route From _____ To _____



This permit becomes void during blizzard, heavy snow or icy road conditions. Applicant shall take every precaution to protect highway and traffic from damage or injury and is to be financially responsible for any damage. It is further understood that this permit is valid only on the highways and/or streets under the jurisdiction of the Arapahoe County Board of Commissioners and that, under section 168 of the Uniform Safety Code of 1935 to operate on highways under other jurisdiction (State Highways or local streets) it is necessary to obtain a separate permit from the entity involved.

Please Note-

1. Mover is required to contact the appropriate Fire District _____ at least 24 Hours prior to entering Fire District.
2. Mover is required to give Arapahoe County Sheriff's Office 24-hour notice to enter Arapahoe County jurisdiction 303-795-4711 or fax 720-874-3775.
3. Please call 720-874-6500 if further information about this permit is required.

Applicant Signature _____ Date _____

Table 13-1

FORMS REQUIRED AND AREAS OF APPLICATION		
TITLE	USED BY	WHEN USED
Street Cut and ROW Use Permit	Permittee	When applying to construct, install, remove, or repair, a utility line, signs and other facilities within the County ROW or easement.
Public Improvements Construction Permit	Permittee	When applying to construct any street or storm drainage Improvements or any improvements in the County ROW or easement.
GESC (Grading, Erosion and Sediment Control) Permit	Permittee	When applying for approval to move any earth, either cut, excavation, or fill on County ROW or on private property.
Traffic Signing, Striping and Signalization Permit	Permittee	Any request for a private contractor to install, remove or otherwise modify signs, traffic striping, or signals maintained or to be maintained by Arapahoe County.
Floodplain Development Permit	Permittee	When applying to perform any grading, excavation or installation of facilities within an established floodplain.
Road Closure Form	Permittee	When no other options are available and the road must be closed overnight to perform the necessary work. This form is necessary not only as an application for County Approval but for referral to other agencies using this roadway, including school districts, police, fire and other agencies.
Application for Review and Approval	Applicant	Any submittal of engineering plans, reports, cost estimates, etc., directly to the PWD for review and comment or approval.
Oversize/Overweight Vehicle permit	Permittee	Any request for transportation of vehicles or material, which exceed size or weight requirements as established by the State of Colorado or Arapahoe County.
Open Space Tax Form	Permittee	A completed Open Space Tax Form shall accompany any Request for Permits. The Open Space Tax shall be paid as part of the Permitting Fees.

CHAPTER 14 SMALL CELL WIRELESS COMMUNICATION FACILITY

14.1 INTRODUCTION

This Chapter 14 sets forth and establishes the procedures, requirements and design standards for location of Small Cell Wireless Communication Facilities (Small Cell WCF) within Arapahoe County rights of way (ROW). In order to facilitate public access to a wide range of telecommunication, broadband and wireless services and in accordance with Sections 29-27-401, *et seq.*, Colorado Revised Statutes (CRS), Sections 38-5.5-101, *et seq.*, CRS, and the applicable provisions of the Telecommunications Act of 1996, including Sections 253 and 332, and as interpreted by Federal Communications Commission Order 18-133 (Sept. 26, 2018), Small Cell WCF are authorized to be located within publicly owned or controlled public ROW, subject to the consent of the jurisdiction controlling the ROW.

In order to accommodate such Small Cell WCF and facilitate public access to wireless communication in a manner that does not create a safety concern for the traveling public or otherwise create the unsightly or overly congested use of the ROW by such facilities, the Arapahoe County Board of County Commissioners hereby establish the following design standards for such facilities proposed to be located in County owned or controlled public road ROW.

The following design standards and procedures for location of Small Cell WCF within the ROW are intended to ensure a complete, thorough, and consistent review of these proposals, without creating barriers to the deployment of wireless communication services in accordance with state and federal law. These design standards may be revised as appropriate and in accordance with State and federal law to address technological changes in the Telecommunication Industry or as necessary to provide for the efficient, safe and appropriate function of the public ROW.

14.2 DEFINITIONS

As used in this Chapter 14, Small Cell WCF mean and include small cell facilities as defined in Section 29-27-402(4), CRS, as amended. This Section currently provides:

14.2.1 (4)(a) “Small cell facility” means:

A wireless service facility that meets both of the following qualifications:

(I) Each antenna is located inside an enclosure of no more than three cubic feet in volume or, in the case of an antenna that has exposed elements, the antenna and all of its exposed elements could fit within an imaginary enclosure of no more than three cubic feet; and

(II) Primary equipment enclosures are no larger than seventeen cubic feet in volume. The following associated equipment may be located outside of the primary equipment enclosure and, if so located, is not included in the calculation of equipment volume: Electric meter, concealment, telecommunications demarcation box, ground-based enclosures, back-up power systems, grounding equipment, power transfer switch, and cut-off switch.

14.2.2 (b) “Small cell facility” includes a micro wireless facility.

14.3 APPLICATION PROCESS

14.3.1 The Application Process is outlined in Chapter 2 Submittal Procedures of the Infrastructure Design and Construction Manual.

14.4 SMALL CELL WCF IN THE ROW DESIGN STANDARDS

14.4.1 The following design standards shall apply to all Small Cell WCF proposed to be located within Arapahoe County owned or controlled public ROW.

14.4.2 Any new Small Cell WCF proposed in the ROW shall be located and deployed in accordance with the County's approval, which approval will take into consideration and be based upon the following hierarchy of preference for location and deployment:

- Any small cell facility to be located in the right of way in an Unincorporated Arapahoe County requires a small cell facility master license agreement between the WCF Provider and the Board of County Commissioners of the County Of Arapahoe.
- The Small Cell WCF shall be collocated and attached to an existing and previously approved Small Cell WCF in the ROW.
- The Small WCF shall be attached to an available and existing structure previously approved in the ROW, either a County owned structure or a third-party owned with the third-party owner's permission. Proposals for attachment to traffic signals shall be independently evaluated for potential transmission or other interference issues as well for structural integrity and shall be subject to the engineering certification requirements contained in these standards.
- A staff engineer, with input from the County Transportation Division and Technical Review Committee (TRC), determines that there is a public safety need for a streetlight at the particular location, the Small Cell WCF shall be mounted on a new free standing structure with an integrated streetlight. New free-standing structures with integrated lights shall be poles that allow for collocation.
- The staff engineer with input from the County Transportation Division and Technical Review Committee (TRC) determines that there is no public safety need to put a streetlight at the particular location. The Small Cell WCF shall be mounted on a new free-standing structure but no integrated streetlight will be required. New free-standing structures shall be poles that allow for collocation.

14.4.3 Subject to the above hierarchy of deployment options, all Small Cell WCF to be located within ROW shall also comply with the applicable standards provided below in Section 14.4.4. Applicants may apply for waivers or variances from the strict application of the above hierarchy or the specific design standards specified below in Section 14.4.4.

14.4.4 Specific Design Standards Applicable to the Type of Attachment or Location of Attachment:

- 14.4.4.1** Attachment to or replacement of existing light pole, utility pole, traffic signal, or other vertical infrastructure:
- Owner of vertical infrastructure must approve use.
 - Facility must not exceed height of existing infrastructure by more than ten feet.

- Maximum antenna/equipment enclosure of 3.0 cubic feet, whether pole- or strand-mounted.
- A single pole/strand mount may have up to two antenna/equipment enclosures.
- If mounted above the existing pole, antenna must be concealed within a shroud (“cantenna”) with a tapered transition from antenna shroud to pole.
- If replacing existing pole or if existing pole accommodates internal wiring, all wiring shall be internal to the pole.
- Facility, including ground-mounted equipment, must not conflict with traffic operations.
- Shall not be in a drainage easement, roadside ditch, swale, etc.
- Shall avoid existing underground utilities or conduit
- Shall not interfere with traffic operations.
- Shall not encroach into pedestrian ways such as sidewalks, trails, or transit stops.

14.4.4.2 Strand-Mounted Small Cell:

- Equipment attached to vertical infrastructure must be less than 3 cubic feet in volume.
- Equipment attached to strands must be less than 3 cubic feet in volume.
- Owner of vertical infrastructure must approve use.
- Applicant must still apply for and receive a Street Cut/Right-of-Way Use permit.

14.4.4.3 Freestanding Small Cell Pole (with integrated street light):

- Pole construction shall match street lighting in the area, generally:
 - Round, straight, galvanized steel (or similar to other street lighting in area).
- Equipment cabinet and pole shall be galvanized in accordance with AASHTO standards.
- Equipment cabinet shall be integrated in base of pole.
- Equipment cabinet shall be round.
- Pole shall be painted to match existing streetlights or traffic signal poles or shall be painted black with a finish spec F264A if no other vertical poles in the area.
- Antennas must be concealed within a shroud (“cantenna”) and must include tapered transition from antenna shroud to pole.
- Antenna/shroud shall be a maximum of 8’-0” in height.
- Maximum antenna/equipment enclosure of three (3) cubic feet.
- Breakaway supports should be used unless Clear Zone Analysis indicates otherwise. Mass of breakaway support should not exceed 1,000 lbs. as defined in the AASHTO Roadside Design Guide.
- Maximum total pole height (including antenna).
 - 40’ in non-residential areas (or height of other adjacent street lights).
 - 30’ in residential areas.
- Maximum equipment cabinet height: 6’-0”.
- Pole location (with integrated street light):
 - Shall only be placed where a street light is specified by the Staff Engineer and as provided in these Standards (generally, unless specified otherwise by the Staff Engineer for public safety purposes, lighted locations will be at street intersections or commercial/multi-family access drives).

- Existing infrastructure shall be used if available.
- No minimum spacing required if replacing existing vertical infrastructure.
- Placed on common property lines separating properties or located at a street intersection.
- Shall not be in a drainage easement, roadside ditch, swale, etc.
- At least 15 feet from existing trees.
- Shall not interfere with traffic operations.
- Shall not encroach into pedestrian ways such as sidewalks, trails, or transit stops.

14.4.4.4 Freestanding Small Cell Pole (without integrated street light):

- Pole design and manufacture:
 - If no other vertical infrastructure present in area: round, straight, galvanized steel, painted with black gloss with a finish spec F264A.
 - If other vertical infrastructure is present in area: design must be compatible with nearby poles (similar color/appearance).
 - Pole shall be designed to accommodate two small cell antennas in order to promote collocation.
- Equipment cabinet and pole shall be galvanized in accordance with AASHTO standards.
- Equipment cabinet shall be integrated in base of pole.
- Equipment cabinet shall be round.
- Wiring shall be internal to the pole.
- Pole shall be painted to match existing streetlights or traffic signal poles.
- Antenna must be concealed within a shroud (“cantenna”).
- Must include tapered transition from antenna shroud to pole.
- Antenna/shroud shall be a maximum of 8’-0” in height.
- Maximum antenna/equipment enclosure of three (3) cubic feet.
- Breakaway supports should be used unless Clear Zone Analysis indicates otherwise. Mass of breakaway support should not exceed 1,000 lbs as defined in the AASHTO Roadside Design Guide
- Maximum total pole height (including antennas):
 - 40’ in non-residential areas.
 - 30’ in residential areas.
- Maximum equipment cabinet height: 6’-0”.
- Pole separation:
 - Freestanding small cell poles - - shall be separated from other vertical infrastructure (light poles, traffic signals, utility poles, etc.) by at least 600 feet.
 - Freestanding small cell poles shall be placed on alternating sides of the street where feasible.at 600 feet radially.
- Pole placement requirements:
 - Located at a street intersection or placed on common property lines separating properties or within 15’ of property line if placement on property line is not feasible.
 - Shall not be in a drainage easement, roadside ditch, swale, etc.
 - At least 15 feet from existing trees.
 - Shall not interfere with traffic operations.

- Shall not encroach into pedestrian ways such as sidewalks, trails, or transit stops.
- In accordance with the provision of 14.6 below, pole location variances of up to 50 feet may be authorized with justification based on meeting other technical requirements (sight triangles, trees, traffic operations, need to place on common property lines, or where requirements described herein are demonstrated to be an effective prohibition of the ability to provide wireless service).

14.5 Engineering Review

14.5.1 Pole location

- Call 811 for Utility Locates before working in the right of way. Confirm with all utility districts for any crossing restrictions
- Confirm location does not obstruct, impede, or hinder pedestrian or vehicular traffic
- Avoid planned roadway improvements/ development/ bike path
- Avoid drainage constraints (swale, roadside drainage, drainage easement)
- Preferably close to corner of two intersecting streets or closest to common side yard property line between adjacent adjoining properties
- New freestanding Small Cell WCF poles are - to be located within 600' radially from an existing freestanding Small Cell WCF
- Not to be located along the frontage of a historical landmark
- Not to be located in a manner that obstructs access to adjacent property
- Not to be located in a valuable sightline of an adjacent property (window of a residence, mountain view, etc.)
- In alignment with existing street trees, utility/ street light poles
- Minimum 15' from existing trees so as not to disturb the root zone
- Minimum 5' from low pressure gas line or 15' from high pressure gas line.

14.5.2 Undergrounding of Equipment - Ancillary equipment that is not integrated in the pole, such as cabinets or boxes, will be required to be located underground where necessary for traffic safety purposes or where the above ground presence of the box or cabinet will not be aesthetically consistent with the community or neighborhood in which the Small Cell WCF is proposed.

14.5.3 Construction Document Requirements – see 14.8 Small Cell WCF Submittal Checklist

14.5.4 Clear Zone Analysis – see 14.8 Small Cell WCF Submittal Checklist

14.5.5 Attachment to County Owned Structure - For any Small Cell WCF proposed to be located on any County owned structure within the ROW, the application submittal materials shall include all appropriate engineering plans and specifications showing such detail of the Small Cell WCF and its location as is reasonably required by the County to evaluate the impacts of the Facility to the ROW and the County structure. The engineering plans and specifications shall also include appropriate Professional Engineer stamped certification(s) in the State of Colorado that: (1). the Small Cell WCF's operation will not interfere with the proper function of the

particular County structure upon which it is proposed for attachment, and (2). that the structural and loading capacity of that Infrastructure will support the Facility proposed to be attached. The manner of attachment and construction of such Facility and the Facility's operations shall comply with the approved plans and specifications.

14.5.6 License Agreement

14.5.6.1 Applicant shall enter into a Master License Agreement (MLA) with the County or signed site supplement for each location as provided under these Standards. The Master License Agreement will require a Site Supplement to evidence the County's approval of Small Cell WCF location and attachment within the ROW. Unless otherwise provided in the MLA, the County will issue an approved Site Supplement for attachment to a third-party owned structure that the County has previously authorized within the ROW provided the applicant supplies the County with a letter or other written authorization from the owner of the third-party structure and provided that the Small Cell WCF does not involve any ground-based equipment or otherwise increase the footprint of the third-party structure.

14.5.6.2 Site Supplements under an MLA or for attachment to a third-party owned structure, once approved and executed by the Director of the Arapahoe Department of Public Works and Development, will be a requirement for approval of the proposed Small Cell WCF within the ROW at the approved location.

14.5.6.3 Site Supplement are available from the County Engineering Service Division and will be sent to applicant for review with 1st submittal redline comments.

14.5.7 Other Permitting and Inspection

14.5.7.1 Street Cut / ROW Use Permit

- Permit will be required for all equipment and conduit associated with the Small Cell WCF that is within the ROW
- Permit will be required to access county right-of-way onto a private property installing a Wireless Communication Facility.
- \$20,000 Permit Bond and Certificate of Liability Insurance

14.5.7.2 Building/Electrical Permits

- Appropriate building and electrical permits will be required for each small cell as required under the Arapahoe County Building Code. Applicant shall submit such building and electrical permit application(s) separately to the Arapahoe County Building Department for review and approval.

14.5.7.3 Acceptance - GIS Shape file must be submitted to the County with the following information.

- Address
- Owner
- Facility description (freestanding, collocation, etc.)
- Pole height
- Survey grade shape file

14.5.8 Radio Frequency Emission Certification - For all Small Cell WCF proposed for any location within the ROW, the application shall include a certification from a qualified engineer that the proposed Small Cell WCF complies with all applicable radio frequency (RF) emission health standards.

14.6 ADMINISTRATIVE WAIVER

14.6.1 Any of the above design standards may be waived by the Director of Arapahoe County Public Works and Development upon written application that demonstrates the following waiver criteria:

- The design standard prohibits or has the effect of prohibiting the provision of wireless service through the Small Cell WCF at the particular location because the particular standard will not allow the technology to function at that location; and
- There is no existing nearby alternate structure for collocation or attachment that will provide the technological functionality and which otherwise meets the design standard sought to be waived; and
- The proposal for varying from the design standard represents a reasonable and best approximation of the particular standard sought to be waived; and
- The proposed alternative does not and will not constitute or create any public safety, health or welfare concern.

14.6.2 If any particular design standard is approved for waiver, the Small Cell WCF proposed shall nevertheless meet all other applicable design standards not approved for waiver.

14.6.3 If a waiver request is denied for failure to meet any of the criteria specified above and there is no alternative for installation of the Small Cell WCF at the particular location in a manner that meets the applicable design standards, then such application for the Small Cell WCF for such specific location shall be denied.

14.7 FEES

Fees for ROW access for attachment of Small Cell WCF to County owned property in the ROW and fees for review of applications for Small Cell WCF proposed for location within County ROW shall be paid in accordance with the Engineering Services Division schedule of fees. This fee is approved and revised from time to time by the Arapahoe County Board of County Commissioners. Such fees shall be no more than the amounts reasonably necessary to recoup the County's costs.

14.8 SMALL CELL WCF SUBMITTAL CHECKLIST

Refer to Appendix F for the submittal checklist which is to be included with submittal packet.

APPENDIX A – STANDARD DETAILS

APPENDIX A
STANDARDS DETAILS

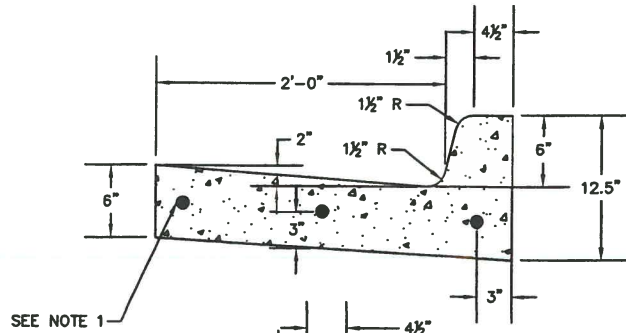
STANDARD DETAIL INDEX

Detail	Detail #
Curb, Gutter, & Sidewalk-Vertical Curb	SP-1
Curb, Gutter, & Sidewalk-Sidewalk and Construction Joints	SP-2
Curb, Gutter, & Sidewalk-Sidewalk and Construction Joints & Notes	SP-3
Residential Driveway Depressions	SP-4
Residential Driveway Depressions	SP-5
Crosspans Type 1	SP-6
General Notes & Pay Areas	SP-7
Type 1 Perpendicular Curb Ramps	SP-8A
Type 1 Curb Ramps Typical Configurations	SP-8B
Type 2 Parallel Curb Ramps	SP-8C
Type 2 Curb Ramps Typical Configurations	SP-8D
Combination Curb Ramps Typical Configurations	SP-8E
Type 5 – Depressed Corner/Blended Transition	SP-8F
Medians/Railroads/Islands	SP-9
Detectable Warning Surface Placement	SP-10A
Detectable Warning Surface Details	SP-10B
Curb Inlet Type R	SP-11a
Curb Inlet Type R	SP-11b
Curb Inlet Type R	SP-11c
Curb Inlet Type R	SP-11d
Curb Inlet Type 13	SP-12
Curb Inlet Type 13	SP-13
Curb Inlet Type C	SP-14a
Curb Inlet Type C	SP-14b
Manhole Ring and Cover Adjustment	SP-15

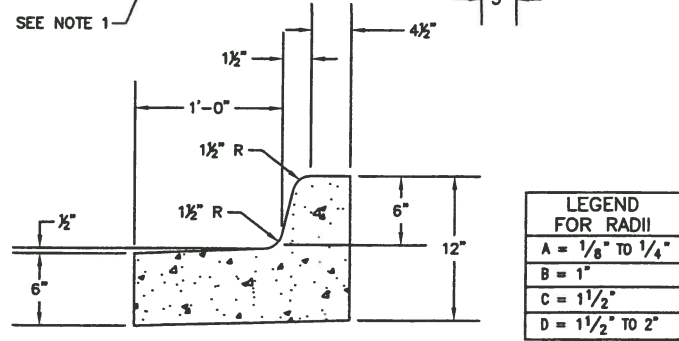
STANDARD DETAIL INDEX

Detail	Detail #
Sidewalk Chase	SP-16a
Sidewalk Chase	SP-16b
Range Box	SP-17
Trench Patch Detail	SP-18
Driveway Culvert Detail for Non -Curbed Rural Areas	SP-19
Utility Line Location-General	SP-20
Utility Line Location-General	SP-21
Utility Line Location-General	SP-22
Intersection Separation	SP-23A
Intersection Separation	SP-23B
Knuckles	SP-24
Maximum Permissible Intersection Grades	SP-25
Sight Triangles	SP-26
Typical Public & Private Roadway Cross Sections	Pages 1-18

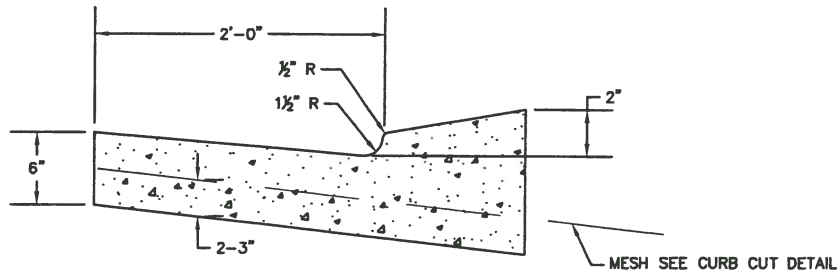
**VERTICAL CURB
& GUTTER**



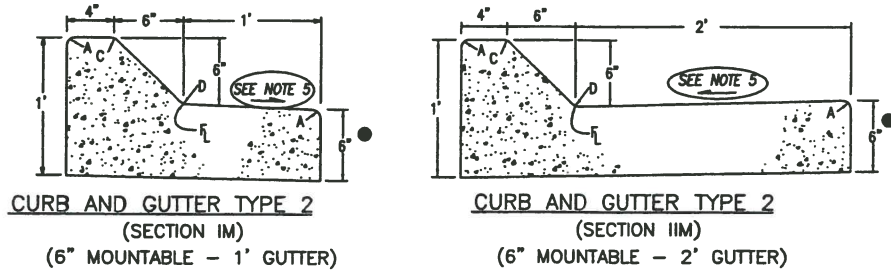
**MEDIAN
CURB & GUTTER**



**TYPICAL
CURB & GUTTER
AT DRIVEWAY**



**TYPICAL
HIGH SPEED
TYPE 2
(FROM CDOT M&S
STANDARDS)**



NOTES:

1. NO. 4 REBAR SHALL BE USED IN ALL CURB RETURNS WITH 25' OR LARGER RADII. THE REBAR SHALL BE USED FROM BEGINNING TO END OF THE CURB RETURN.
2. AT THE LOW POINT(S) OF EACH MEDIAN A DRAIN SYSTEM SHALL BE DESIGNED TO CONVEY STORM AND IRRIGATION FLOWS.
3. NATIVE SUBGRADE UNDER CURB AND GUTTER TO BE COMPACTED TO THE SPECIFICATIONS IN CHAPTER 8 OF THESE STANDARDS.
4. CHANGES TO THE HIGH SPEED TYPE 2 CURB AND GUTTER DETAIL IN THE CDOT M&S STANDARDS SHALL OVERRULE THIS DETAIL.
5. GUTTER CROSS SLOPE SHALL BE 1/2" PER FOOT WHEN DRAINING AWAY FROM CURB AND 1" PER FOOT WHEN DRAINING TOWARD CURB.

Drawn By: SBW *SBW*

Checked By: *AM*

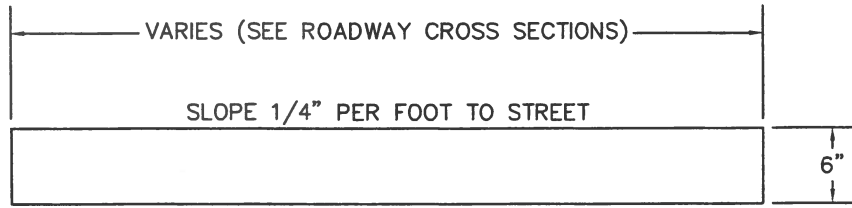
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CURB, GUTTER AND SIDEWALK
VERTICAL CURB

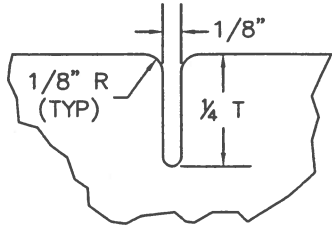
Issued: 5/10/05

Revised: 8/31/06

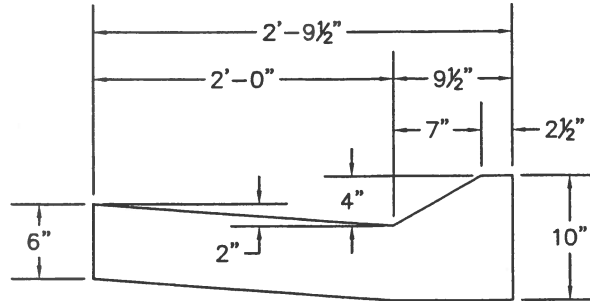
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SP. 1



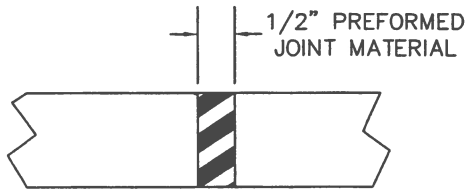
ATTACHED OR DETACHED WALK



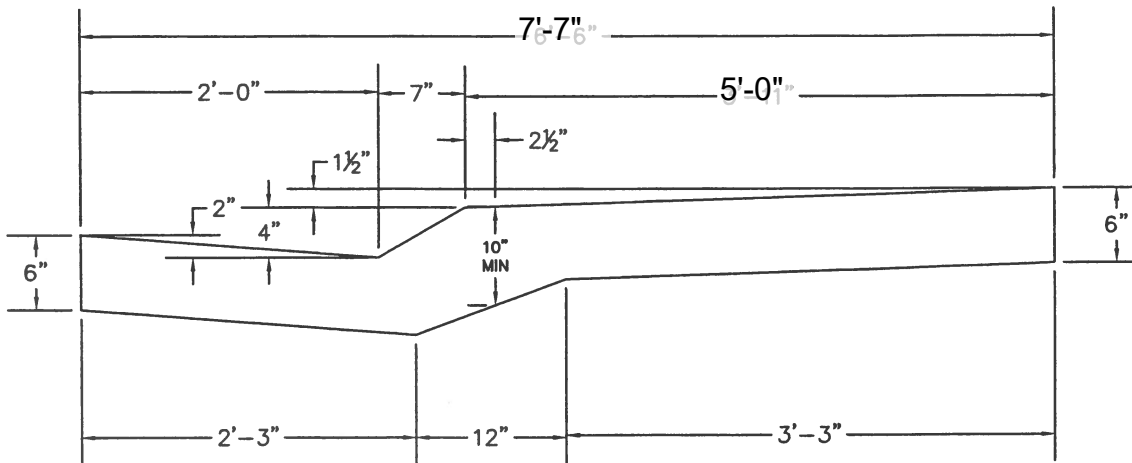
CONTRACTION OR WEAKENED PLANE JOINT



4" MOUNTABLE CURB & GUTTER



EXPANSION JOINT



MOUNTABLE COMBINATION CURB, GUTTER & WALK

Drawn By: SBW *SBW*

Checked By: *[Signature]*

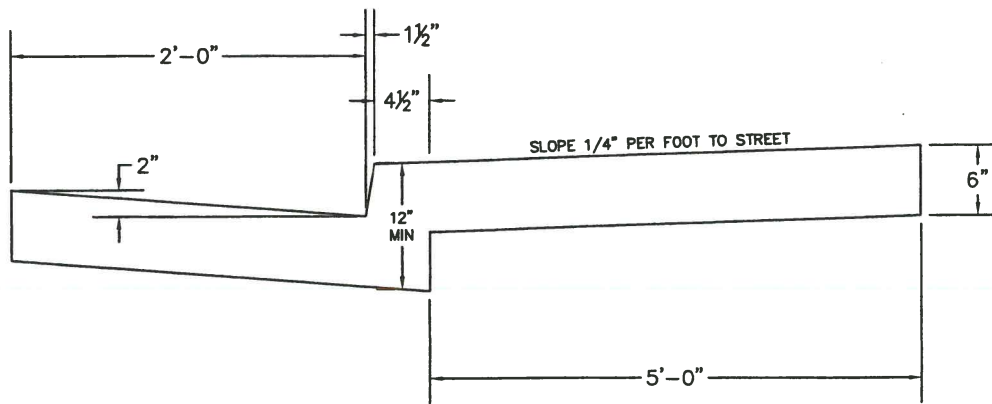
Approved By: *[Signature]*

CURB, GUTTER AND SIDEWALK
SIDEWALK AND CONSTRUCTION JOINTS

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 2



COMBINATION
VERTICAL CURB,
GUTTER & WALK

SIDEWALK, CURB AND GUTTER NOTES:

ALL SIDEWALK, CURB AND GUTTER CONSTRUCTION SHALL CONFORM WITH THE MGPEC STANDARDS FOR MATERIALS AND CONSTRUCTION INCLUDING BUT NOT LIMITED TO THE FOLLOWING;

1. ALL SIDEWALK, CURB AND GUTTER SUBGRADE SHALL CONFORM WITH THE REQUIREMENTS SET FORTH FOR THE ADJACENT ROADWAY AS DEFINED IN THE PAVEMENT DESIGN REPORT.
2. CURB AND GUTTER EXPANSION JOINTS SHALL BE 1/2-INCH WIDE AND CONSTRUCTED AT 90-FOOT INTERVALS. EXPANSION JOINTS SHALL BE FILLED WITH JOINT FILLER STRIPS, 1/2-INCH THICK CONFORMING TO ASTM D 1751, FIBER TYPE AND SHALL BE FURNISHED IN A SINGLE PIECE FOR THE FULL DEPTH AND WIDTH REQUIRED FOR THE JOINT.
3. SIDEWALK EXPANSION JOINTS SHALL BE 1/2-INCH WIDE AND CONSTRUCTED AT 100-FOOT INTERVALS. EXPANSION JOINTS SHALL BE FILLED WITH JOINT FILLER STRIPS, 1/2-INCH THICK CONFORMING TO ASTM D 1751, FIBER TYPE AND SHALL BE FURNISHED IN A SINGLE PIECE FOR THE FULL DEPTH AND WIDTH REQUIRED FOR THE JOINT.
4. JOINT FILLER SHALL BE PLACED WITH THE TOP EDGE 1/4-INCH BELOW THE CONCRETE SURFACE AND SHALL BE HELD IN PLACE BY STEEL PINS DRIVEN INTO THE SUBGRADE AT SPACING ADEQUATE TO PREVENT ANY WARPING OF THE FILLER DURING FLOATING. UPON COMPLETION OF FLOATING THE STEEL PINS SHALL BE REMOVED AND WHEN FINISHING OPERATIONS HAVE BEEN COMPLETED, THE JOINT SHALL BE EDGED WITH AN EDGING TOOL HAVING A RADIUS OF 1/8-INCH.
5. TRANSVERSE CONTRACTION (DUMMY) JOINTS SHALL BE SPACED AT THE FOLLOWING INTERVALS:
 1. 10-FOOT SPACING FOR ALL COMBINATION CURB, GUTTER AND SIDEWALK.
 2. 10-FOOT SPACING FOR ALL CURB AND GUTTER, CURBHEAD OR MOUNTABLE CURB AND GUTTER.
 3. 5-FOOT SPACING FOR ALL DETACHED SIDEWALKS.

Drawn By: SBW *SBW*

Checked By: *[Signature]*

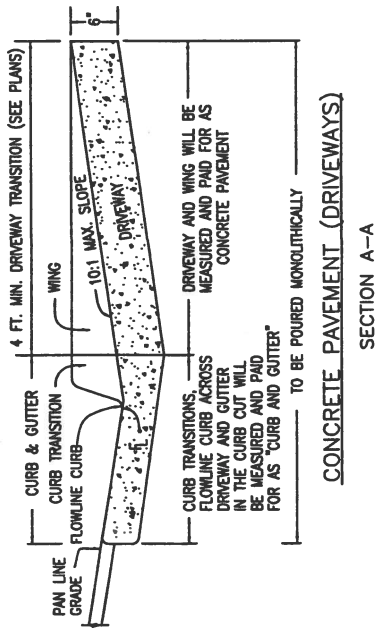
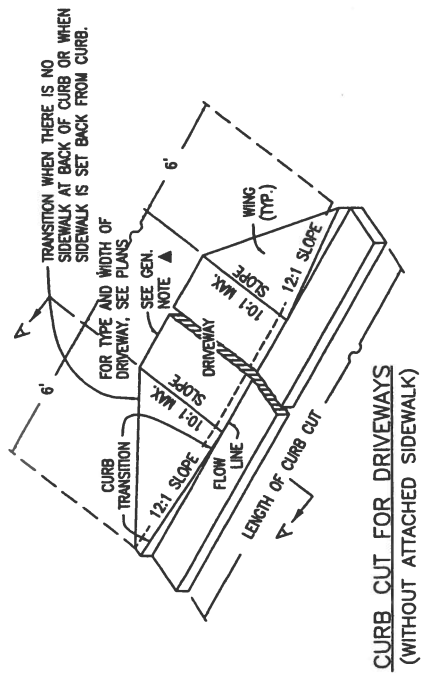
Approved By: *[Signature]*

CURB, GUTTER AND SIDEWALK
SIDEWALK, CONSTRUCTION JOINTS
AND NOTES

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 3



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Checked By: *[Signature]*

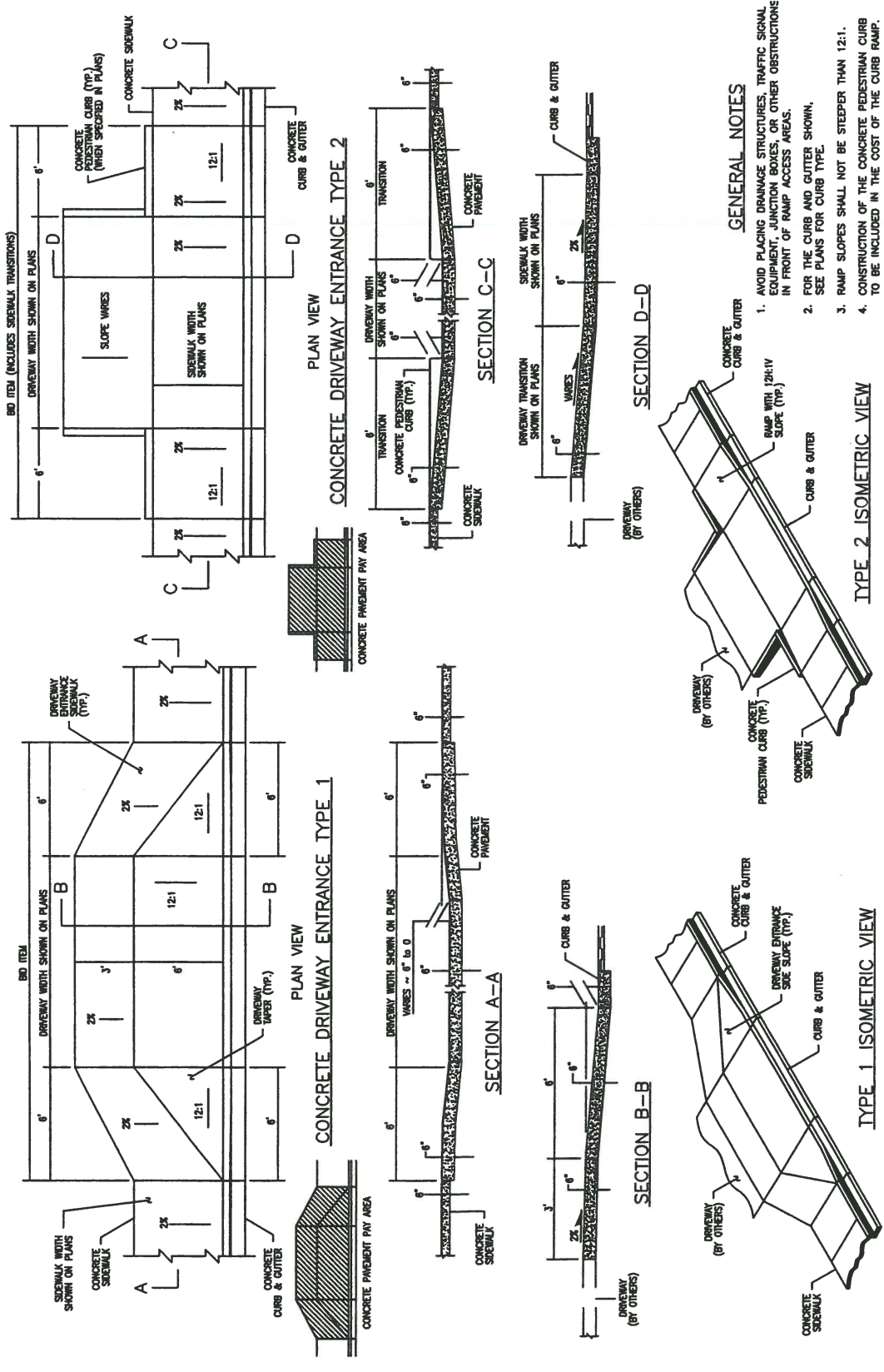
Approved By: *[Signature]*

RESIDENTIAL DRIVEWAY
DEPRESSIONS

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 4



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Checked By: *[Signature]*

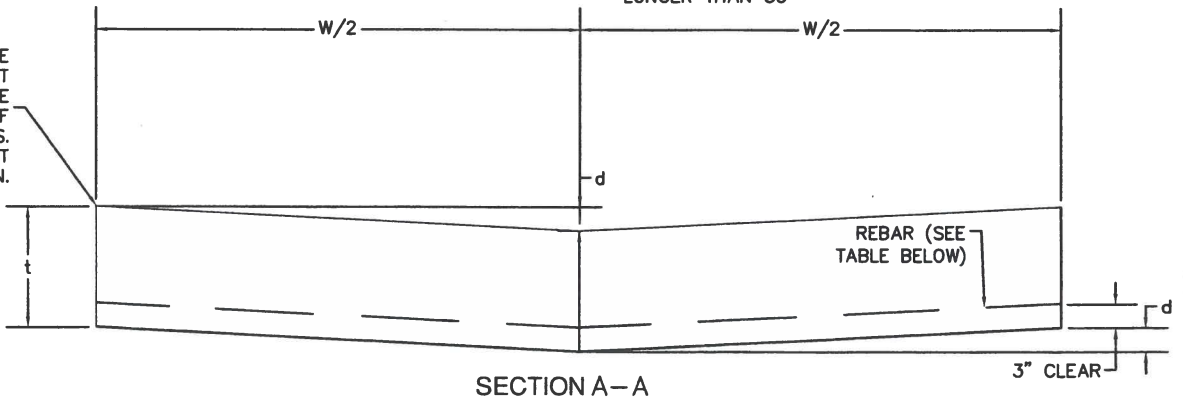
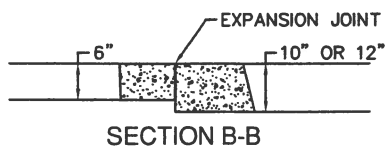
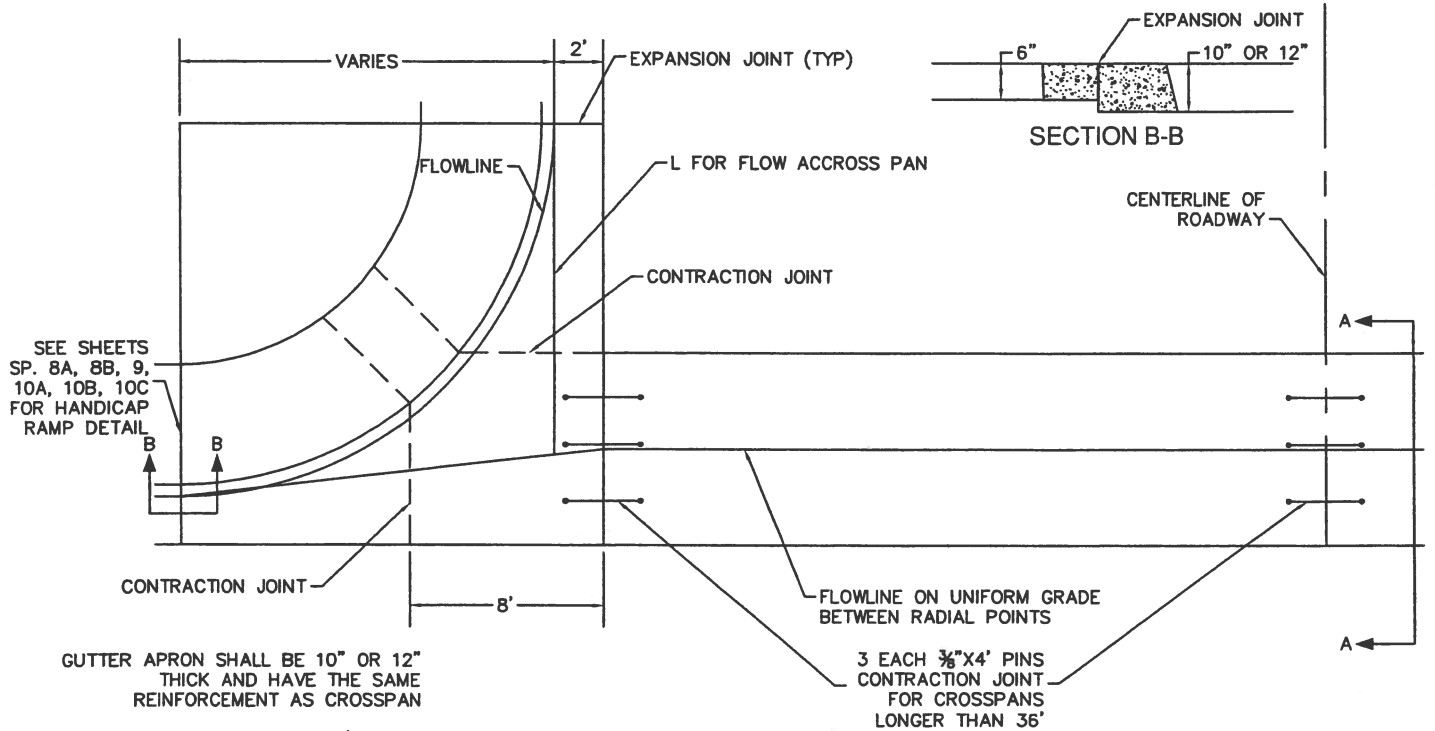
Approved By: *[Signature]*

RESIDENTIAL DRIVEWAY DEPRESSIONS

Issued: 5/10/05

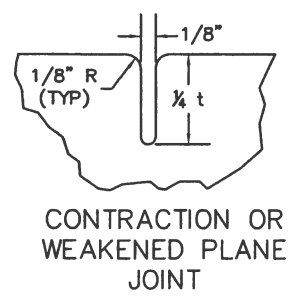
Revised: 8/31/06

Drawing Number:
SP. 5



CROSSPAN INFORMATION			
WIDTH (W)	DEPTH (d)	THICKNESS (t)	THICKNESS (t)
8'	2"	10" W/ #4	12" NO REBAR
10'	2 1/2"	10" W/ #4	12" NO REBAR

PAN LENGTH	REBAR REQUIREMENTS
36'	0.10 SQ.IN. PER FOOT (#4 @ 18")
46'	0.13 SQ.IN. PER FOOT (#4 @ 18")
64'	0.20 SQ.IN. PER FOOT (#4 @ 12")
84'	0.26 SQ.IN. PER FOOT (#4 @ 9")



NOTES:
 1. THE CROSSPAN SHALL BE 12" THICK WITHOUT REINFORCING, 10" WITH REINFORCING AS DETAILED ABOVE.

Drawn By: SBW *[Signature]*
 Checked By: *[Signature]*
 Approved By: *[Signature]*

CROSSPANS
 TYPE 1

Issued: 5/10/05
 Revised: 8/31/06
 Drawing Number:
 SP. 6

CURB RAMP GENERAL NOTES

- IN NEW CONSTRUCTION OR FULL-DEPTH RECONSTRUCTION, PROVIDE A SEPARATE CURB RAMP FOR EACH MARKED OR UNMARKED PEDESTRIAN STREET CROSSING. CURB RAMPS SHALL BE CONTAINED WHOLLY WITHIN THE WIDTH OF THE PEDESTRIAN STREET CROSSING OR CROSSWALK THEY SERVE, OR AS SHOWN ON THE CONTRACT PLANS. APEX AND DIAGONAL RAMPS MAY BE INSTALLED ON LOCAL-TO-LOCAL ROADS. APEX RAMPS ARE PROHIBITED ON LOCAL-TO-COLLECTOR ROADS. APEX RAMPS AND DIAGONAL RAMPS MAY BE INSTALLED ON LOCAL-TO-LOCAL ROADS FOR NEW CONSTRUCTION OR BY VARIANCE REQUEST THROUGH ARAPAHOE COUNTY PUBLIC WORKS.
- ALTERATIONS ARE DEFINED AS CHANGES TO AN EXISTING HIGHWAY THAT AFFECT PEDESTRIAN ACCESS, CIRCULATION, OR USE. ALTERATIONS INCLUDE, BUT ARE NOT LIMITED TO, RESURFACING, REHABILITATION, RECONSTRUCTION, CURB RAMP RETROFITS, HISTORIC RESTORATION, OR CHANGES OR REARRANGEMENT TO STRUCTURAL PARTS OR ELEMENTS OF A PEDESTRIAN FACILITY.
- A WALKABLE SURFACE IS DEFINED AS A PAVED SURFACE ADJACENT TO A CURB RAMP OR TURNING SPACE, WITHOUT RAISED OBSTACLES, THAT COULD BE MISTAKENLY TRAVERSED BY A USER WHO IS VISUALLY IMPAIRED.
- IN ALTERATIONS, WHERE AN EXISTING PHYSICAL CONSTRAINT PREVENTS PROVIDING A SEPARATE CURB RAMP FOR EACH PEDESTRIAN STREET CROSSING, A SINGLE DIAGONAL RAMP (ON THE APEX) SHALL BE PERMITTED TO SERVE BOTH PEDESTRIAN STREET CROSSINGS. THE USE OF A SINGLE DIAGONAL RAMP SHALL BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION. DIAGONAL RAMPS ARE NOT ACCEPTABLE IN NEW CONSTRUCTION OR FULL-DEPTH RECONSTRUCTION. APEX RAMPS ARE PROHIBITED FOR USE ON LOCAL-TO-COLLECTOR ROADS.
- DETECTABLE WARNING SURFACES (DWS) ARE INTENDED TO INDICATE THE BOUNDARY BETWEEN A PEDESTRIAN ROUTE AND VEHICULAR ROUTE WHERE THERE IS A FLUSH RATHER THAN CURBED CONNECTION. DWS ARE NOT INTENDED TO PROVIDE WAYFINDING. DWS SHALL BE CAST IRON UNLESS OTHERWISE APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS & DEVELOPMENT. DWS SHALL BE PROVIDED AT THE FOLLOWING LOCATIONS:
 - CURB RAMPS, BLENDED TRANSITIONS, AND DEPRESSED CORNERS AT PEDESTRIAN STREET CROSSINGS;
 - PEDESTRIAN REFUGE ISLANDS (6 FEET IN WIDTH OR GREATER);
 - BOARDING PLATFORMS AT TRANSIT STOPS WHERE THE EDGE OF THE PLATFORM IS NOT PROTECTED TO PEDESTRIAN CROSS TRAFFIC; AND
 - BOARDING AREAS AT SIDEWALK OR STREET LEVEL TRANSIT STOPS WHERE THE AREA IS NOT PROTECTED TO PEDESTRIAN CROSS TRAFFIC.
- DETECTABLE WARNING SURFACES SHALL CONTRAST VISUALLY WITH THE ADJACENT GUTTER, HIGHWAY, OR PEDESTRIAN ACCESS ROUTE SURFACE, EITHER LIGHT-ON-DARK OR DARK-ON-LIGHT. ARAPAHOE COUNTY PUBLIC WORKS & DEVELOPMENT PREFERS A NATURAL IRON FINISH AS DICTATED IN THE INFRASTRUCTURE DESIGN CONSTRUCTION STANDARDS. FEDERAL YELLOW COLOR CAN BE USED UPON APPROVAL FROM ARAPAHOE COUNTY PUBLIC WORKS & DEVELOPMENT, OTHER COLORS MAY BE USED IF APPROVED BY THE ENGINEER.
- IN ALTERATIONS, TO AVOID CHASING GRADE INDEFINITELY ON STEEP ROADWAYS, A CURB RAMP LENGTH IS NOT REQUIRED TO EXCEED 15 FEET REGARDLESS OF THE RESULTING RAMP RUNNING SLOPE.
- ALL SLOPES ARE MEASURED WITH RESPECT TO A LEVEL PLANE.
- DRAINAGE STRUCTURES, TRAFFIC SIGNAL EQUIPMENT, OR OTHER OBSTRUCTIONS SHALL NOT BE INSTALLED ON THE CURB RAMP, OR TURNING SPACE AREAS.
- IN NEW CONSTRUCTION, PULL BOXES, METER BOXES, MAINTENANCE HOLE COVERS, VAULT LIDS, OR SIMILAR, SHALL NOT BE CONSTRUCTED WITHIN ANY PART OF CURB RAMP OR TURNING SPACE. IN ALTERATIONS, WHERE THESE ITEMS CANNOT BE RELOCATED OUTSIDE OF THE CURB RAMP OR TURNING SPACE, THEY MUST NOT CREATE A VERTICAL DISCONTINUITY GRATER THAN 1/2 INCH. ANY VERTICAL DISCONTINUITY BETWEEN 1/4 INCH AND 1/2 INCH SHALL BE BEVELED WITH A SLOPE NOT STEEPER THAN 1V:2H. THE BEVEL SHALL BE APPLIED ACROSS THE ENTIRE SURFACE DISCONTINUITY.
- CONSTRUCTION OF ANY REQUIRED PEDESTRIAN CURB SHALL BE INCLUDED IN THE BID PRICE OF THE CONCRETE CURB RAMP AND WILL NOT BE PAID FOR SEPARATELY.
- ALL CURB RAMP JOINTS AND GRADE BREAKS SHALL BE FLUSH (0'-1/8"). THE JOINT BETWEEN THE ROADWAY SURFACE AND THE GUTTER PAN SHALL BE FLUSH.
- THE CONTRACTOR SHALL VERIFY REMOVAL LIMITS ARE SUFFICIENT TO PROVIDE POSITIVE DRAINAGE, MAINTAIN EXISTING DRAINAGE PATTERNS, AND AVOID PONDING IN THE FINAL CONFIGURATION.
- FLARED SIDE SLOPES MAY EXCEED 10.0% ONLY WHERE THEY ABUT A NON-WALKABLE SURFACE, OR WHERE THE ADJACENT RAMP SURFACE IS BLOCKED TO PEDESTRIAN TRAFFIC.
- THE CHANGE IN GRADE AT THE BOTTOM OF THE CURB RAMP SHALL NOT EXCEED AN ALGEBRAIC DIFFERENCE OF 13.33%. THE COUNTER SLOPE OF THE GUTTER AT THE FOOT OF A RAMP, TURNING SPACE, OR BLENDED TRANSITION SHALL NOT EXCEED 5.0%.
- GRADE BREAKS AT THE TOP AND BOTTOM OF RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF THE RAMP RUN OR TURNING SPACE. SURFACE SLOPES THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
- A BROOM FINISH, WITH SWEEPS PERPENDICULAR TO THE DIRECTION OF PEDESTRIAN TRAFFIC, SHALL BE APPLIED TO ALL RAMP AND TURNING SPACE SURFACES.
- IN ALTERATIONS, WHERE A RAMP OR TURNING SPACE MUST TIE INTO AN EXISTING GRADE THAT CANNOT BE ALTERED, THE RAMP OR TURNING SPACE MAYBE WARPED TO TRANSITION TO THE REQUIRED CROSS SLOPE. THE TRANSITION TO THE REQUIRED CROSS SLOPE SHALL BE SPREAD EVENLY OVER THE LENGTH OF THE RAMP OR TURNING SPACE TO MINIMIZE THE DEGREE OF WARPING. THE RATE OF CHANGE ON A RAMP OR TURNING SPACE SHALL NOT EXCEED 3% PER LINEAR FOOT.
- DESIGN AND CONSTRUCT CURB RAMPS, TURNING SPACES, AND FLARE SLOPES WITH THE FLATTEST SLOPES POSSIBLE. THE SLOPES INDICATED IN THESE DETAILS SHOW THE MAXIMUM SLOPES ALLOWABLE. PREFERRED VALUES TO BE USED DURING DESIGN, LAYOUT, AND CONSTRUCTION ARE:
 - RAMP RUNNING SLOPE 7.5%
 - RAMP CROSS SLOPE 1.5%
 - TURNING SPACE RUNNING SLOPE 1.5%
 - TURNING SPACE CROSS SLOPE 1.5%
 - FLARE SLOPE 8.0-9.0%
- WHERE SNOW REMOVAL EQUIPMENT WILL BE USED TO CLEAR THE PEDESTRIAN ACCESS ROUTE, CONSULT THE ENGINEER PRIOR TO CONSTRUCTION TO ENSURE THE WIDTH AND THICKNESS OF CURB RAMPS IS SUFFICIENT TO ACCOMMODATE SUCH EQUIPMENT.
- PROVIDE EXPANSION JOINT MATERIAL 1/2" THICK WHERE CURB RAMPS ADJOIN ANY RIGID PAVEMENT, OR STRUCTURE. THE TOP OF THE JOINT FILLER MATERIAL SHALL BE FLUSH WITH ADJOINING CONCRETE SURFACES. THE EXPANSION JOINT MATERIAL SHALL EXTEND FOR THE FULL DEPTH OF THE CONCRETE SURFACE.
- PROVIDE TIE BAR REINFORCING BETWEEN INDEPENDENTLY POURED CONCRETE CURB RAMPS OR TURNING SPACES AND CURB AND GUTTER. DRILL AND GROUT NO. 4 12 INCH LONG REINFORCEMENT BARS (EPOXY COATED) AT 18 INCHES CENTER TO CENTER MINIMUM.
- CONTROL AND EXPANSION JOINTS SHALL BE INSTALLED TO ISOLATE ACCESS RAMPS AS DEPICTED IN THESE DETAILS.
- NO VERTICAL CURB FACES SHALL BE CONSTRUCTED WHERE VEHICLE TURNING RADI COULD BE PRESENT. CONTRACTOR TO INSTALL SLOPED WINGS IN-LIEU OF VERTICAL CURB FACES. CONTRACTOR TO ENSURE POSITIVE DRAINAGE IN ANY CONSTRUCTION PERFORMED. QUESTIONS CAN BE DIRECTED TO ARAPAHOE COUNTY PUBLIC WORKS & DEVELOPMENT.

CURB RAMP PAY AREAS

TYPE 1

TYPE 2 - TWO RAMPS

TYPE 2 - ONE RAMP

TYPE 2 - DIRECTIONAL

BLENDED TRANSITION

DEPRESSED CORNER

COMBINATION

SLOPE TABLE

PERCENT SLOPE	1%	2%	5%	7.1%	8.3%	10%
EQUIVALENT SLOPE	100:1	50:1	20:1	14:1	12:1	10:1

REVISIONS			
#	DATE	DESCRIPTION	BY
1		ISSUED	

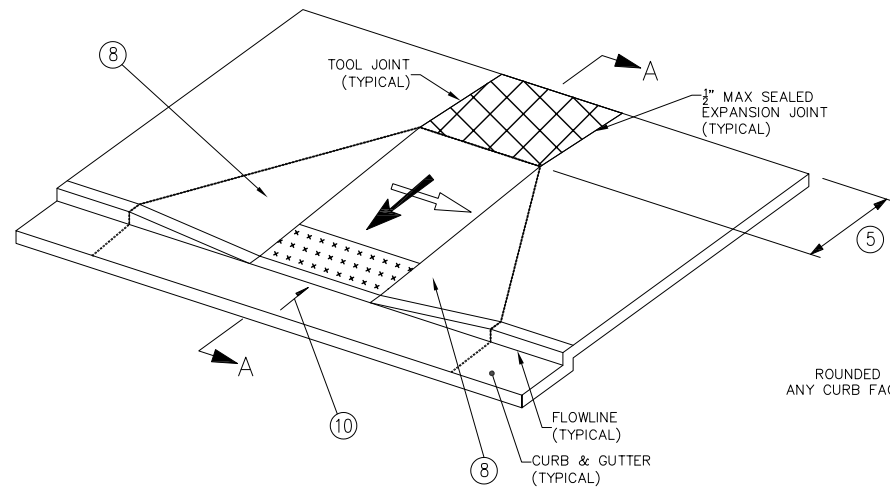
Arapahoe County
 ARAPAHOE COUNTY, COLORADO
 DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT
 Colorado's First
 PREPARED BY THE ARAPAHOE COUNTY ENGINEERING & TRANSPORTATION DIVISIONS
 6924 SOUTH LIMA STREET - CENTENNIAL COLORADO 80112 - PH. 720-874-6500 - FAX. 303-874-6611

GENERAL NOTES & PAY AREAS

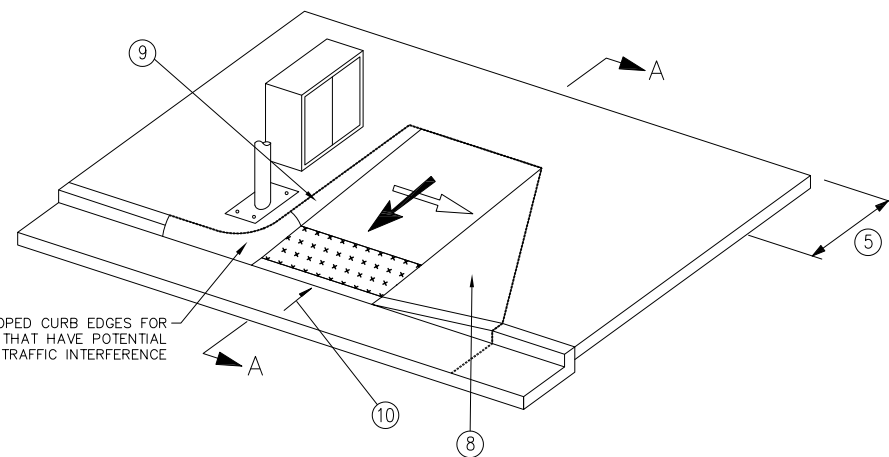
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 1 of 10
 SP-7

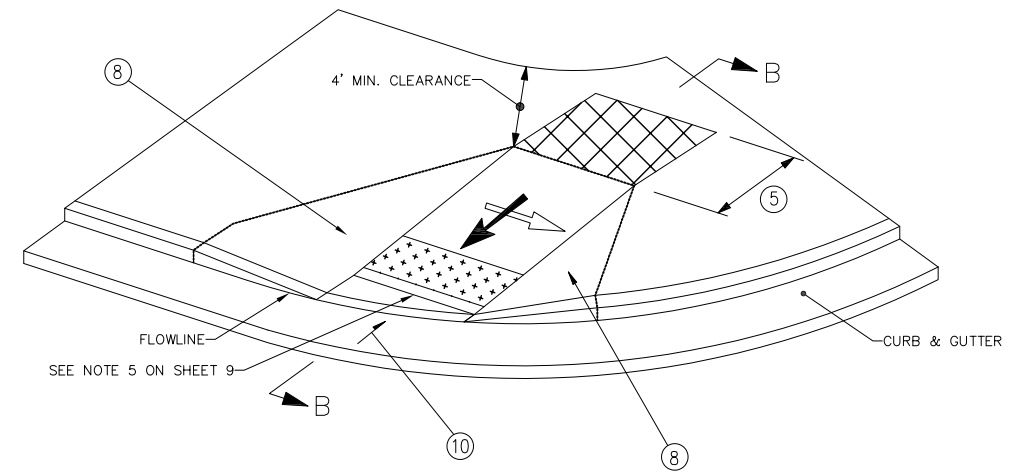
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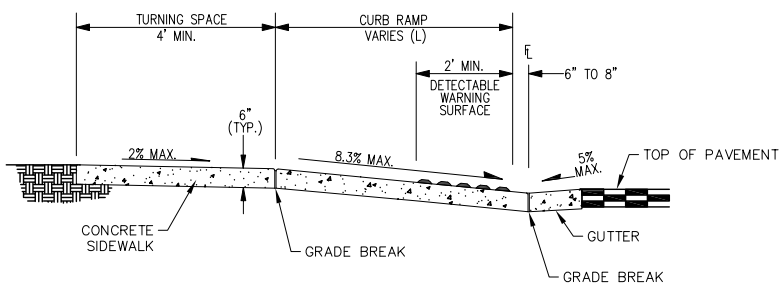
PERPENDICULAR RAMP
(TYPICAL)



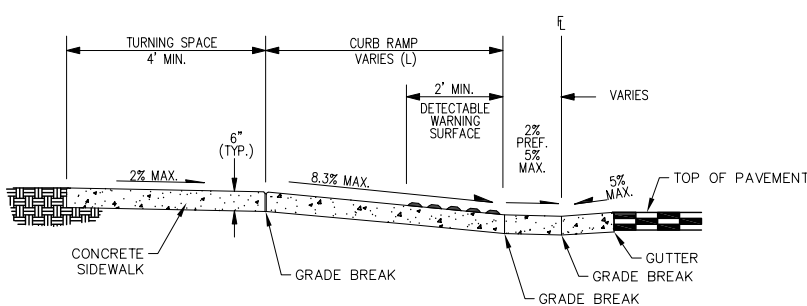
PERPENDICULAR RAMP
(WITH VERTICAL RETURN CURB)



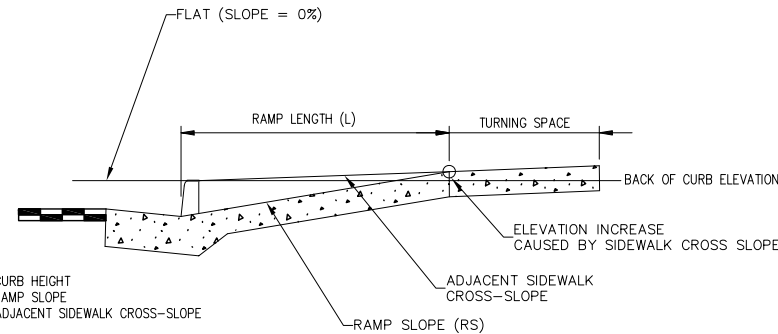
PERPENDICULAR RAMP
(DIRECTIONAL)



SECTION A-A



SECTION B-B



$$L = \frac{CH}{(RS - ACS)}$$

EXAMPLE: CH = 6" (0.5 ft.), RS = 7.5% (0.075), ACS = 1.5% (0.015)
L = 0.5 / (0.075 - 0.015) = 8.3 ft.

DETAIL A - RAMP LENGTH

- SIDEWALK
- TURNING SPACE ③ ④ ⑤
- DETECTABLE WARNING SURFACE (DWS)
- 1/2" EXPANSION JOINT

PERPENDICULAR RAMP NOTES

1. RAMP WIDTH - PROVIDE 5 FT. OR GREATER WHERE POSSIBLE. IF SITE CONSTRAINTS DO NOT PERMIT, PROVIDE 4 FT. MINIMUM. RAMP SERVING SHARED USE PATHS SHALL MATCH THE WIDTH OF THE PATH.
2. RAMP RUNNING SLOPE - 8.3% MAX.
3. TURNING SPACE RUNNING SLOPE - 2.0% MAX. TURNING SPACE RUNNING SLOPE IS MEASURED IN THE SAME DIRECTION AS THE RAMP RUNNING SLOPE.
4. RAMP AND TURNING SPACE CROSS-SLOPE - 2.0% TYPICAL. AT CROSSINGS WITHOUT YIELD OR STOP CONTROL, OR WITH A SIGNAL WHERE VEHICLES CAN PROCEED THROUGH THE INTERSECTION WITHOUT SLOWING OR STOPPING, THE CROSS-SLOPE OF RAMPS AND TURNING SPACES MAY EQUAL THE HIGHWAY GRADE. AT MIDBLOCK PEDESTRIAN STREET CROSSINGS THE RAMP AND TURNING SPACE CROSS-SLOPE MAY EQUAL THE HIGHWAY GRADE.
5. TURNING SPACE DIMENSIONS - PROVIDE A TURNING SPACE AT THE TOP OF PERPENDICULAR RAMPS WITH A WIDTH EQUAL TO THE WIDTH OF THE CURB RAMP. TURNING SPACE LENGTH MUST BE 4 FT. MINIMUM, MEASURED IN THE DIRECTION OF THE RAMP RUN. WHEN A TURNING SPACE IS CONSTRAINED AT THE BACK OF SIDEWALK, INCREASE LENGTH TO 5 FT. MINIMUM IN THE DIRECTION OF THE RAMP RUN.
6. RAMP ALIGNMENT - RAMPS SHALL BE ALIGNED TO BE FULLY CONTAINED WITHIN THE CROSSWALK OR STREET CROSSING THEY SERVE. PROVIDE ONE RAMP FOR EACH STREET CROSSING DIRECTION. IN ALTERATIONS, WHERE EXISTING PHYSICAL CONSTRAINTS PREVENT PROVIDING ONE CURB RAMP FOR EACH CROSSING DIRECTION, A SINGLE DIAGONAL CURB RAMP (ON THE APEX OF A CORNER) SHALL BE PERMITTED TO SERVE BOTH PEDESTRIAN STREET CROSSINGS. IF A DIAGONAL RAMP IS USED, A CLEAR SPACE 4 FT. X 4 FT. MUST BE PROVIDED AT THE BASE OF THE RAMP. THE CLEAR SPACE MUST BE WITHIN BOTH CROSSWALKS AND WHOLLY OUTSIDE OF ANY ADJACENT VEHICULAR TRAVEL LANES. DIAGONAL RAMPS ARE NOT ACCEPTABLE IN NEW CONSTRUCTION, OR FULL-DEPTH RECONSTRUCTION WITH THE EXCEPTION OF LOCAL-TO-LOCAL ROADWAYS WITH MINIMUM 20FT RADIUS.
7. RAMP LENGTH - PERPENDICULAR RAMP LENGTH IS DEPENDENT UPON THE RAMP SLOPE, HEIGHT OF CURB, AND ADJACENT SIDEWALK CROSS-SLOPE WHICH MUST BE INTERCEPTED. SEE DETAIL A FOR CALCULATING RAMP LENGTH WHEN CHASING SIDEWALK CROSS-SLOPE. WHERE TERRAIN IS SLOPING A RAMP IS NOT REQUIRED TO CHASE GRADE MORE THAN 15 FT. REGARDLESS OF THE RESULTING RAMP SLOPE.
8. RAMP FLARES - WHERE A RAMP EDGE ABUTS A WALKABLE SURFACE, A FLARED SIDE SHALL BE PROVIDED. RAMP FLARE SLOPES SHALL NOT EXCEED 10.0%.
9. VERTICAL CURB RETURNS - VERTICAL CURB RETURNS MAY BE USED ONLY WHERE A RAMP ABUTS A NON-WALKABLE SURFACE, OR WHERE A RAMP IS PROTECTED FROM PEDESTRIAN CROSS TRAFFIC (FOR EXAMPLE BY A SIGNAL CABINET OR UTILITY POLE WHICH BLOCKS PASSAGE).
10. GUTTER COUNTER SLOPE - 5.0% MAX.
11. RAMP WING FLARES AND SIDEWALKS SHALL BE 6" THICK IF EITHER WILL EXPERIENCE VEHICULAR LOADING.

REVISIONS

#	DATE	DESCRIPTION	BY
1		ISSUED	



ARAPAHOE COUNTY, COLORADO
DEPARTMENT OF
PUBLIC WORKS AND
DEVELOPMENT

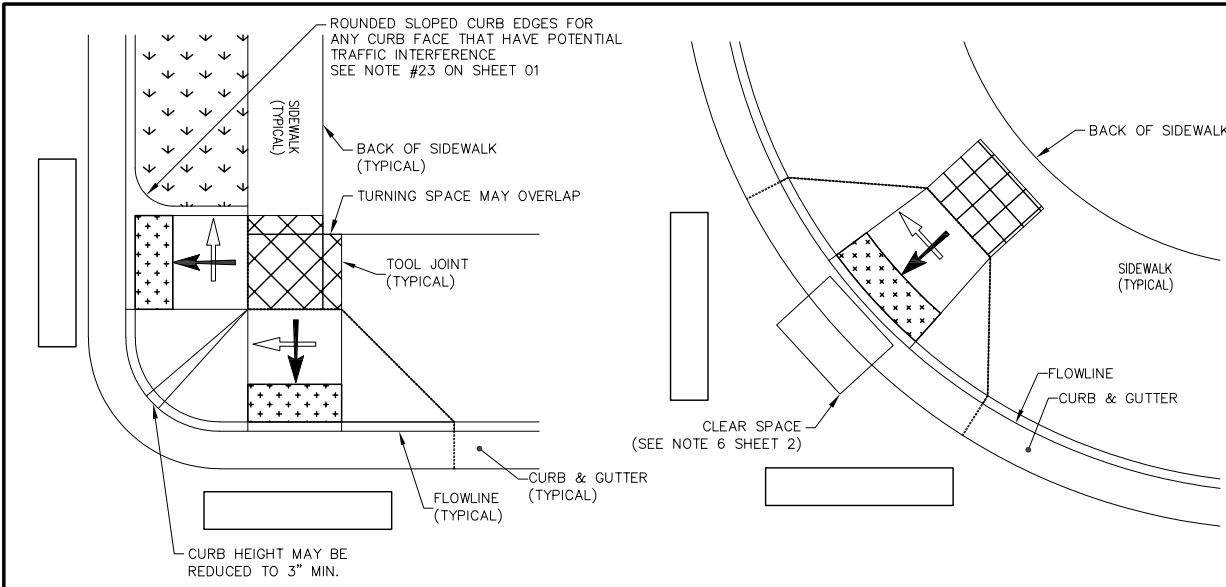
PREPARED BY THE ARAPAHOE COUNTY ENGINEERING & TRANSPORTATION DIVISIONS
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TYPE 1 PERPENDICULAR CURB RAMPS

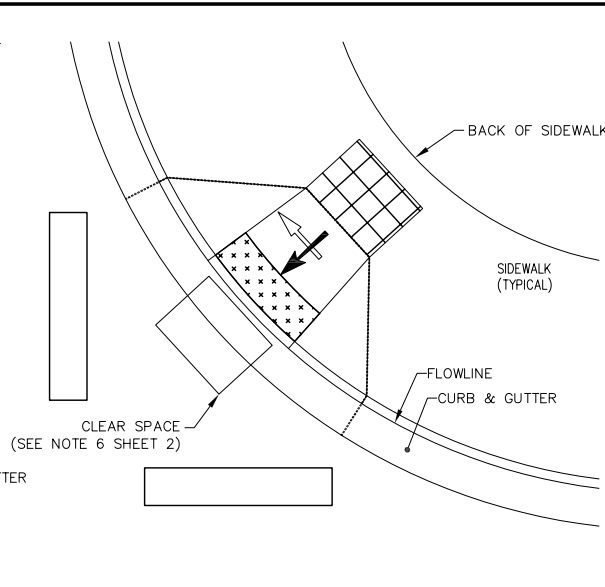
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2 of 10
SP-8A

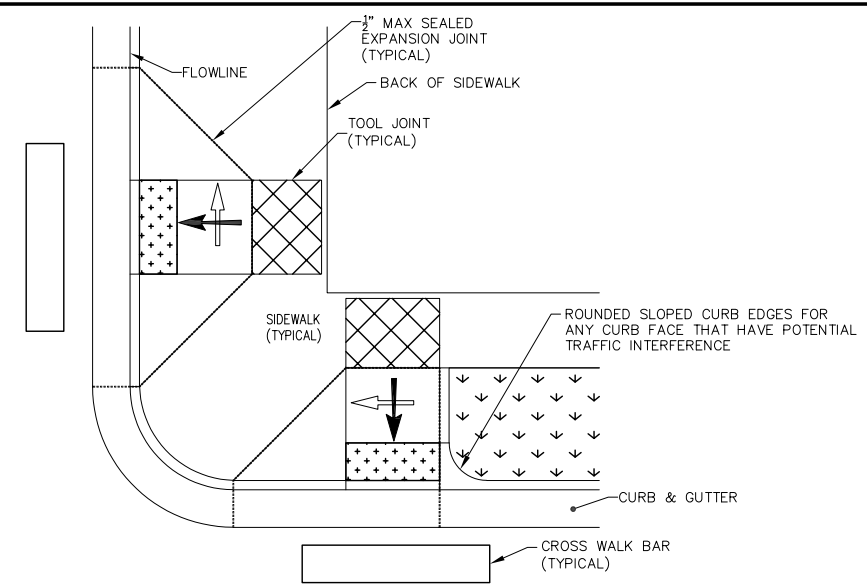


**TYPE 1 RAMP FOR WIDE SIDEWALK
(3" REDUCED CURB)**

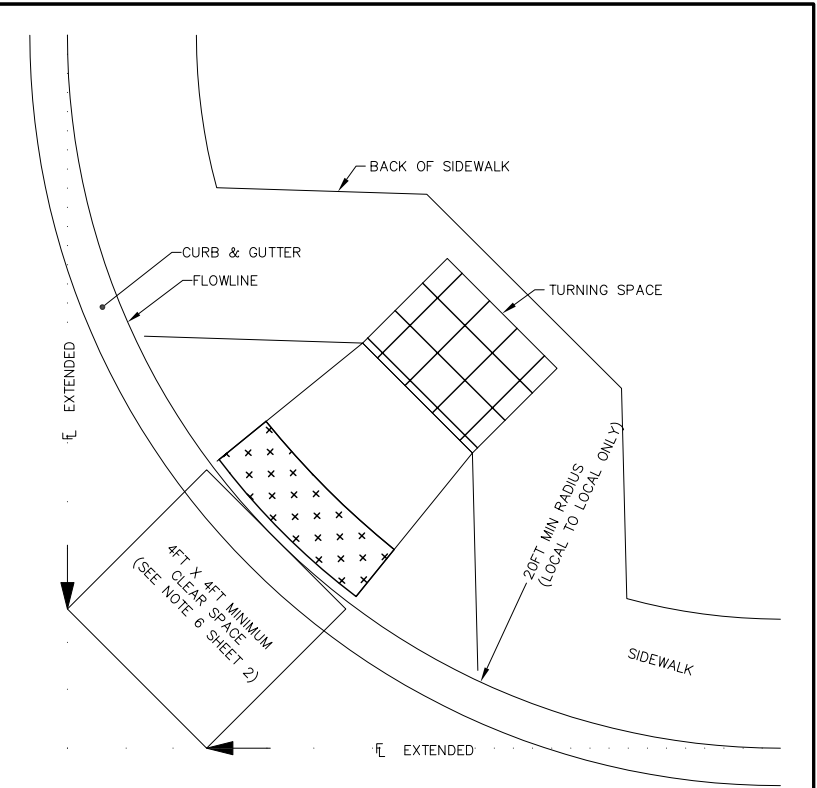


**TYPE 1 RAMP
(DIAGONAL)**

NOT ALLOWABLE IN NEW CONSTRUCTION/FULL DEPTH RECONSTRUCTION WITH THE EXCEPTION OF LOCAL-TO-LOCAL CONSTRUCTION - SEE GENERAL NOTE 4

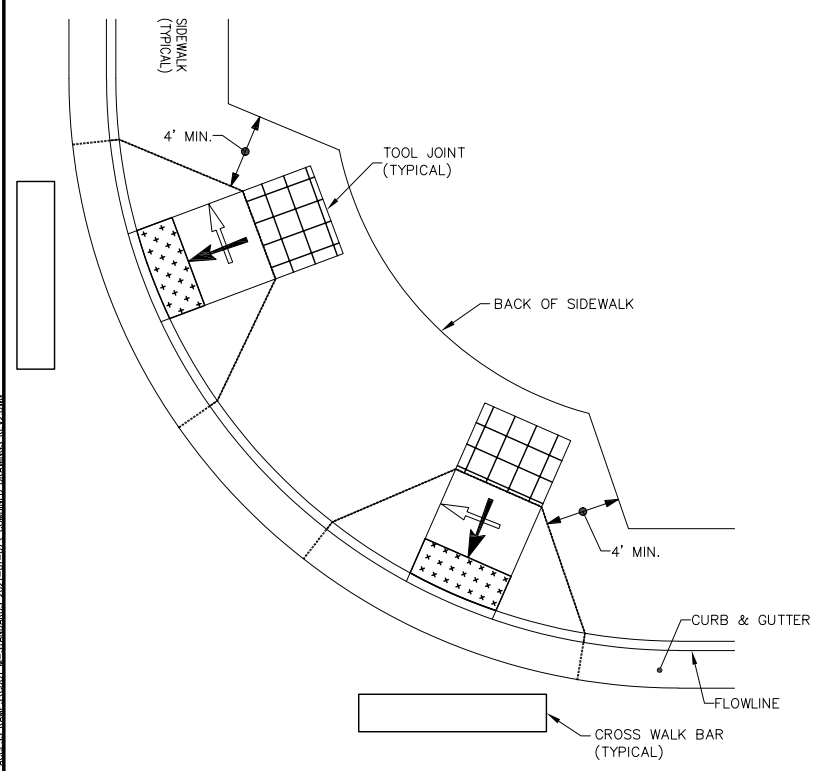


TYPE 1 RAMP FOR WIDE SIDEWALK

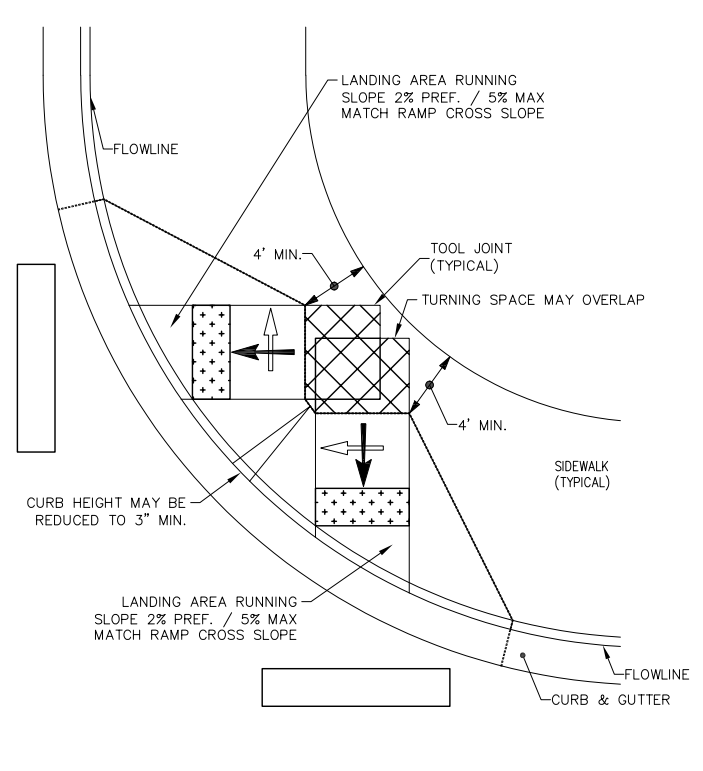


TYPE 1 DIAGONAL RAMP CLEAR ZONE

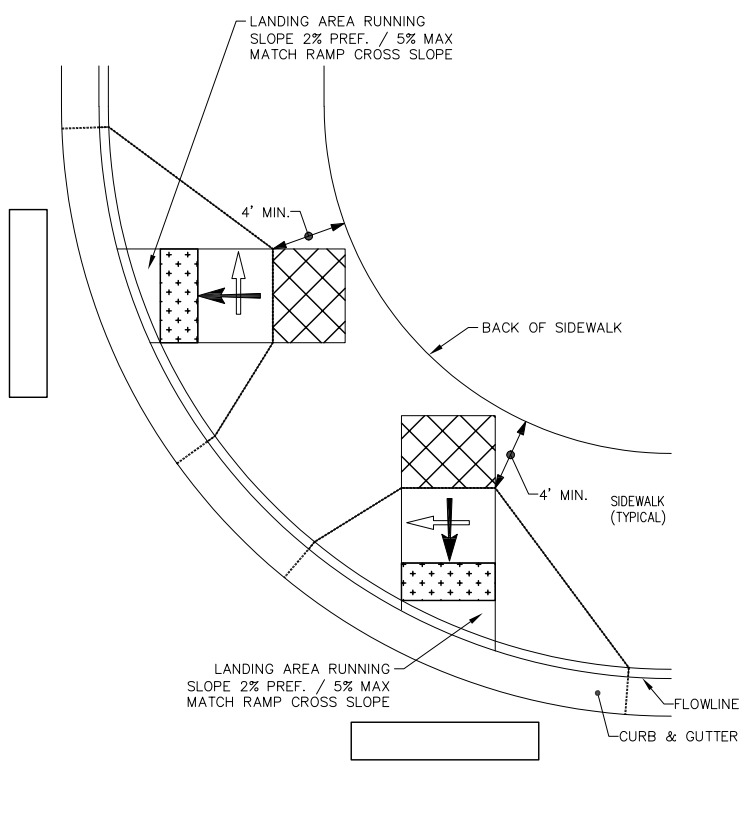
A CLEAR SPACE OF 4FT X 4FT (MINIMUM) SHALL BE PLACED AT THE BOTTOM OF THE GRADE BREAK WITHIN THE WIDTH OF THE PEDESTRIAN WALKWAY OUTSIDE OF PARALLEL VEHICLE TRAVEL (AS MEASURED BY THE FLOWLINE EXTENDED).



TYPE 1 PERPENDICULAR RAMPS



**TYPE 1 DIRECTIONAL RAMPS
(3" REDUCED CURB)**



**TYPE 1 DIRECTIONAL RAMPS
(LARGE RADIUS)**

- 1/2" EXPANSION JOINT
- [Cross-hatched box] TURNING SPACE (SEE NOTES 3, 4, 5 - SHEET 2)
- [Dotted box] DETECTABLE WARNING SURFACE (DWS) SEE DWS SHEETS FOR PLACEMENT DETAILS
- [Arrow pointing down] RAMP RUNNING SLOPE
- [Arrow pointing left] RAMP CROSS SLOPE

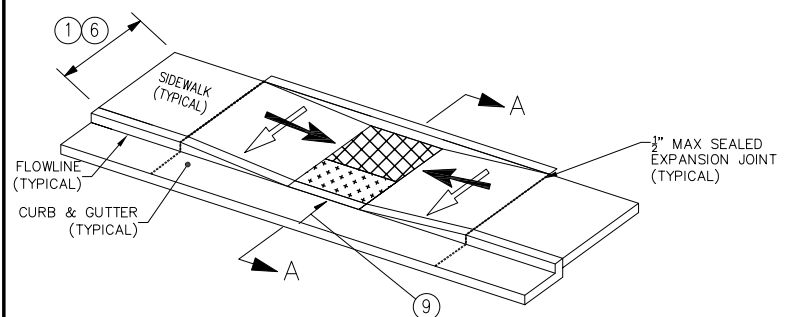
NOTE
PLACEMENTS SHOWN ARE TYPICAL CONFIGURATIONS ONLY AND NOT INDICATIVE OF ALL OPTIONS. OTHER RAMP CONFIGURATIONS MAY BE ACCEPTABLE AS LONG AS THEY CONFORM TO THE CRITERIA IN THESE STANDARDS, AND ARE APPROVED BY THE ENGINEER.

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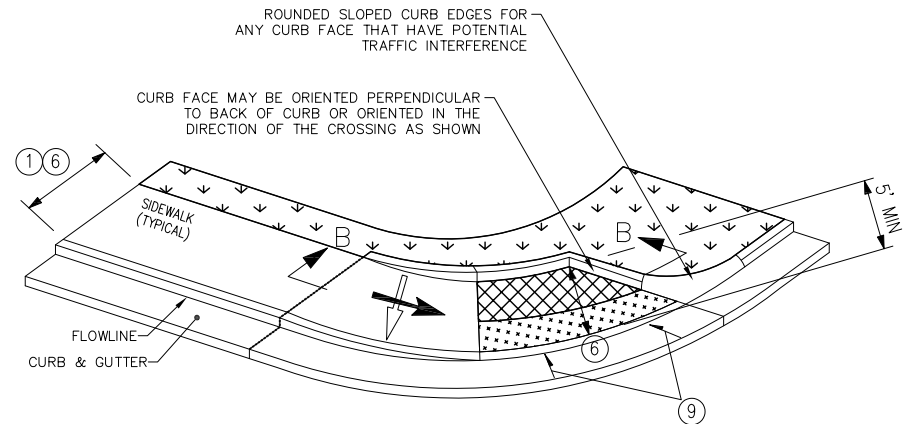
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TYPE 1 CURB RAMPS TYPICAL CONFIGURATIONS

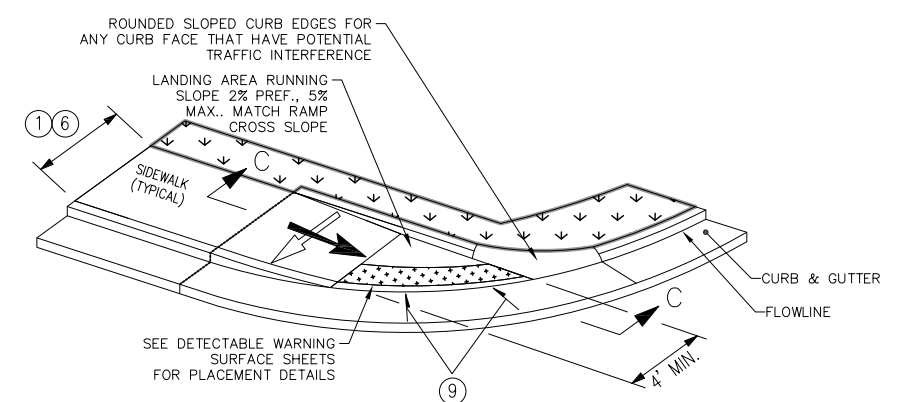
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DETAIL #
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SP-8B



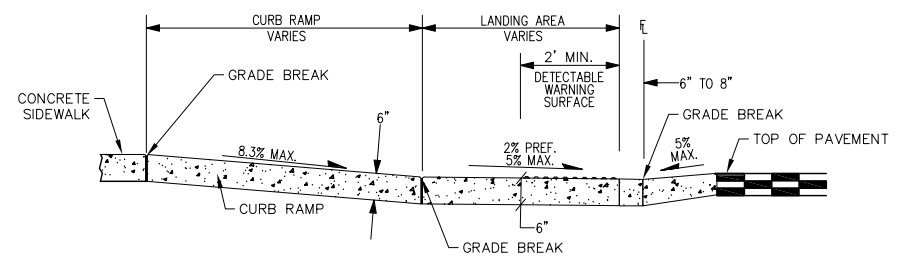
PARALLEL RAMP (TYPICAL)



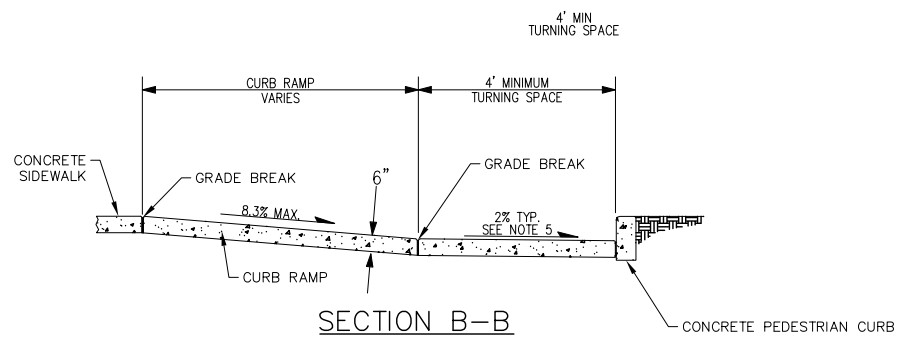
PARALLEL RAMP (SIDEWALK ENDS)



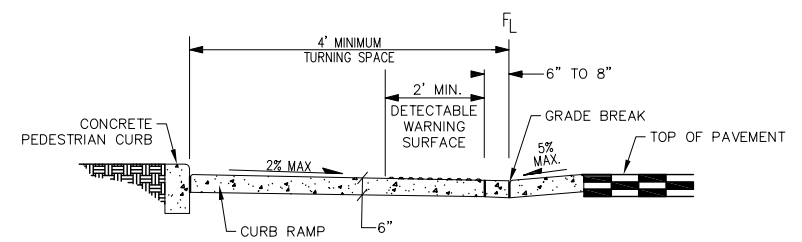
PARALLEL RAMP (DIRECTIONAL - CROSSING IN ONE DIRECTION ONLY)



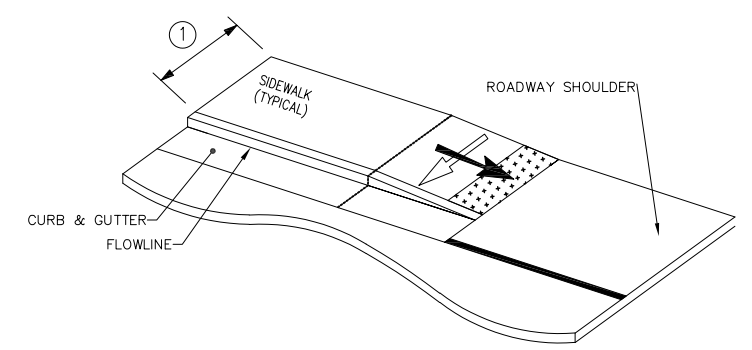
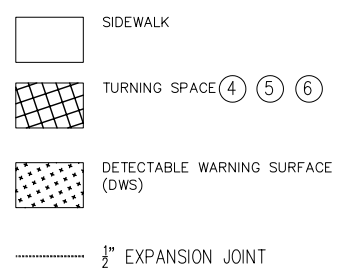
SECTION C-C



SECTION B-B



SECTION A-A



SIDEWALK TO SHOULDER TRANSITION

PARALLEL RAMP NOTES

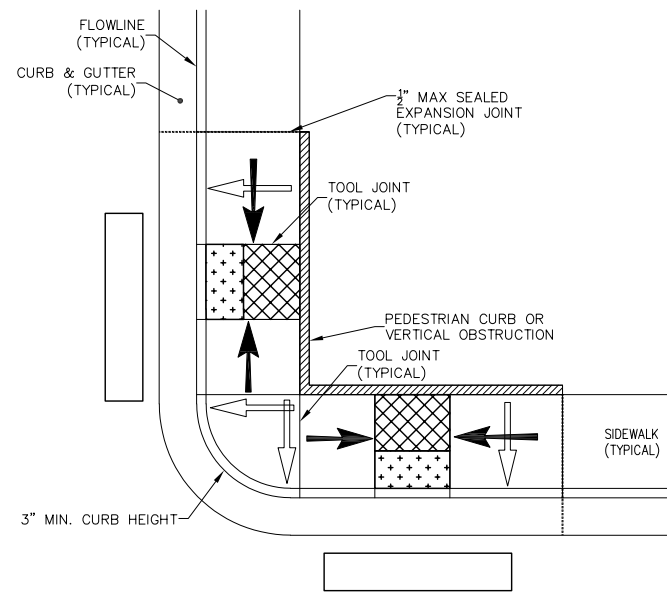
1. RAMP WIDTH - PROVIDE A RAMP WIDTH EQUAL TO THE ADJOINING SIDEWALK, PROVIDE 4 FT. WIDTH MINIMUM. RAMP SERVING SHARED USE PATHS SHALL MATCH THE WIDTH OF THE PATH.
2. RAMP RUNNING SLOPE - 8.3% MAX.
3. RAMP CROSS SLOPE - 2.0% MAX.
4. TURNING SPACE RUNNING SLOPE - 2.0% MAX. TURNING SPACE RUNNING SLOPE IS MEASURED PERPENDICULAR TO THE BACK OF CURB.
5. TURNING SPACE CROSS SLOPE - 2.0% TYPICAL, AT CROSSINGS WITHOUT YIELD OR STOP CONTROL, OR WITH A SIGNAL WHERE VEHICLES CAN PROCEED THROUGH THE INTERSECTION WITHOUT SLOWING OR STOPPING, THE CROSS SLOPE OF THE TURNING SPACE MAY EQUAL THE HIGHWAY GRADE. AT MIDBLOCK PEDESTRIAN STREET CROSSINGS THE TURNING SPACE CROSS SLOPE MAY EQUAL THE HIGHWAY GRADE. TURNING SPACE CROSS SLOPE IS MEASURED IN THE DIRECTION OF THE RAMP RUN.
6. TURNING SPACE DIMENSIONS - PROVIDE A TURNING SPACE AT THE BOTTOM OF PARALLEL RAMP WITH A WIDTH EQUAL TO THE WIDTH OF THE CURB RAMP. PROVIDE 4 FT. MINIMUM, MEASURED IN THE DIRECTION OF THE RAMP RUN. IF THE TURNING SPACE IS CONSTRAINED ON TWO SIDES, PROVIDE 5 FT. MEASURED IN THE DIRECTION OF PEDESTRIAN STREET CROSSING. THE TURNING SPACE MAY CONTAIN THE DETECTABLE WARNING SURFACE.
7. RAMP ALIGNMENT - RAMP SHALL BE ALIGNED SO THE TURNING SPACE IS FULLY CONTAINED WITHIN THE CROSSWALK OR STREET CROSSING THEY SERVE. PROVIDE ONE RAMP FOR EACH STREET CROSSING DIRECTION. IN ALTERATIONS, WHERE EXISTING PHYSICAL CONSTRAINTS PREVENT PROVIDING ONE CURB RAMP FOR EACH CROSSING DIRECTION, A SINGLE DIAGONAL CURB RAMP (ON THE APEX OF A CORNER) SHALL BE PERMITTED TO SERVE BOTH PEDESTRIAN STREET CROSSINGS. DIAGONAL RAMP ARE NOT ACCEPTABLE IN NEW CONSTRUCTION, OR FULL-DEPTH RECONSTRUCTION.
8. RAMP LENGTH - PARALLEL RAMP LENGTH IS DEPENDENT UPON THE RAMP SLOPE AND THE CHANGE OF ELEVATION FROM THE TURNING SPACE TO THE SIDEWALK. WHERE TERRAIN IS SLOPING A RAMP IS NOT REQUIRED TO CHASE GRADE MORE THAN 15 FT. REGARDLESS OF THE RESULTING RAMP SLOPE.
9. GUTTER COUNTER SLOPE - 5.0% MAX.

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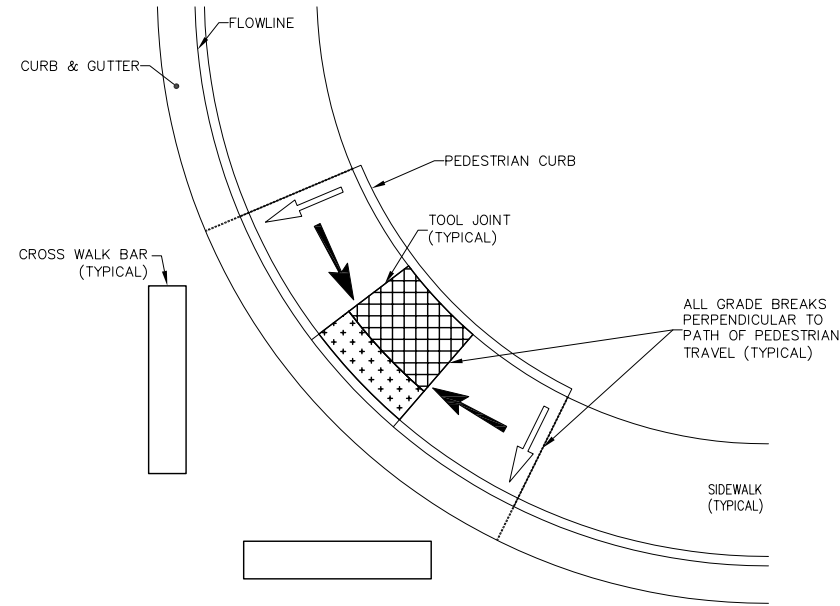
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TYPE 2 PARALLEL CURB RAMPS

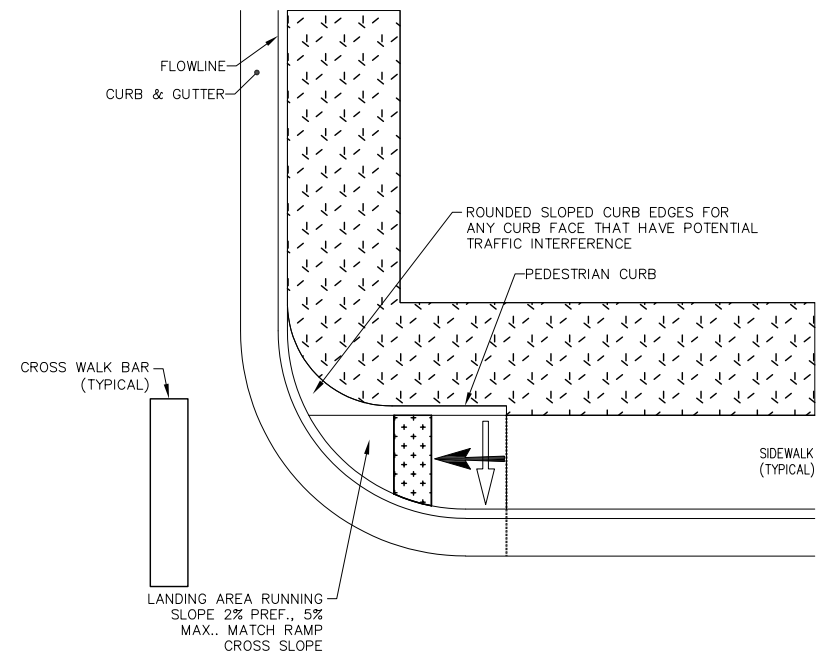
SCALE: DETAIL #
4 of 10
SP-8C



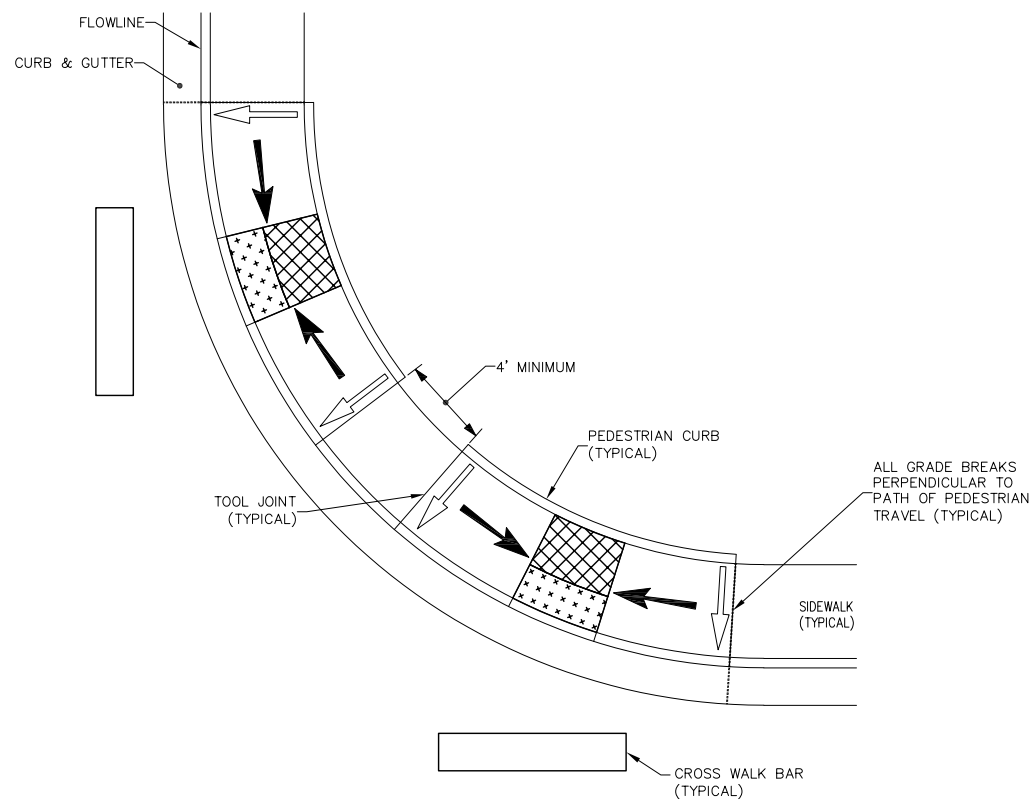
TYPE 2 RAMPS SMALL RADIUS
(3" REDUCED CURB)



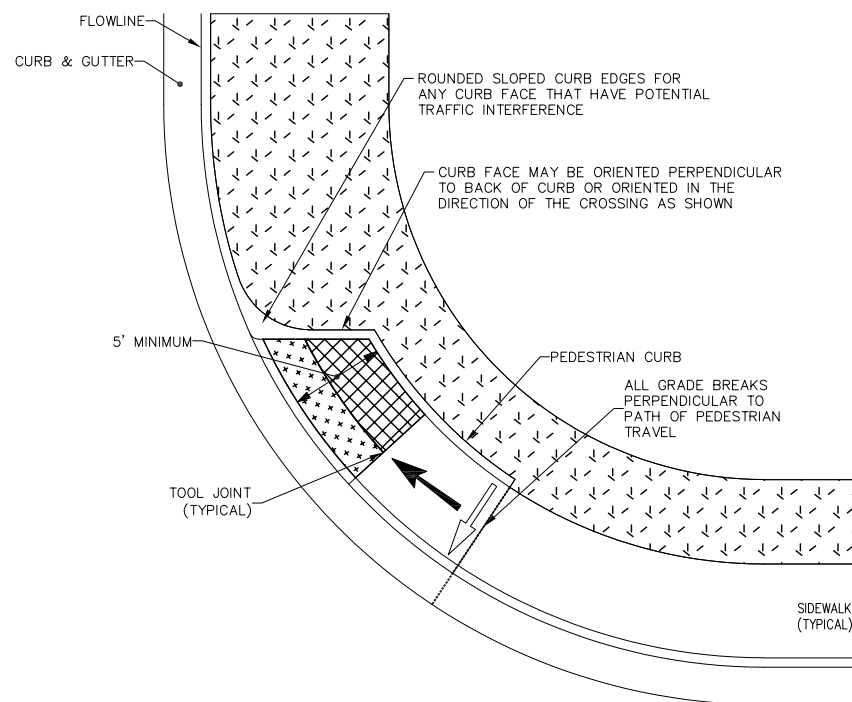
TYPE 2 RAMP (DIAGONAL)
NOT ALLOWABLE IN NEW CONSTRUCTION/FULL-DEPTH RECONSTRUCTION
SEE NOTE GENERAL NOTE 4



TYPE 2 RAMP SMALL RADIUS
(CROSSING IN ONE DIRECTION)



TYPE 2 RAMPS LARGE RADIUS





TYPE 2 RAMP LARGE RADIUS
(CROSSING IN ONE DIRECTION)

NOTES

PLACEMENTS SHOWN ARE TYPICAL CONFIGURATIONS ONLY AND NOT INDICATIVE OF ALL OPTIONS. OTHER RAMP CONFIGURATIONS MAY BE ACCEPTABLE AS LONG AS THEY CONFORM TO THE CRITERIA IN THESE STANDARDS, AND ARE APPROVED BY THE ENGINEER.

CURB, GUTTER, AND SIDEWALK SHALL BE 6" IN THICKNESS IN ANY AREA THAT VEHICLES MAY TRAVEL OVER.

 TURNING SPACE
(SEE NOTE 4, 5, 6 - SHEET 4)

 DETECTABLE WARNING SURFACE (DWS)
SEE DWS SHEETS FOR PLACEMENT DETAILS

 1/2" EXPANSION JOINT

 RAMP RUNNING SLOPE

 RAMP CROSS SLOPE

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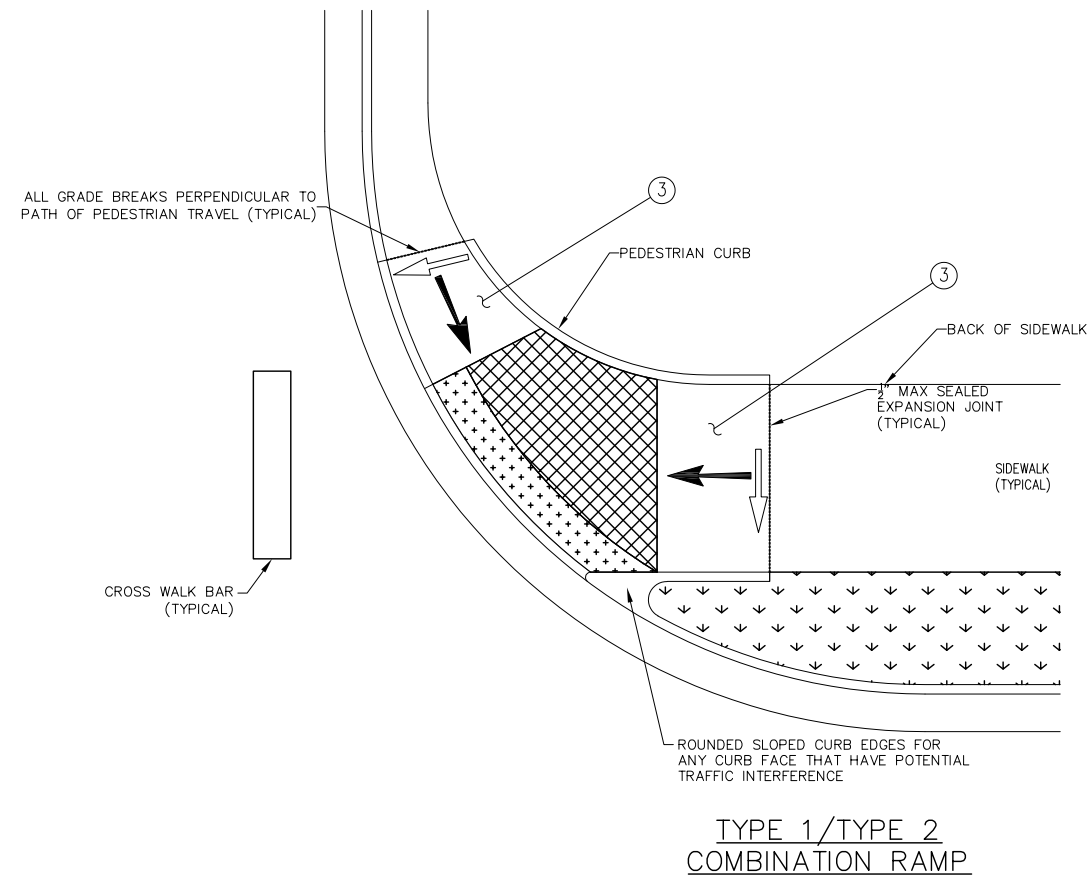
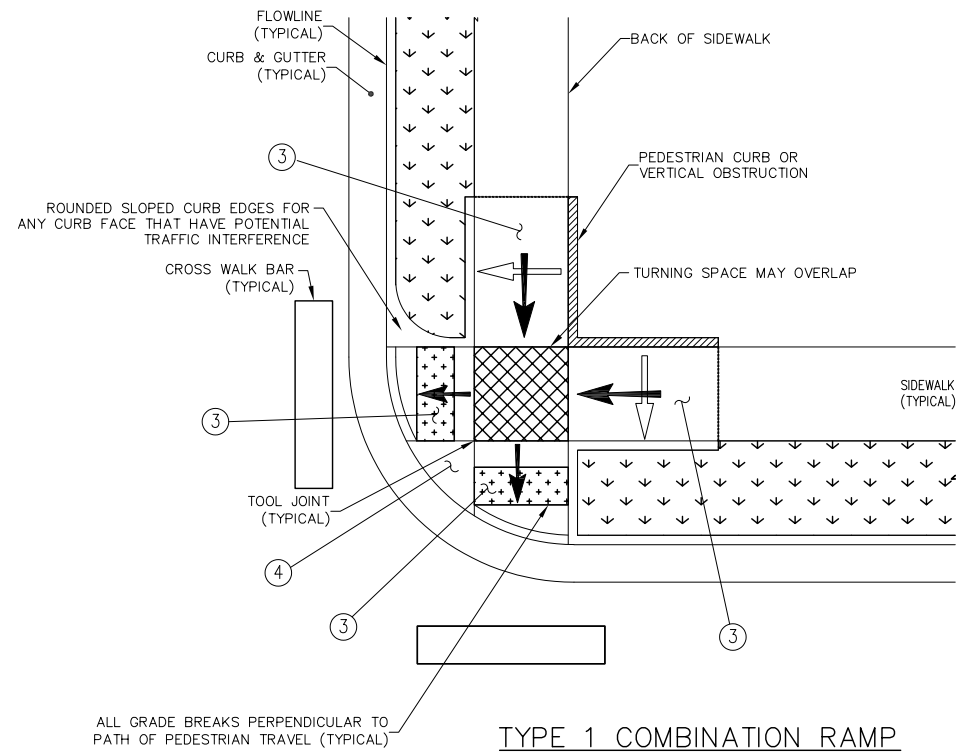
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TYPE 2 CURB RAMPS TYPICAL CONFIGURATIONS

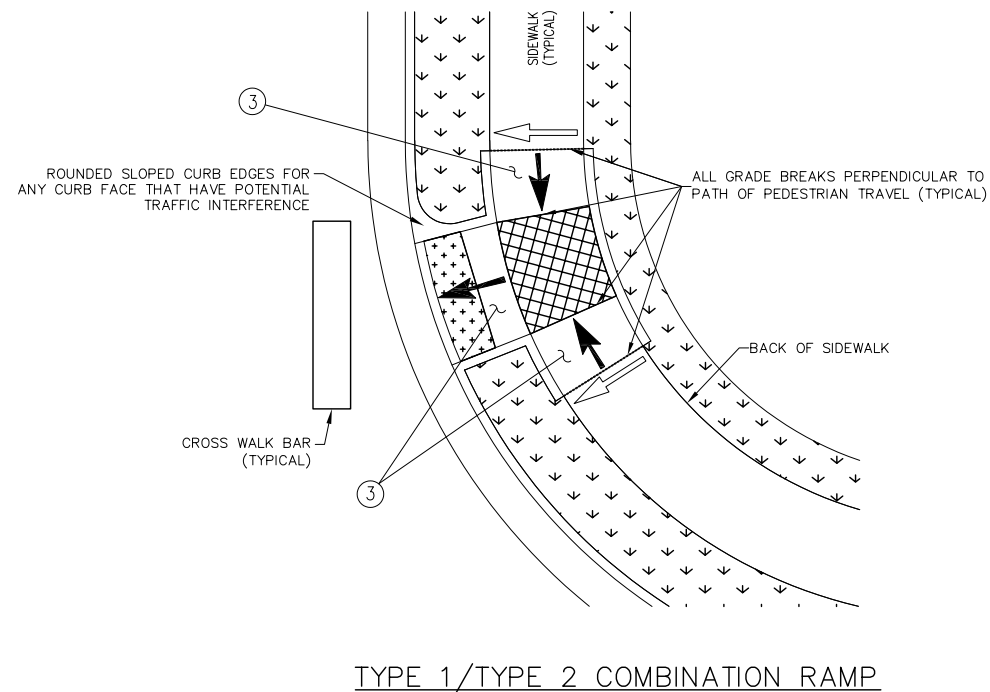
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




DETAIL #
5 of 10
SP-8D



COMBINATION CURB RAMP NOTES:

1. THE CURB RAMP PLACEMENTS SHOWN ARE TYPICAL CONFIGURATIONS ONLY AND NOT INDICATIVE OF ALL OPTIONS. OTHER CURB RAMP CONFIGURATIONS MAY BE ACCEPTABLE AS LONG AS THEY CONFORM TO THE CRITERIA IN THESE STANDARDS, AND ARE APPROVED BY THE ENGINEER.
2. RAMP AND TURNING SPACE CROSS SLOPE - 2.0% TYPICAL. AT CROSSINGS WITHOUT YIELD OR STOP CONTROL, OR WITH A SIGNAL WHERE VEHICLES CAN PROCEED THROUGH THE INTERSECTION WITHOUT SLOWING OR STOPPING, THE CROSS SLOPE OF THE RAMP AND TURNING SPACE MAY EQUAL THE HIGHWAY AT MIDBLOCK PEDESTRIAN STREET CROSSINGS THE RAMP AND TURNING SPACE CROSS SLOPE MAY EQUAL THE HIGHWAY GRADE.
3. WHERE IT IS ACCEPTABLE FOR A RAMP OR TURNING SPACE CROSS SLOPE TO EXCEED 2.0% AND MATCH THE HIGHWAY GRADE, THE RAMP ABOVE THE TURNING SPACE MAY BE WARPED TO TIE INTO THE ADJOINING SIDEWALK CROSS SLOPE. THE TRANSITION TO THE SIDEWALK CROSS SLOPE SHALL BE SPREAD EVENLY OVER THE LENGTH OF THE RAMP TO MINIMIZE WARPING. THE RATE OF CHANGE IN CROSS SLOPE MAY NOT EXCEED 3.0% PER LINEAR FOOT.
4. AREA MUST BE 6" DEEP, FINISHED OR PATTERNED CONCRETE. NO VEGETATION IS PERMITTED IN THIS AREA



-  TURNING SPACE (2) (3)
-  DETECTABLE WARNING SURFACE (DWS) SEE DWS SHEETS FOR PLACEMENT DETAILS
-  1/2" EXPANSION JOINT
-  RAMP RUNNING SLOPE
-  RAMP CROSS SLOPE (2) (3)

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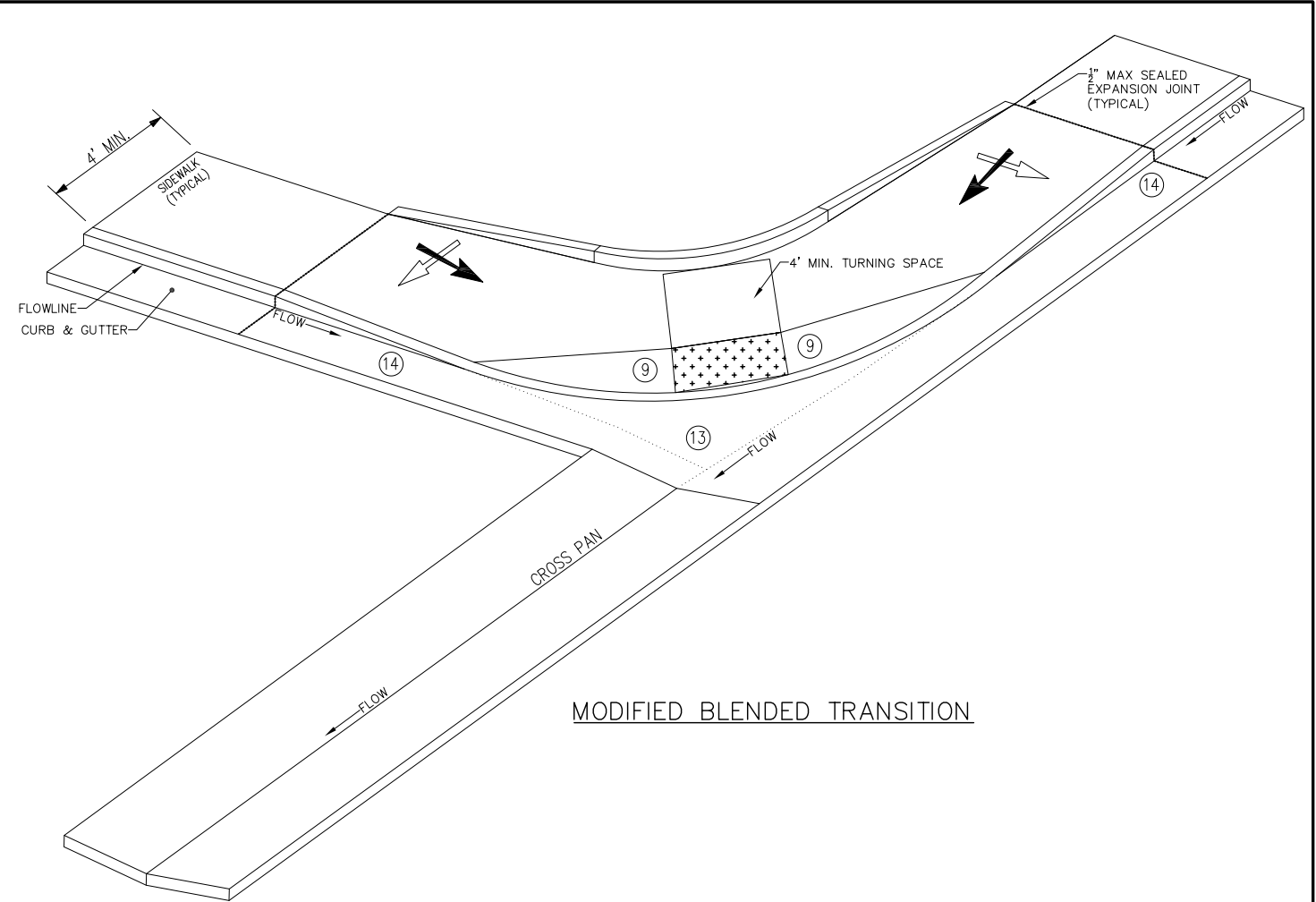
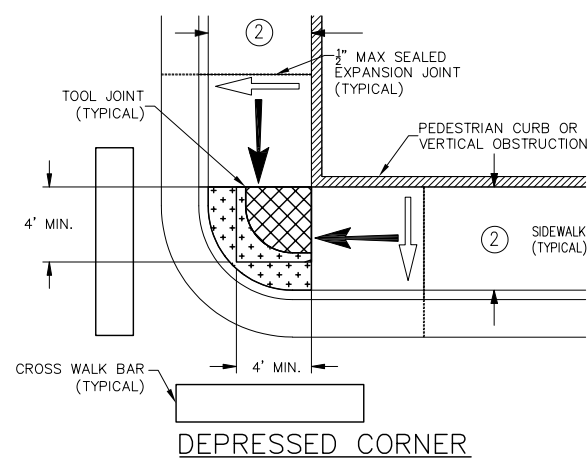
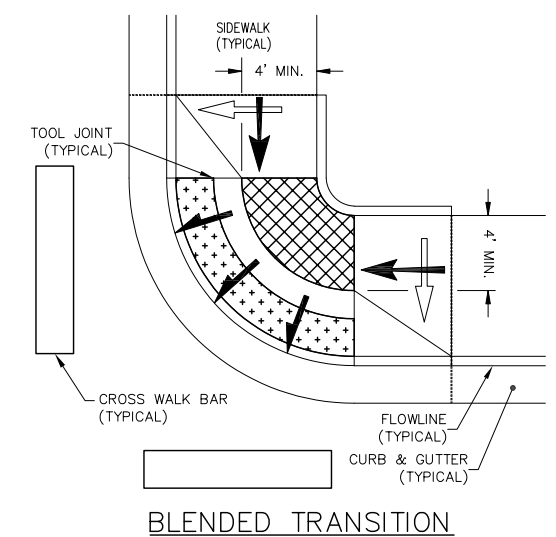
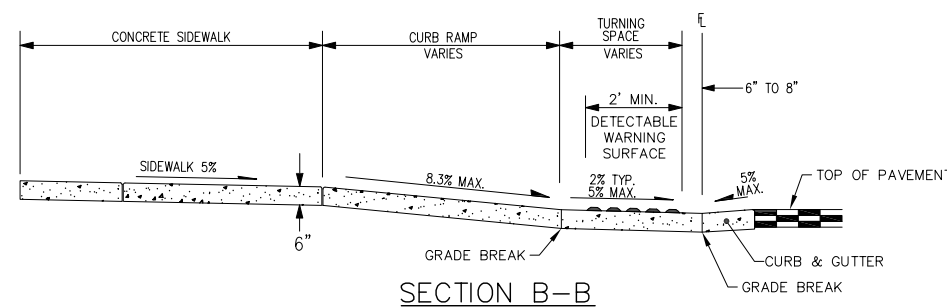
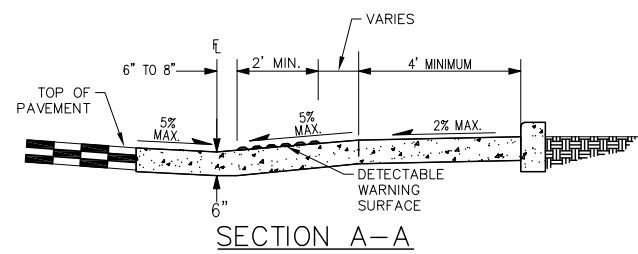
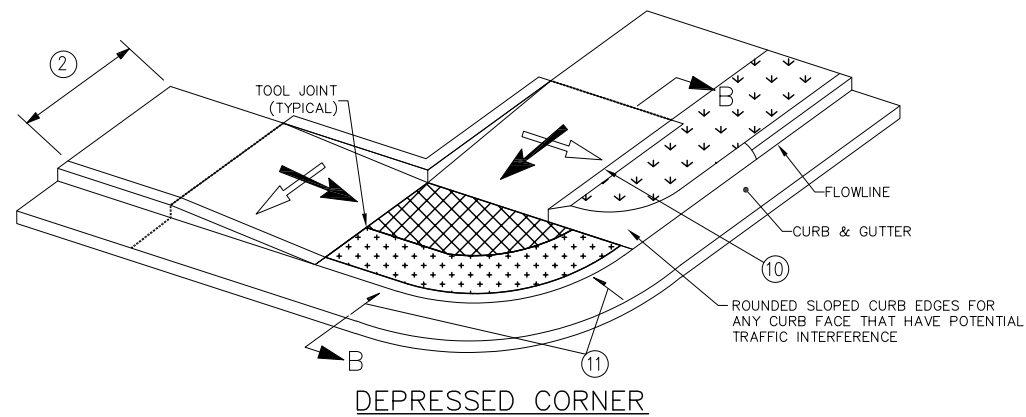
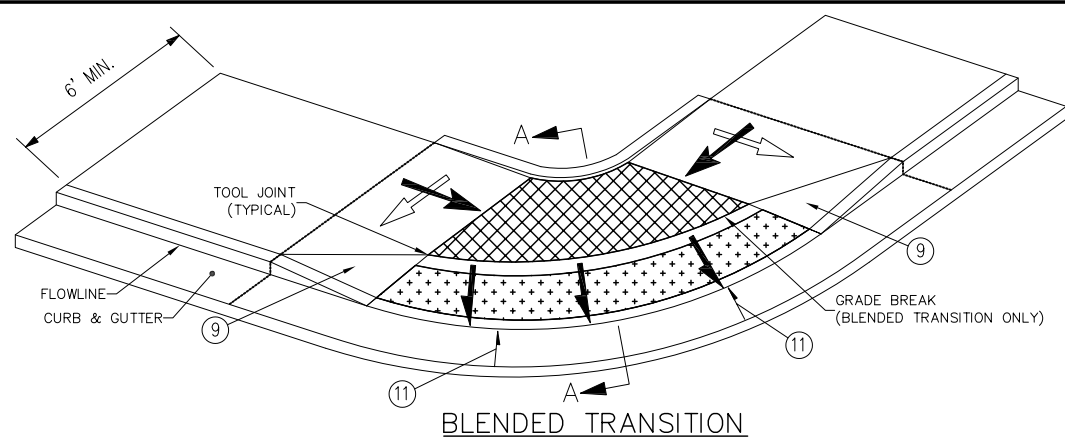
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COMBINATION CURB RAMPS TYPICAL CONFIGURATIONS

SCALE:

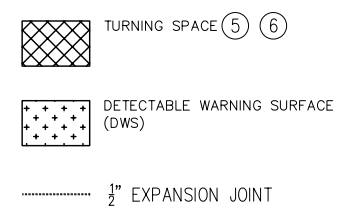
DETAIL #
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SP-8E



MODIFIED BLENDED TRANSITION

BLENDED TRANSITION & DEPRESSED CORNER NOTES

- PERPENDICULAR AND PARALLEL RAMP CONFIGURATIONS ARE PREFERRED. BLENDED TRANSITIONS AND DEPRESSED CORNERS SHOULD ONLY BE USED WHERE SITE CONDITIONS MAKE THEM A MORE APPROPRIATE OPTION, OR WHERE PERPENDICULAR OR PARALLEL RAMP CONFIGURATIONS CANNOT BE INSTALLED DUE TO A PHYSICAL SITE CONSTRAINT.
- RAMP WIDTH - PROVIDE 5 FT. OR GREATER WHERE POSSIBLE. IF SITE CONSTRAINTS DO NOT PERMIT, PROVIDE 4 FT. WIDTH MINIMUM. RAMP SERVING SHARED USE PATHS SHALL MATCH THE WIDTH OF THE PATH.
- RAMP RUNNING SLOPE - 8.3% MAX.
- BLENDED TRANSITION RUNNING SLOPE - 5.0% MAX.
- RAMP AND TURNING SPACE CROSS SLOPE - 2.0% TYPICAL. AT CROSSINGS WITHOUT YIELD OR STOP CONTROL, OR WITH A SIGNAL WHERE VEHICLES CAN PROCEED THROUGH THE INTERSECTION WITHOUT SLOWING OR STOPPING, THE CROSS SLOPE OF RAMP AND TURNING SPACES MAY EQUAL THE HIGHWAY GRADE.
- TURNING SPACE DIMENSIONS - PROVIDE A 4 FT. X 4 FT. MIN. TURNING SPACE AT THE BOTTOM OF RAMP THE TURNING SPACE MAY CONTAIN THE DETECTABLE WARNING SURFACES.
- RAMP ALIGNMENT - TURNING SPACE SHALL BE ALIGNED TO BE FULLY CONTAINED WITHIN THE CROSSWALK OR STREET CROSSING(S) THEY SERVE.
- RAMP LENGTH - RAMP LENGTH IS DEPENDENT UPON THE RAMP SLOPE AND THE CHANGE OF ELEVATION FROM THE TURNING SPACE TO THE SIDEWALK. WHERE TERRAIN IS SLOPING A RAMP IS NOT REQUIRED TO CHASE GRADE MORE THAN 15 FT. REGARDLESS OF THE RESULTING RAMP SLOPE.
- RAMP FLARES - WHERE A RAMP EDGE ABUTS A WALKABLE SURFACE, A FLARED SIDE MUST BE PROVIDED. RAMP FLARE SLOPES SHALL NOT EXCEED 10.0%.
- VERTICAL CURB RETURNS - VERTICAL CURB RETURNS MAY BE USED ONLY WHERE A RAMP ABUTS A NON-WALKABLE SURFACE, OR WHERE A RAMP IS PROTECTED FROM PEDESTRIAN CROSS TRAFFIC (FOR EXAMPLE BY A SIGNAL CABINET OR UTILITY POLE WHICH BLOCKS PASSAGE).
- GUTTER COUNTER SLOPE - 5.0% MAX.
- DWS PLACEMENT - DWS SHALL BE PLACED AROUND THE RADIUS AND LOCATED AT THE BACK OF CURB ON BLENDED TRANSITION AND DEPRESSED CORNER RAMP.
- FLOWLINE MAY DEVIATE AWAY FROM FACE OF CURB WHEN DRAINAGE PANS ARE IN USE. SLOPES SHALL NOT EXCEED ALGEBRAIC DIFFERENCE OF 13.3% WHEN FLOWLINES DEVIATE AWAY FROM CURB FACE.
- EXPANSION JOINTS MAY BE OMITTED IN 'REMOVE & REPLACE' SCENARIOS AT THE DISCRETION OF THE ARAPAHOE COUNTY PUBLIC WORKS REPRESENTATIVE.



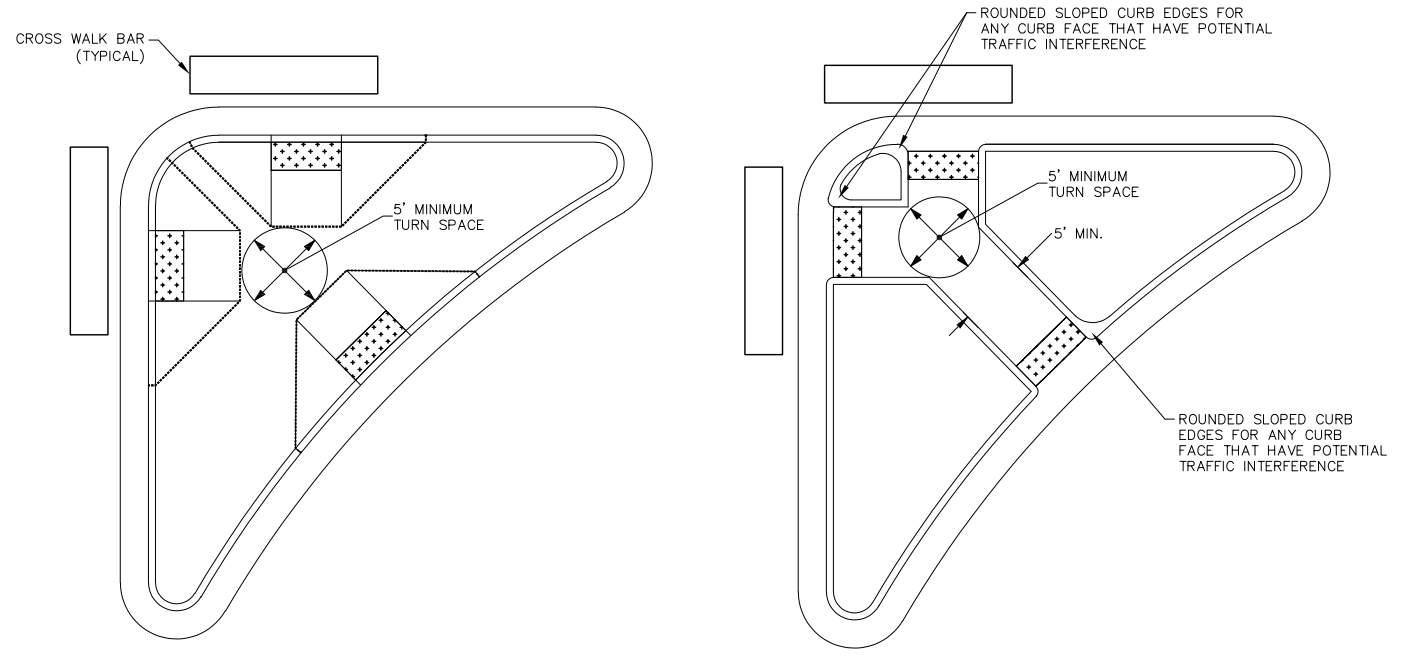
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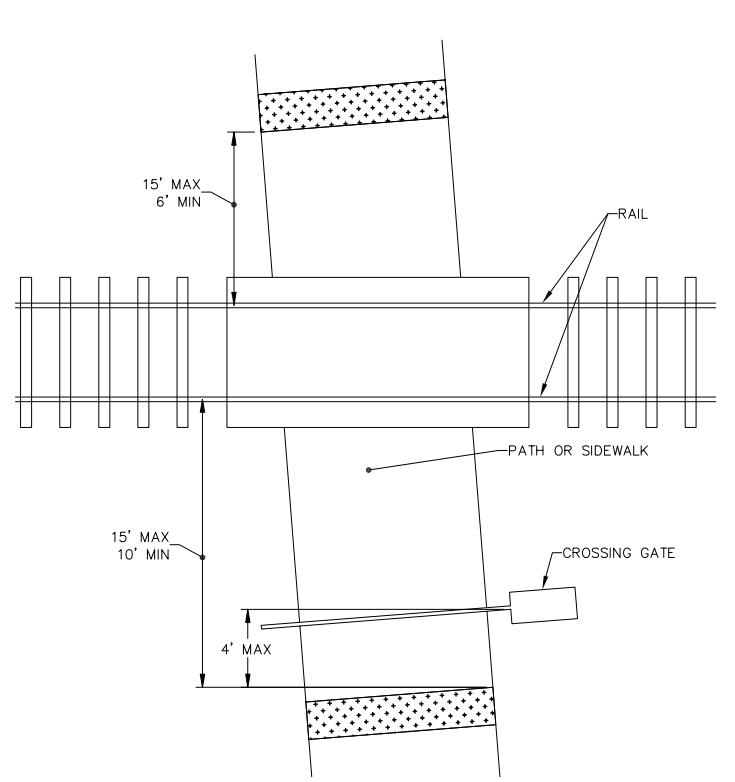
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TYPE 5 - DEPRESSED CORNER/BLENDED TRANSITION

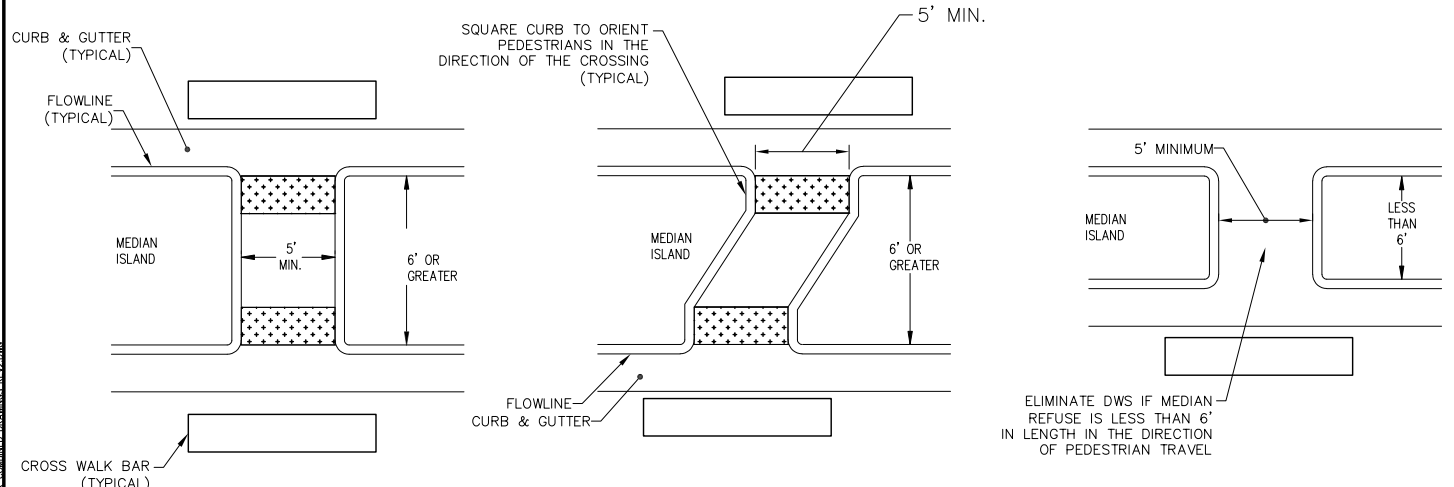
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INTERSECTION ISLANDS

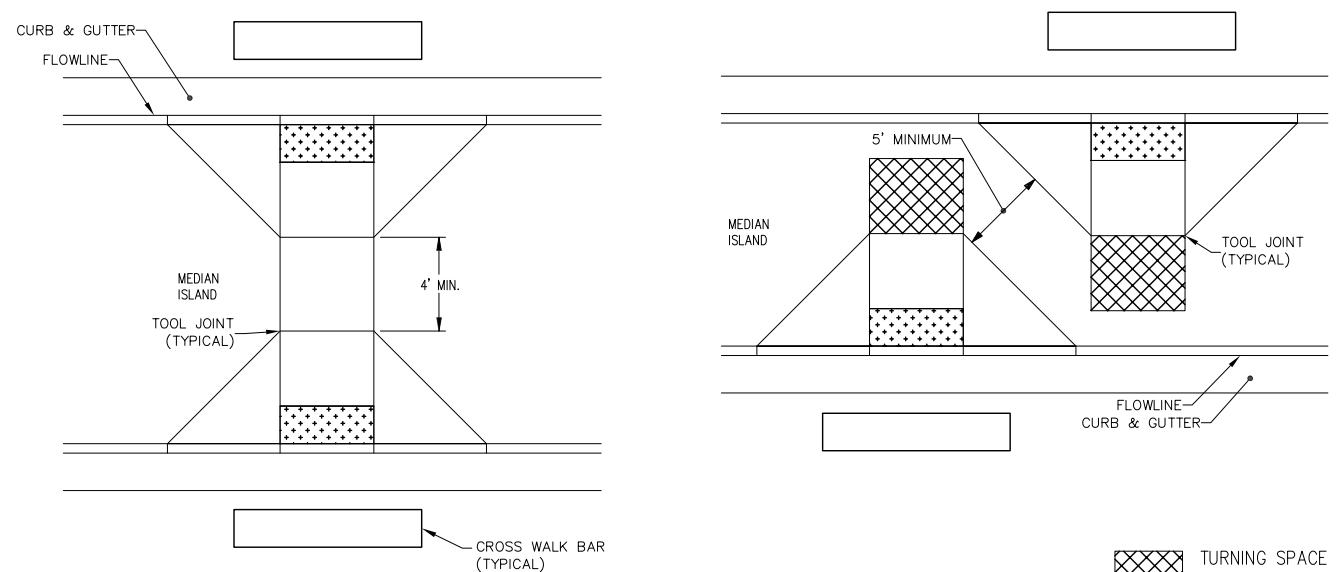


AT-GRADE RAIL CROSSING



MEDIAN ISLANDS

- NOTES:**
1. DETECTABLE WARNING SURFACES SHALL BE PLACED IN ALIGNMENT WITH THE BACK OF CURB.
 2. FLARED SIDES ARE PREFERENTIAL ON RAISED INTERSECTION ISLANDS AND SHOULD BE PROVIDED ON ISLANDS WHICH SERVE SHARED USE PATHS, OR AT LOCATIONS WHERE BICYCLE USE IS EXPECTED.
 3. FOR CUT-THROUGH MEDIAN ISLANDS, DETECTABLE WARNING SURFACES SHALL BE PLACED IN ALIGNMENT WITH THE BACK OF CURB AND BE SEPARATED BY A MINIMUM 2 FOOT SPACE WITHOUT DWS. IF A 2 FOOT SEPARATION BETWEEN DETECTABLE WARNING SURFACES CANNOT BE PROVIDED NO DETECTABLE WARNING SURFACE SHALL BE INSTALLED.
 4. CURB RAMP AND CUT-THROUGH WIDTHS SHOULD BE THE SAME WIDTH AS ANY SIDEWALK OR SHARED USE PATH WHICH THEY SERVE.
 5. EXPANSION JOINTS AND CONTROL JOINTS OMITTED FOR CLARITY. REFERENCE OTHER DRAWINGS FOR EXPANSION JOINTS AND CONTROL JOINTS.



- TURNING SPACE
- DETECTABLE WARNING SURFACE (DWS)
- 1/2" EXPANSION JOINT

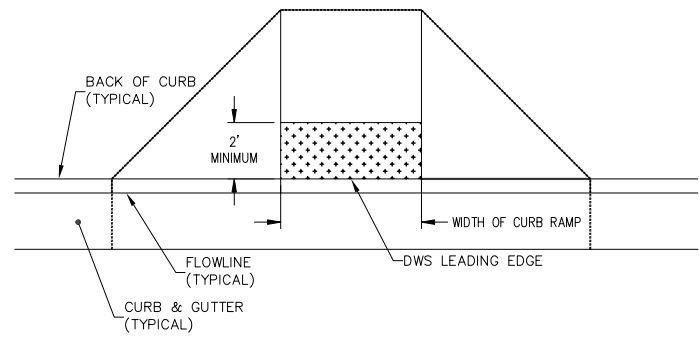
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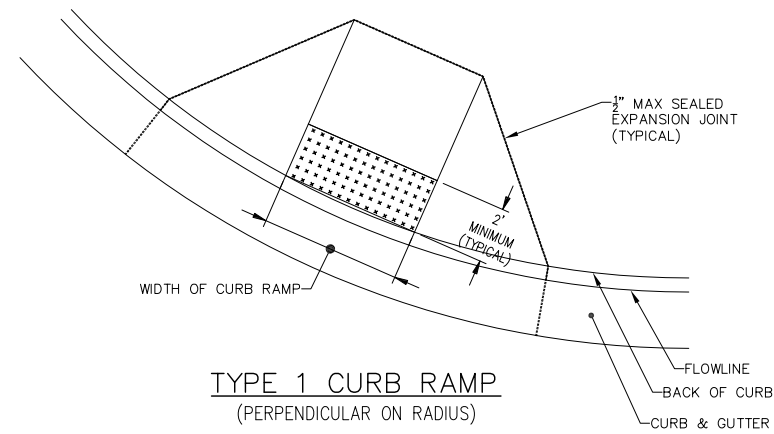
MEDIANS / RAILROADS / ISLANDS

SCALE:

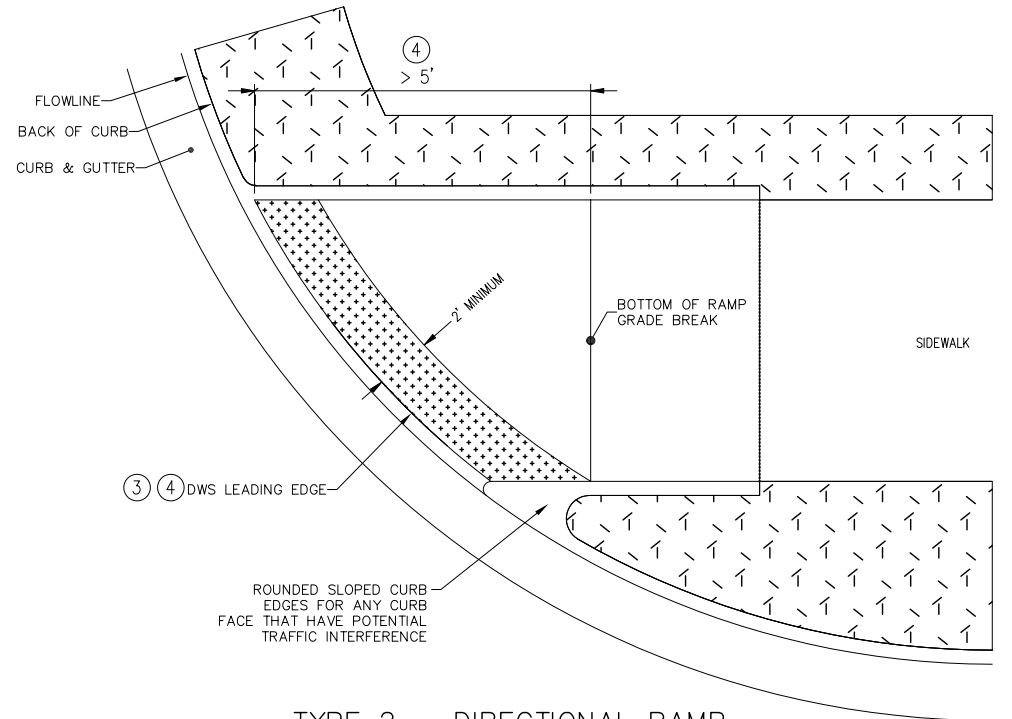
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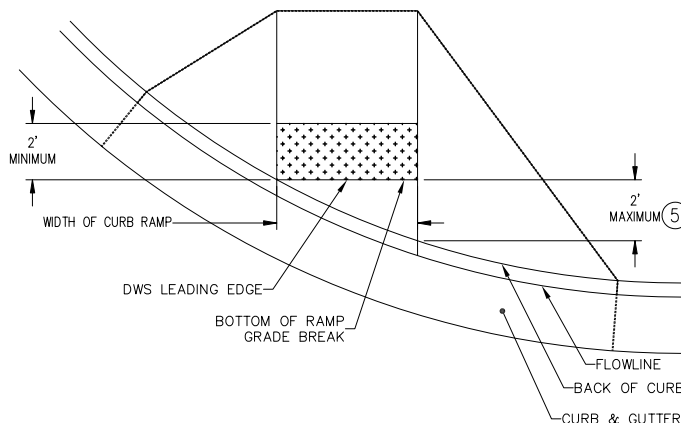
TYPE 1 CURB RAMP
(PERPENDICULAR ON TARGET)



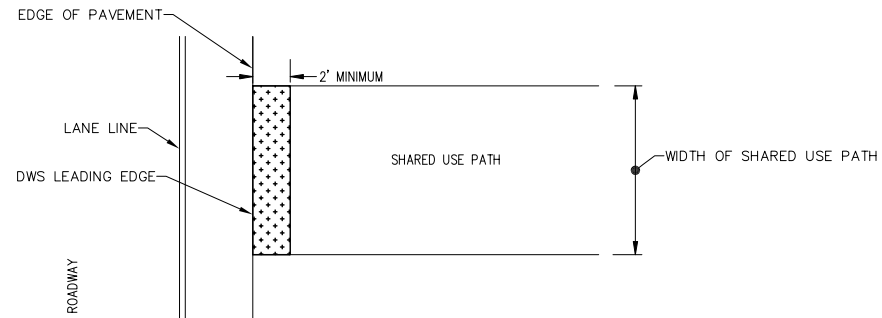
TYPE 1 CURB RAMP
(PERPENDICULAR ON RADIUS)



TYPE 2 - DIRECTIONAL RAMP



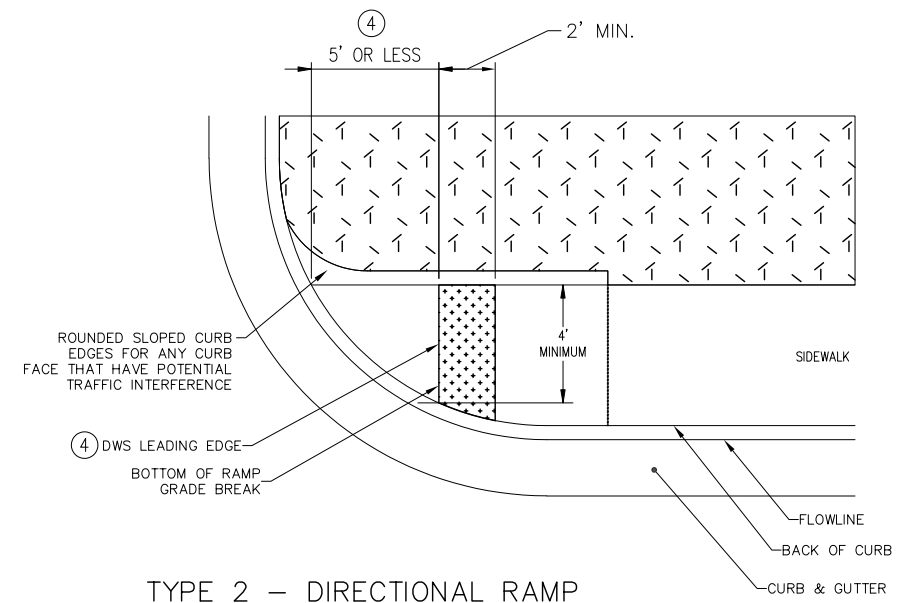
TYPE 1 CURB RAMP
(DIRECTIONAL ON RADIUS)



SHARED USE PATH CROSSING

DETECTABLE WARNING SURFACE NOTES:

1. DETECTABLE WARNING SURFACES (DWS) SHALL BE INSTALLED AT SIDEWALK, OR SHARED USE PATH, TO STREET TRANSITIONS, AND SHALL CONSIST OF TRUNCATED DOME SURFACES. ANY TRUNCATED DOME PANELS OR PAVERS WHICH ARE USED MUST BE ON THE CDOT APPROVED PRODUCTS LIST (APL).
2. THE DETECTABLE WARNING SURFACE SHALL SPAN THE FULL WIDTH OF THE CURB RAMP, SHARED USE PATH, OR OTHER ROADWAY ENTRANCE AS APPLICABLE. A GAP OF 2 INCHES FROM THE EDGE OF THE DETECTABLE WARNING SURFACE TO THE EDGE OF THE CURB RAMP OR SHARED USE PATH IS PERMITTED.
3. WHEN DETECTABLE WARNING SURFACES ARE PLACED ON A SLOPE GREATER THAN 5.0%, TRUNCATED DOMES SHOULD BE ALIGNED IN THE DIRECTION OF THE RAMP RUN; OTHERWISE DOMES ARE NOT REQUIRED TO BE ALIGNED. TRUNCATED DOMES SHALL BE IN A SQUARE GRID OR RADIAL PATTERN. WHEN PLACED RADIALLY, PLACE ADJACENT DWS PLATES EDGE TO EDGE. EDGES OF CUT PLATES SHALL BE STRAIGHT.
4. LOCATE ONE CORNER OF THE DWS LEADING EDGE AT THE BACK OF CURB. NO POINT ON THE LEADING EDGE OF THE DWS MAY BE MORE THAN 5 FT. FROM THE BACK OF CURB. WHEN ANY POINT OF THE LEADING EDGE OF THE DWS WILL BE GREATER THAN 5 FT. FROM THE BACK OF CURB, PLACE THE DWS RADIALLY AT THE BACK OF CURB.
5. WHERE PERPENDICULAR DIRECTIONAL RAMPS ABUT A WALKABLE SURFACE, THE LEADING EDGE OF THE DWS SHALL NOT BE PLACED FURTHER THAN 2 FEET FROM THE BACK OF CURB. IF THE RADIUS OF A CORNER MAKES THIS IMPOSSIBLE, ORIENT THE CURB RAMP PERPENDICULAR TO THE CURB AND GUTTER.
6. IF THE DETECTABLE WARNING SURFACE IS CUT, GRIND OFF THE REMAINING PORTION OF ANY CUT TRUNCATED DOMES. SEAL ALL CUT PANEL EDGES WITH AN APL SEALANT TO PREVENT WATER DAMAGE.
7. TRUNCATED DOME PLATES SHALL BE EMBEDDED IN THE CONCRETE CURB RAMP WHILE THE CONCRETE IS PLASTIC.
8. DWS SHALL NOT BE PLACED OVER GRADE BREAKS.
9. LANDING AND TURNING SPACE OMITTED FOR CLARITY.



TYPE 2 - DIRECTIONAL RAMP

DETECTABLE WARNING SURFACE (DWS)
 1/2" EXPANSION JOINT

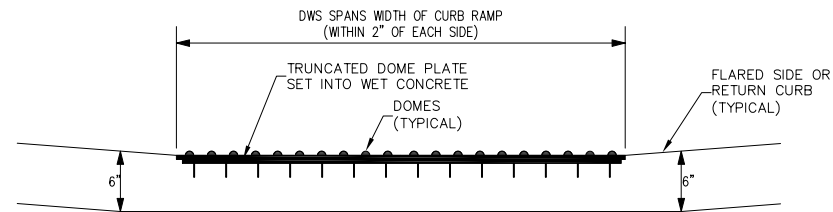
C:\USERS\WILLIAM.DREIERE\ARAPAHOE COUNTY GOVERNMENT\BROWNS ACCESS RAMPS\CDOT STANDARDS 2021\01-01-2021-COMBINED-REVISED-ARAPAHOE-BROWNS.DWG

REVISIONS			
#	DATE	DESCRIPTION	BY
1		ISSUED	

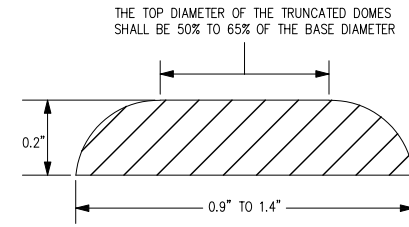
ARAPAHOE COUNTY, COLORADO
 DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT
 PREPARED BY THE ARAPAHOE COUNTY ENGINEERING & TRANSPORTATION DIVISIONS
 6924 SOUTH LIMA STREET - CENTENNIAL COLORADO 80112 - PH. 720-874-6500 - FAX. 303-874-6611

DETECTABLE WARNING SURFACE PLACEMENT

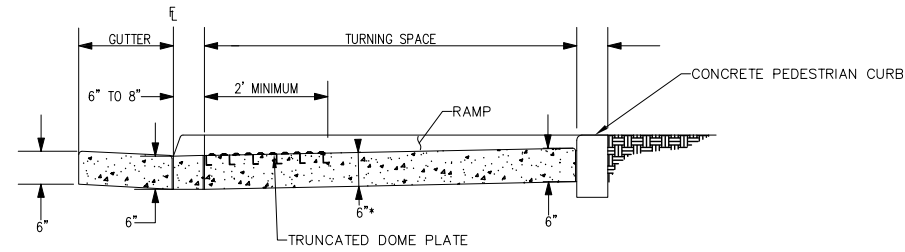
SCALE:
DETAIL #
 9 of 10
SP-10A



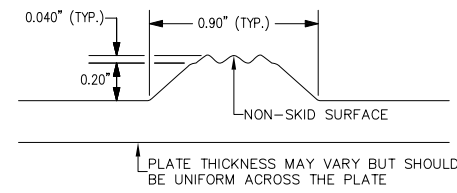
SECTION VIEW OF DETECTABLE WARNING SURFACE PLATE
(LOOKING AT PERPENDICULAR RAMP RUN FROM STREET)



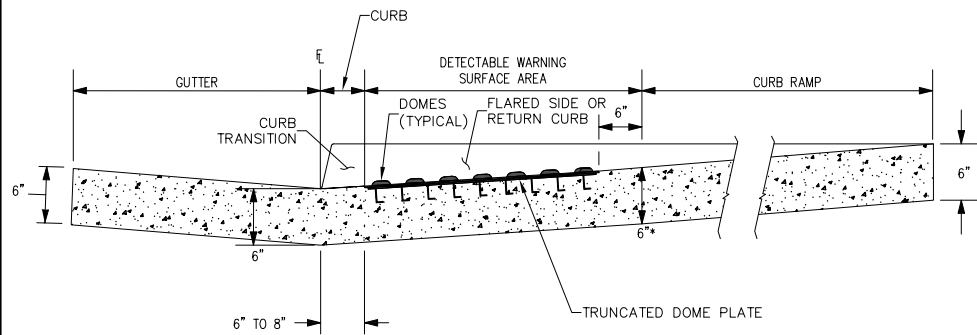
ELEVATION VIEW OF SINGLE TRUNCATED DOME



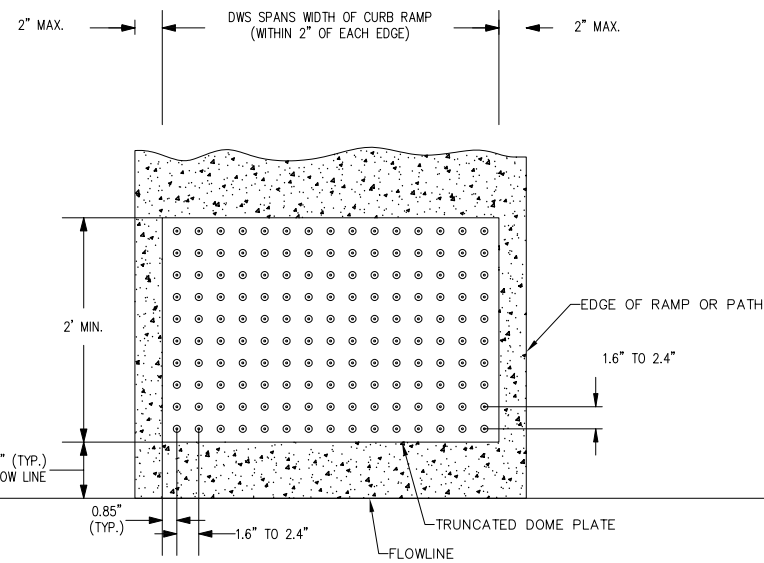
SECTION VIEW FOR PARALLEL CURB RAMP TYPES
(LOOKING PERPENDICULAR TO TURNING SPACE)



ELEVATION VIEW OF TRUNCATED DOME FOR DETECTABLE WARNING PLATE



SECTION VIEW FOR PERPENDICULAR CURB RAMP TYPES
(LOOKING PERPENDICULAR TO RAMP RUN)



PLAN VIEW OF DETECTABLE WARNING SURFACE PLATE

C:\USERS\WILLIAM\DRAWING - ARAPAHOE COUNTY GOVERNMENT\DRAWING STANDARDS 2021.DWG

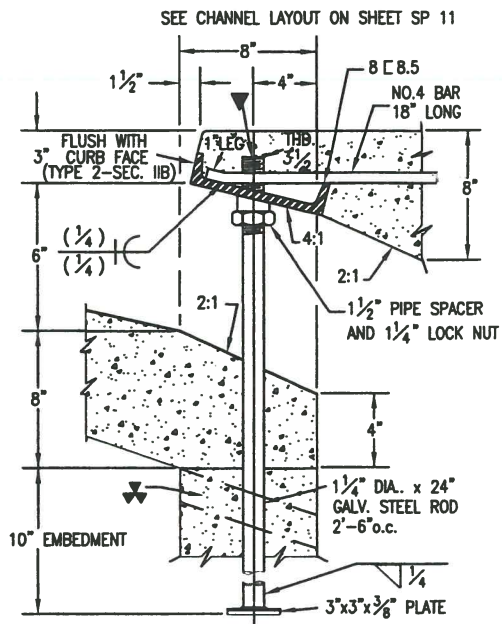
REVISIONS			
#	DATE	DESCRIPTION	BY
1		ISSUED	

Arapahoe County
ARAPAHOE COUNTY, COLORADO
DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT
Colorado's First
PREPARED BY THE ARAPAHOE COUNTY ENGINEERING & TRANSPORTATION DIVISIONS
6924 SOUTH LIMA STREET - CENTENNIAL COLORADO 80112 - PH. 720-874-6500 - FAX. 303-874-6611

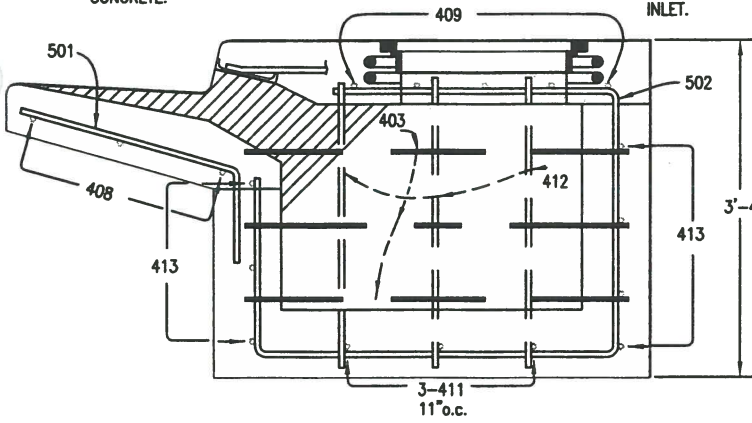
DETECTABLE WARNING SURFACE DETAILS

SCALE:

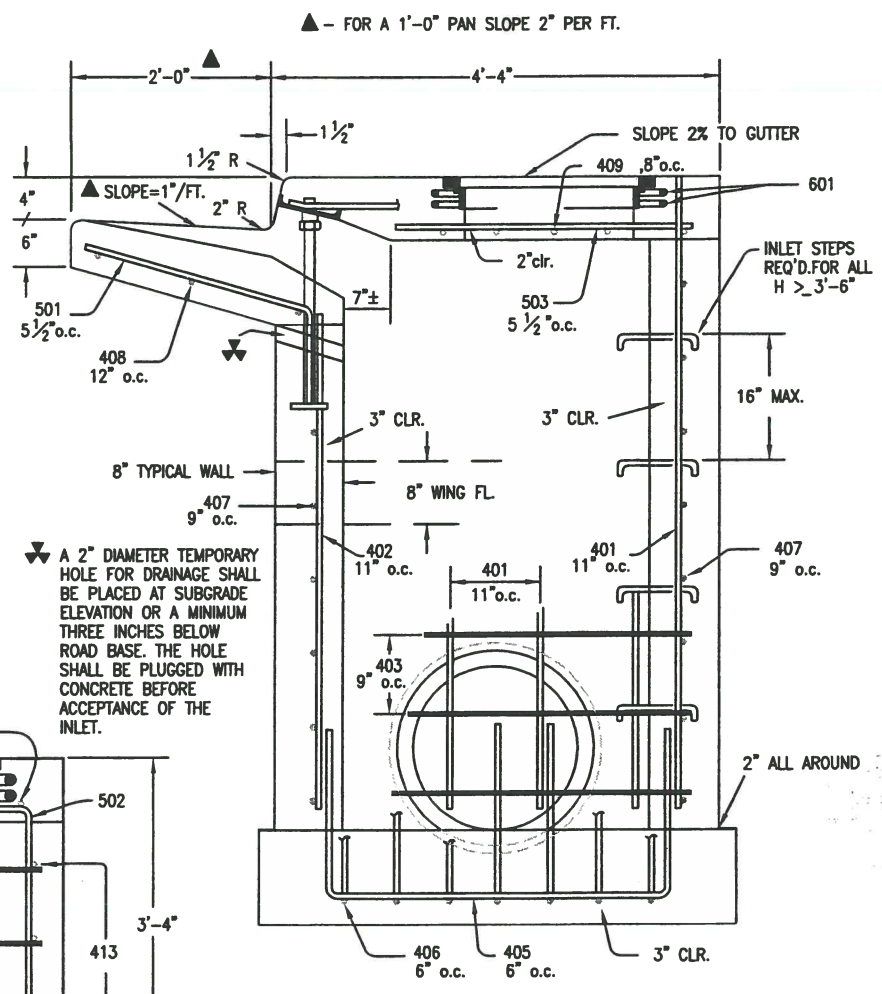
DETAIL #
10 of 10
SP-10B



CURB FACE ASSEMBLY
PLACE ENTIRE ASSEMBLY BEFORE POURING CONCRETE.

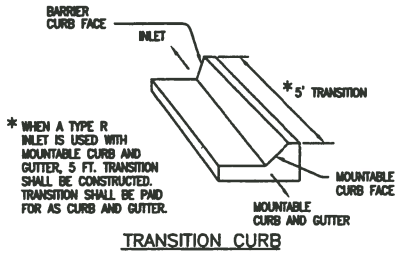


SECTIONS C-C & D-D
(DOTTED BARS ARE IN SECTION D-D)



SECTION B-B
TYPICAL END VIEW

NOTE: MANHOLE RING & COVER, STATION POINT AND OUTFLOW PIPE SHALL BE LOCATED AT THE SAME END OF THE INLET.



* WHEN A TYPE R INLET IS USED WITH MOUNTABLE CURB AND GUTTER, 5 FT. TRANSITION SHALL BE CONSTRUCTED. TRANSITION SHALL BE PAID FOR AS CURB AND GUTTER.

TRANSITION CURB

Drawn By: SBW *SBW*
Checked By: *SA*
Approved By: *JEL*

CURB INLET
TYPE R

Issued: 5/10/05
Revised: 8/31/06
Drawing Number:
SP. 11a

TABLE ONE ~ BAR LIST FOR CURB INLETS, TYPE "R"

MARK	DIA IN.	O.C. SPACING	TYPE	ALL INLETS		INLETS, H ≈ 5'				INLETS, H ≈ 5'			
				L = 5'		10'		15'		10'		15'	
				NO.REQ'D.	LENGTH	NO.REQ'D.	LENGTH	NO.REQ'D.	LENGTH	NO.REQ'D.	LENGTH	NO.REQ'D.	LENGTH
401		11"	II	15	*	21	*	26	*	11	*	11	*
402		11"	II	7	*	13	*	18	*	7	*	7	*
403		9"	II	*	4'-10"	*	4'-0"	*	4'-0"	*	4'-0"	*	4'-10"
405		6"	VI	11	6'-10"	21	6'-10"	31	6'-10"	11	6'-10"	11	6'-10"
406		6"	VIII	7	8'-10"	7	13'-10"	7	18'-10"	7	8'-10"	7	8'-10"
407	1/2"	9"	II	*	5'-10"	*	10'-10"	*	15'-10"	*	5'-10"	*	5'-10"
408		12"	II	3	6'-10"	3	11'-0"	3	16'-0"	3	11'-0"	3	16'-0"
409		8"	II	6	5'-10"	6	10'-10"	6	15'-10"	6	10'-10"	6	15'-10"
410		11"	VII							3	*	3	*
411		11"	II							3	5'-2"	3	10'-2"
412		11"	II							3	2'-9"	3	2'-9"
413		9"	II							7	10'-10"	7	15'-10"
501		5 1/2"	IV	11	3'-4"	22	3'-4"	33	3'-4"	22	3'-4"	33	3'-4"
502	5/8"	5 1/2"	III							11	11'-5"	17	11'-5"
503		5 1/2"	II	5	3'-6"	16	3'-6"	27	3'-6"	6	3'-6"	6	3'-6"
504		5 1/2"	IX									5	8'-4"
601	3/4"	2 1/2"	V	2	8'-10"	2	8'-10"	2	8'-10"	2	8'-10"	4	8'-10"
#8[B.5				1	5'-10"	1	10'-10"	1	15'-10"	1	10'-10"	1	15'-10"
				2BARS,1ROD	---	4BARS,3RODS	---	8BARS,5RODS	---	4BARS,3RODS	---	8BARS,5RODS	---

* VARIABLE, REFER TO TABLE TWO.

☯ INCLUDE 18" NO. 4 BARS (SEE CHANNEL LAYOUT DETAIL).

▼ SEE CURB FACE ASSEMBLY ON SHEET 1 AND CHANNEL LAYOUT DETAILS ON THIS SHEET.

REGULAR INLETS

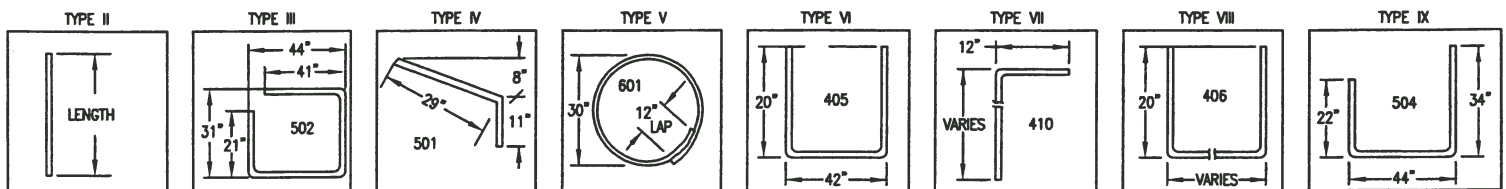
DROP BOX INLETS

TABLE TWO ~ BARS AND QUANTITIES VARIABLE WITH "H"

'H'	LENGTH			NO. REQ'D. REGULAR		NO. REQ'D. DROP BOX		L=5'		L=10'		L=15'	
	401	402	410	403	407	403	407	CU.YD.CONC.	LB.STEEL	CU.YD.CONC.	LB.STEEL	CU.YD.CONC.	LB.STEEL
	3'-0"	2'-8"	1'-8"		10	7			3.2	285	5.3	497	7.4
3'-6"	3'-2"	2'-2"		10	7			3.4	305	5.7	528	7.9	747
4'-0"	3'-8"	2'-8"		12	9			3.7	326	6.0	559	8.4	786
4'-6"	4'-2"	3'-2"		12	9			3.9	334	6.4	571	8.8	803
5'-0"	4'-8"	3'-8"		14	11			4.1	354	6.7	602	9.3	844
5'-6"	5'-2"	4'-2"	3'-5"	16	13	15	6	4.4	375	6.0	607	7.4	850
6'-0"	5'-8"	4'-8"	3'-11"	16	13	16	6	4.6	382	6.2	616	7.6	860
6'-6"	6'-2"	5'-2"	4'-5"	18	15	18	8	4.8	402	6.4	637	7.8	880
7'-0"	6'-8"	5'-8"	4'-11"	20	17	19	10	5.0	423	6.6	654	8.0	897
7'-6"	7'-2"	6'-2"	5'-5"	20	17	20	10	5.3	430	6.9	664	8.3	907
8'-0"	7'-8"	6'-8"	5'-11"	22	19	22	12	5.5	451	7.1	684	8.5	927
8'-6"	8'-2"	7'-2"	6'-5"	24	21	23	14	5.7	471	7.3	702	8.7	944
9'-0"	8'-8"	7'-8"	6'-11"	24	21	24	14	6.0	479	7.6	711	9.0	954
9'-6"	9'-2"	8'-2"	7'-5"	26	23	26	16	6.2	499	7.8	732	9.2	974
10'-0"	9'-8"	8'-8"	7'-11"	28	25	27	18	6.4	520	8.0	749	9.4	992
10'-6"	10'-2"	9'-2"	8'-5"	28	25	28	18	6.7	527	8.3	759	9.7	1001
11'-0"	10'-8"	9'-8"	8'-11"	30	27	30	20	6.9	547	8.5	779	9.9	1022

NOTE: FOR L=5', L=10' AND L=15'
REGULAR INLETS: TOTAL QUANTITIES NEEDED ARE OUTSIDE OF THE HEAVY BLACK LINE.
DROP BOX INLETS: TOTAL QUANTITIES NEEDED ARE INSIDE OF THE HEAVY BLACK LINE

STEEL WEIGHTS DO NOT INCLUDE STRUCTURAL STEEL.



BAR BENDING DIAGRAMS ~ (Dimensions are Out-to-Out of bar)

Drawn By: SBW *SBW*

Checked By: *PH*

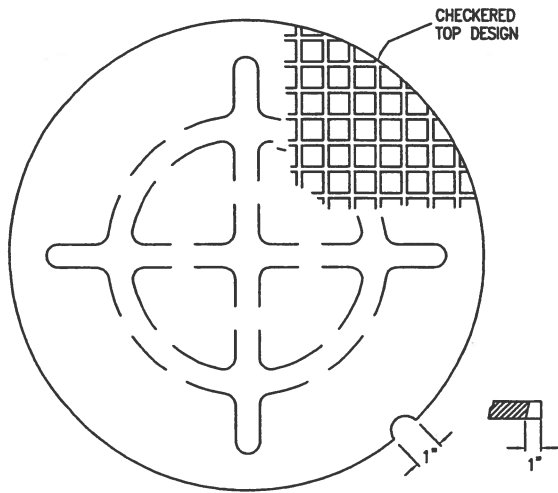
Approved By: *JEP*

CURB INLET
TYPE R

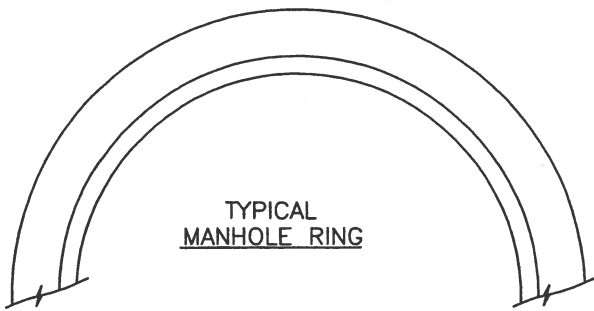
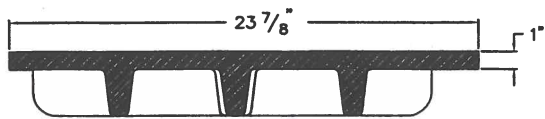
Issued: 5/10/05

Revised: 8/31/06

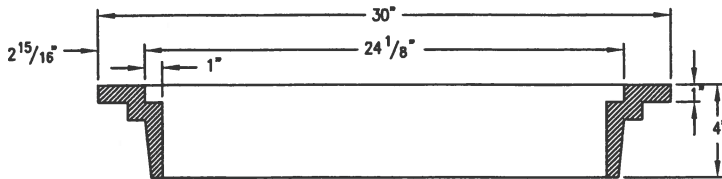
Drawing Number:
SP. 11c



TYPICAL
MANHOLE COVER



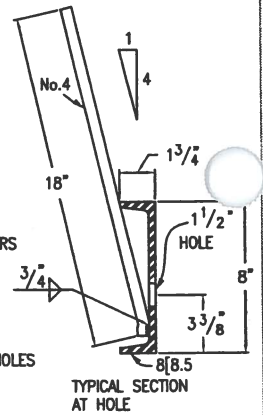
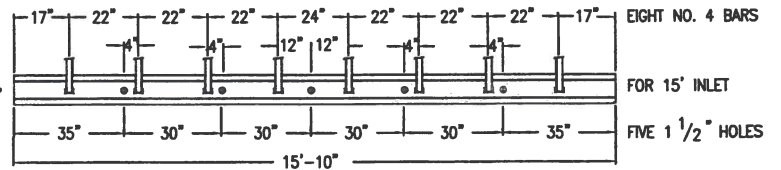
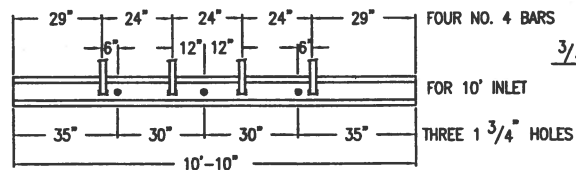
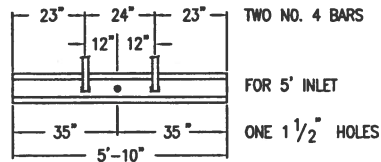
TYPICAL
MANHOLE RING



WEIGHTS: COVER = 125 LBS.
RING = 135 LBS.
TOTAL = 260 LBS.

GENERAL NOTES

1. ALL CONCRETE SHALL BE CLASS B.
2. CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES AND SHALL BE 8 IN. THICK.
3. INLET STEPS SHALL BE IN ACCORDANCE WITH AASHTO M 199.
4. CURB FACE ASSEMBLY SHALL BE GALVANIZED AFTER WELDING.
5. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4 IN. CURB AND GUTTER CORNERS SHALL BE FINISHED TO MATCH THE EXISTING CURB AND GUTTER BEYOND THE TRANSITION GUTTER.
6. REINFORCING BARS SHALL BE DEFORMED AND SHALL HAVE A 2 IN. MINIMUM CLEARANCE. ALL REINFORCING BARS SHALL BE EPOXY COATED.
7. DIMENSIONS AND WEIGHTS OF TYPICAL MANHOLE RING AND COVER ARE NOMINAL.
8. MATERIAL FOR MANHOLE RINGS AND COVERS SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO 712.06.
9. SINCE PIPE ENTRIES INTO THE INLET ARE VARIABLE, THE DIMENSIONS SHOWN ARE TYPICAL. ACTUAL DIMENSIONS AND QUANTITIES FOR CONCRETE AND REINFORCEMENT SHALL BE AS REQUIRED IN THE WORK. QUANTITIES INCLUDE VOLUMES OCCUPIED BY PIPES.
10. STRUCTURAL STEEL SHALL BE GALVANIZED AND SHALL CONFORM TO THE REQUIREMENTS OF 712.06.



CHANNEL LAYOUT DETAILS

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

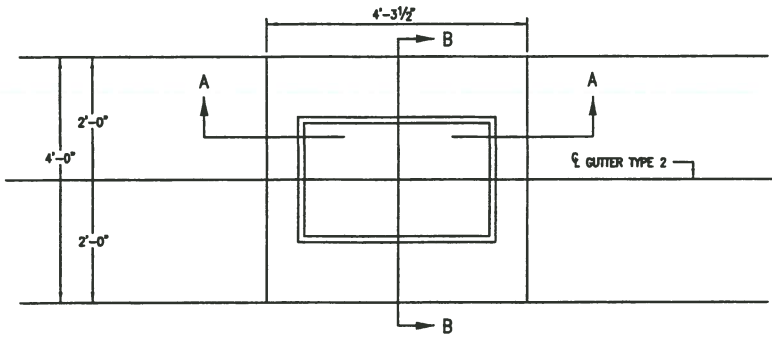
Approved By: *[Signature]*

CURB INLET
TYPE R

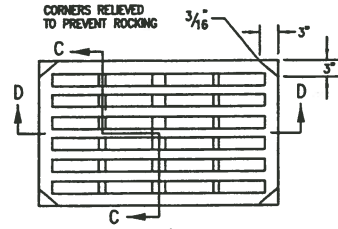
Issued: 5/10/05

Revised: 8/31/06

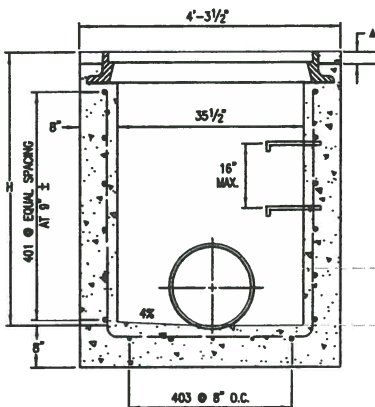
Drawing Number:
SP. 11d



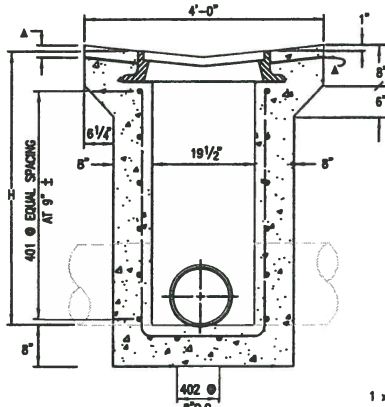
PLAN OF TYPE 13 INLET FOR GUTTER TYPE 2



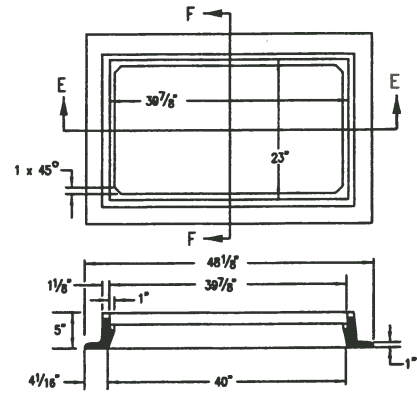
SECTION D-D
NO. 13 GRATE



SECTION A-A

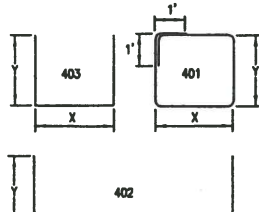


SECTION B-B



SECTION E-E
NO. 13 GRATING & FRAMES

APPROX. WEIGHT 590 LBS.



ALL DIMENSIONS ARE OUT-TO-OUT OF BAR.
BENDING DIAGRAM

Drawn By: SBW *SBW*

Checked By: *MH*

Approved By: *JEP*

CURB INLET
TYPE 13

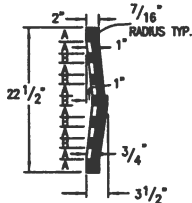
Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 12

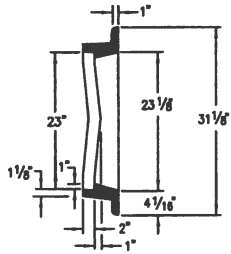
GENERAL NOTES

1. CONCRETE SHALL BE CLASS B. INLET MAY BE CAST-IN-PLACE OR PRECAST.
2. CAST-IN-PLACE CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES.
3. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4 IN.
4. REINFORCING BARS SHALL BE DEFORMED AND SHALL HAVE A 2 IN. MINIMUM CLEARANCE. ALL REINFORCING BARS SHALL BE EPOXY COATED.
5. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" EXCEEDS 3 FT.-6 IN. AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.
6. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO 712.06. GRATES AND FRAMES SHALL BE DESIGNED TO WITHSTAND HS 20 LOADING.



SECTION C-C

- A = 1 3/4"
- B = 11 1/8"
- C = 7 15/16"



SECTION F-F

QUANTITIES

H	CONCRETE	REINFORCING STEEL	NO. OF 401 BARS REQ'D.
	CU. YD.	Ø LB.	
3'-0"	1.3	72	4
3'-6"	1.5	76	4
4'-0"	1.6	80	5
4'-6"	1.8	104	6
5'-0"	1.9	109	6
5'-6"	2.1	122	7
6'-0"	2.2	136	8
6'-6"	2.4	141	8
7'-0"	2.5	154	9
7'-6"	2.7	168	10
8'-0"	2.8	173	10
8'-6"	3.0	187	11
9'-0"	3.1	200	12
9'-6"	3.3	205	12
10'-0"	3.4	219	13

Ø INCLUDES 1% FOR OVERRUN.
NOTE: CONCRETE QUANTITIES INCLUDE VOLUME OCCUPIED BY PIPE.

BAR LIST FOR H=3'-0"

MARK	NO. REQ'D.	DIMENSIONS		LENGTH
		X	Y	
401	4	3'-6"	2'-2"	13'-4"
402	2	3'-4 1/2"	* 2'-8 1/2"	8'-5 1/2"
403	5	2'-1 1/2"	* 2'-7"	7'-2 1/2"

* ADD 6 IN. TO THIS DIMENSION FOR EACH 6 IN. INCREASE OF "H" OVER 3 FT.-0 IN.

NOTE:

SEE PLAN DETAILS FOR LOCATION AND SIZE OF PIPE.

- ▲ WHEN BITUMINOUS MATERIAL IS TO EXTEND TO THE EDGE OF THE GRATING FRAME, CONCRETE MAY BE DEPRECATED.

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

Approved By: *[Signature]*

CURB INLET
TYPE 13

Issued: 5/10/05

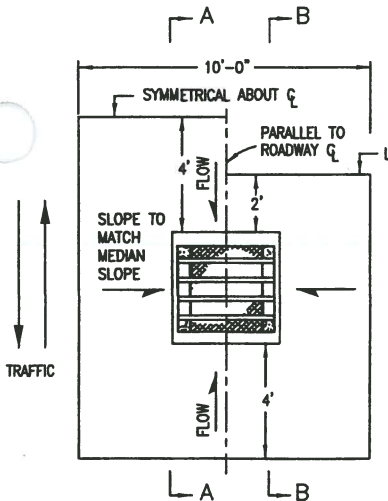
Revised: 8/31/06

Drawing Number:
SP. 13

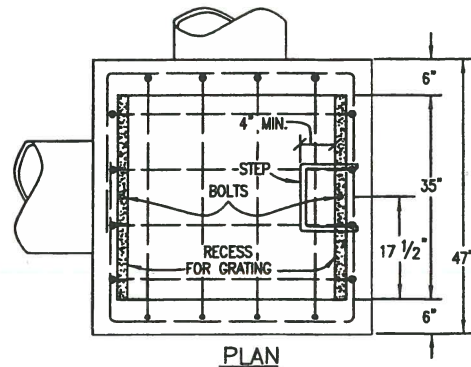
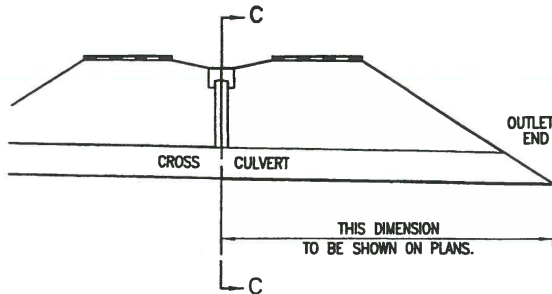
STEEL GRATE QUANTITIES

NO. PIECES	DESCRIPTION	LENGTH	LB. PER FT.	WEIGHT (LBS.)
4	S4 x 7.7 BEAM	40"	7.70	103
2	3 1/2" x 1/4" FLAT	26 5/8"	2.98	13
2	3" x 1/4" FLAT	26 5/8"	2.55	12

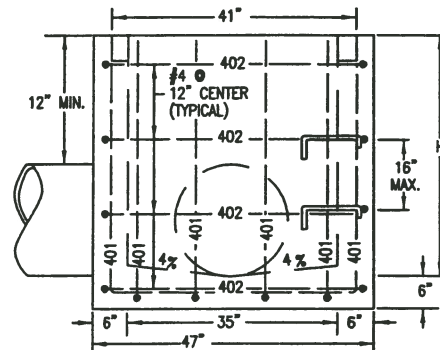
TOTAL 128 LBS.



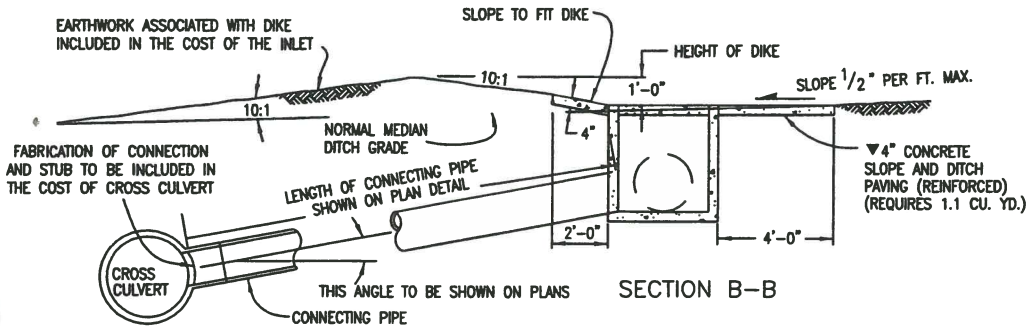
INLET WITH DITCH PAVING



PLAN

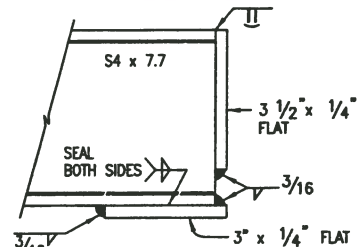


**ELEVATION
CONCRETE INLET**



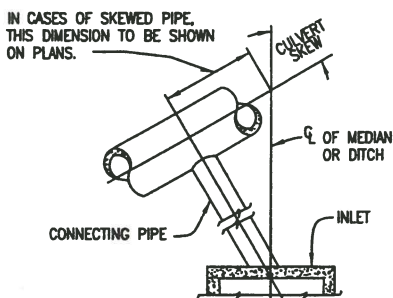
SECTION B-B

**INLET ON GRADE
(FLOW FROM ONE DIRECTION)**

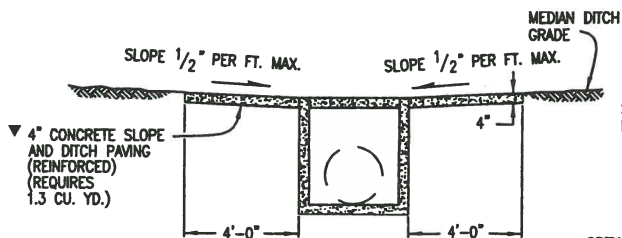


SECTION D-D

**SECTION C-C
INLET CONNECTED TO A CROSS CULVERT**

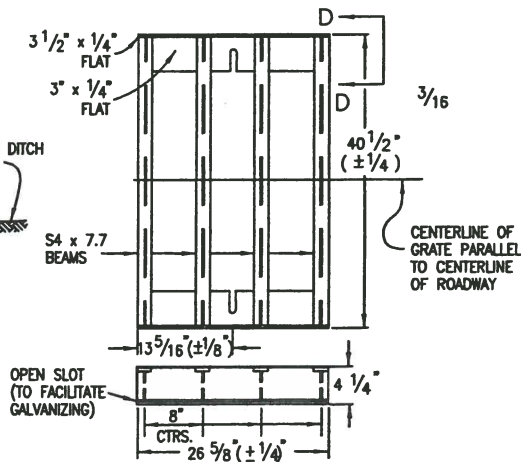


**INLET CONNECTED TO A
SKEWED CROSS CULVERT**



SECTION A-A

**INLET AT BOTTOM
OF VERTICAL CURVE**



STANDARD INLET GRATE

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

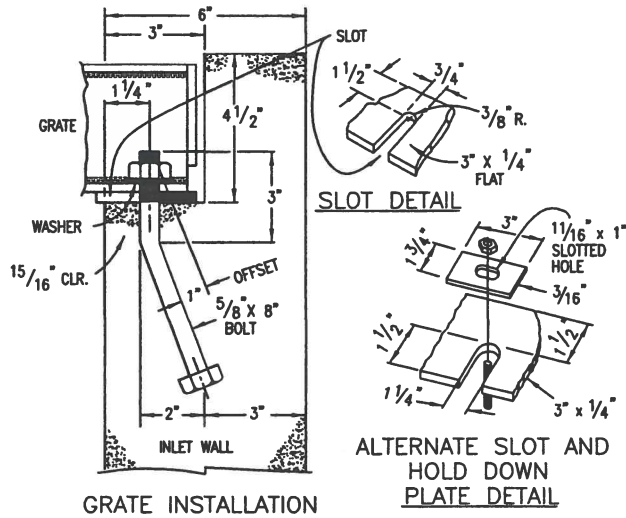
Approved By: *[Signature]*

INLET
TYPE C

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 14a

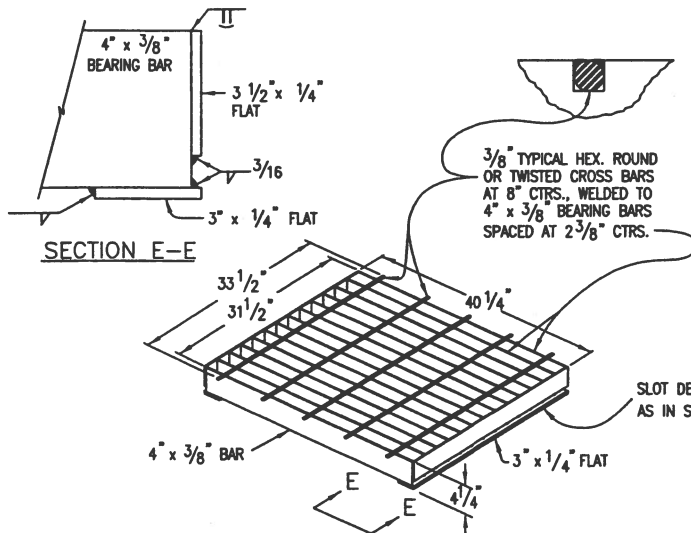


GRATE INSTALLATION
DETAIL

GENERAL NOTES

1. CONCRETE SHALL BE CLASS B. INLET MAY BE CAST-IN-PLACE OR PRECAST.
2. REINFORCING BARS SHALL BE EPOXY COATED AND DEFORMED, AND SHALL HAVE A MINIMUM 2 IN. CLEARANCE.
3. CONCRETE SLOPE AND DITCH PAVING SHALL CONFORM TO SECTION 507. REINFORCEMENT FOR CONCRETE SLOPE PAVING SHALL BE 6 X 6 - W1.4 OR 6 X 6 - W2.1 X W2.1.
4. STRUCTURAL STEEL FOR GRATES AND GRATE INSTALLATION HARDWARE SHALL BE GALVANIZED AND SHALL BE IN ACCORDANCE WITH 712.06.
5. THE STANDARD INLET GRATES SHALL BE USED ON ALL TYPE C INLETS UNLESS CLOSE MESH GRATES ARE SPECIFIED ON THE PLANS.
6. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" EXCEEDS 3 FT.-6 IN. AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.
7. SEE SHEET M-604-11, INLET, TYPE D, FOR REINFORCEMENT AROUND THE PIPE OPENING.

▼ - CONCRETE SLOPE AND DITCH PAVING WILL BE REQUIRED WHEN SHOWN ON PLANS.



CLOSE MESH GRATE

HYDRAULICALLY INEFFICIENT, POOR TOLERANCE FOR DEBRIS AND ICE. USE FOR PEDESTRIAN AND BICYCLE AREAS.

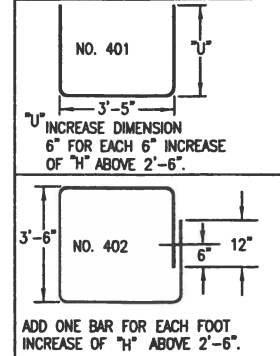
QUANTITIES
FOR ONE INLET

H	CONCRETE * (cu. YDS.)	REINF. STEEL (LBS.)	NO. STEPS REQ'D.
2'-6"	0.9	75	0
3'-0"	1.0	80	0
3'-6"	1.2	96	0
4'-0"	1.3	101	1
4'-6"	1.4	116	2
5'-0"	1.5	122	2
5'-6"	1.7	137	2
6'-0"	1.8	142	3
6'-6"	1.9	158	3
7'-0"	2.0	163	3
7'-6"	2.2	179	4
8'-0"	2.3	184	4
8'-6"	2.4	199	4
9'-0"	2.5	205	5
9'-6"	2.7	220	5
10'-0"	3.0	235	6
11'-6"	3.4	251	6

* INCLUDES VOLUME OCCUPIED BY PIPES.

BAR LIST FOR H=2'-6"
AND BENDING DIAGRAM

MARK	NO. REQ'D.	HGT.	LENGTH
401	2	2'-3"	7'-11"
401	6	2'-7" 5/8"	8'-7"
402	3		15'-0"



ALL BARS TO BE 1/2" DIA. CUT OR BEND AROUND PIPES AS REQUIRED. 402 BARS WILL BE EQUALLY SPACED FROM EACH OTHER.

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

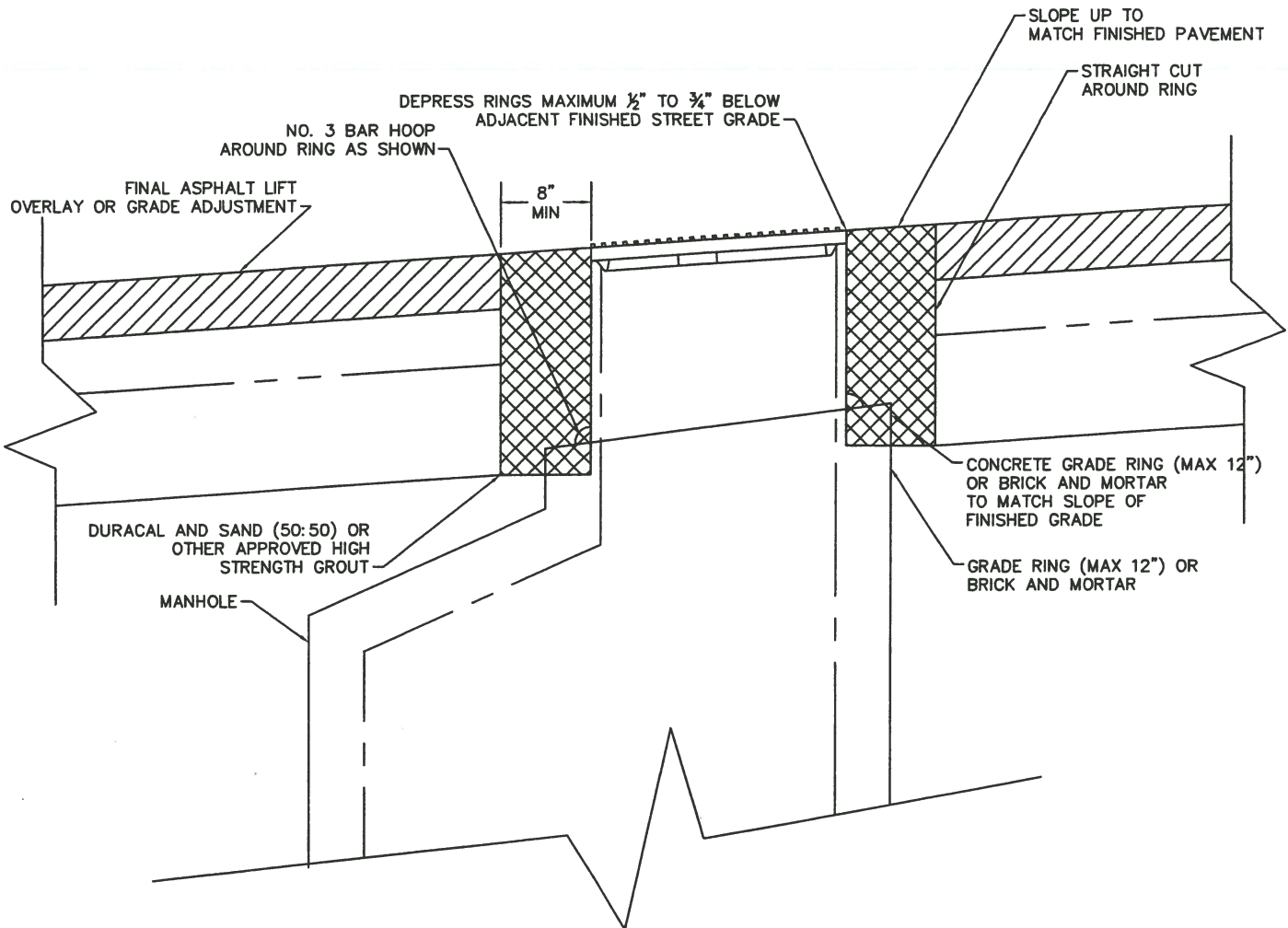
Approved By: *[Signature]*

INLET
TYPE C

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 14b



NOTES:

1. ADEQUATE BARRICADES SHALL BE PLACED AND MAINTAINED UNTIL THE COLLAR ATTAINS A COMPRESSIVE STRENGTH OF 3000 PSI OR GREATER.
2. DURACAL GROUT SHALL BE A MIXTURE OF 100 LBS DURACAL, 26 LBS WATER (3.12 GALLONS) AND 100 LBS OF SAND CONFORMING TO ASTM C-35.

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

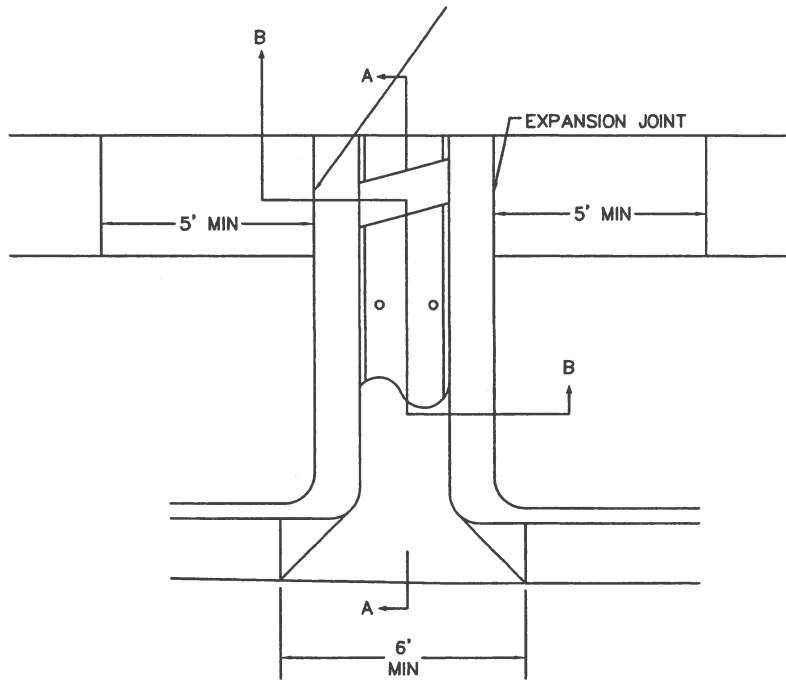
Approved By: *[Signature]*

MANHOLE RING AND COVER
ADJUSTMENT

Issued: 5/10/05

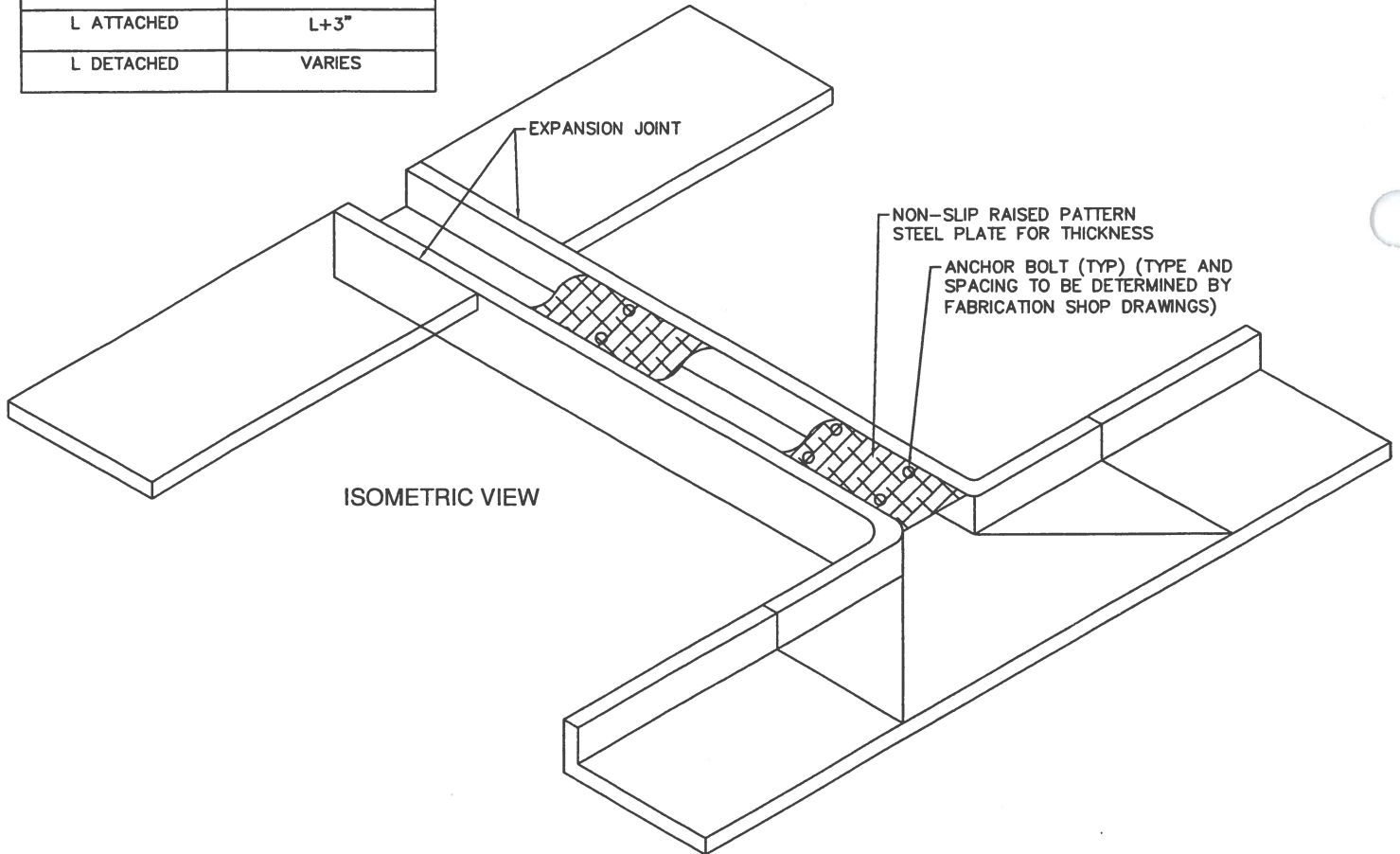
Revised: 8/31/06

Drawing Number:
SP. 15



PLAN VIEW

TYPE OF WALK	LENGTH OF PLATE
L ATTACHED	L+3"
L DETACHED	VARIES



ISOMETRIC VIEW

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

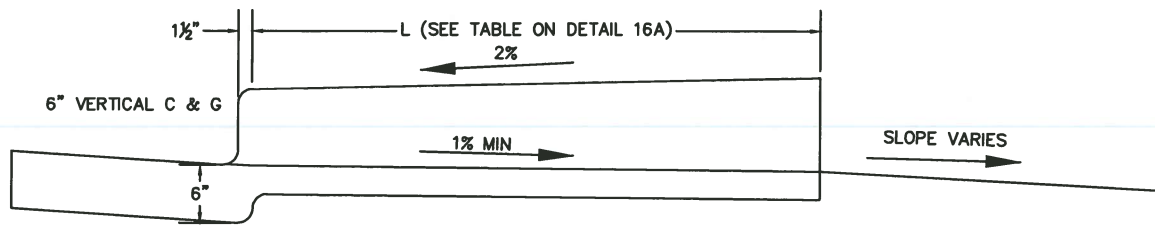
Approved By: *[Signature]*

SIDEWALK CHASE
IF PERMITTED BY VARIANCE

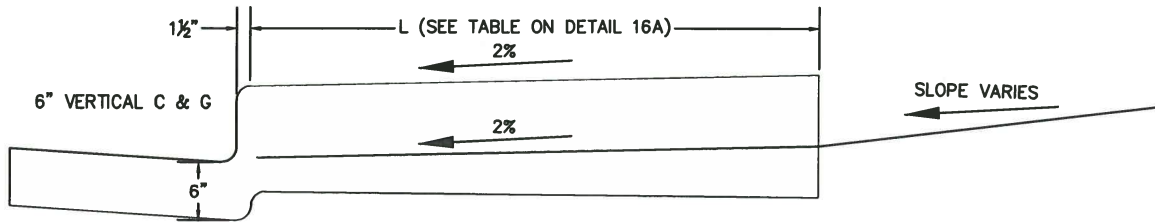
Issued: 5/10/05

Revised: 8/31/06

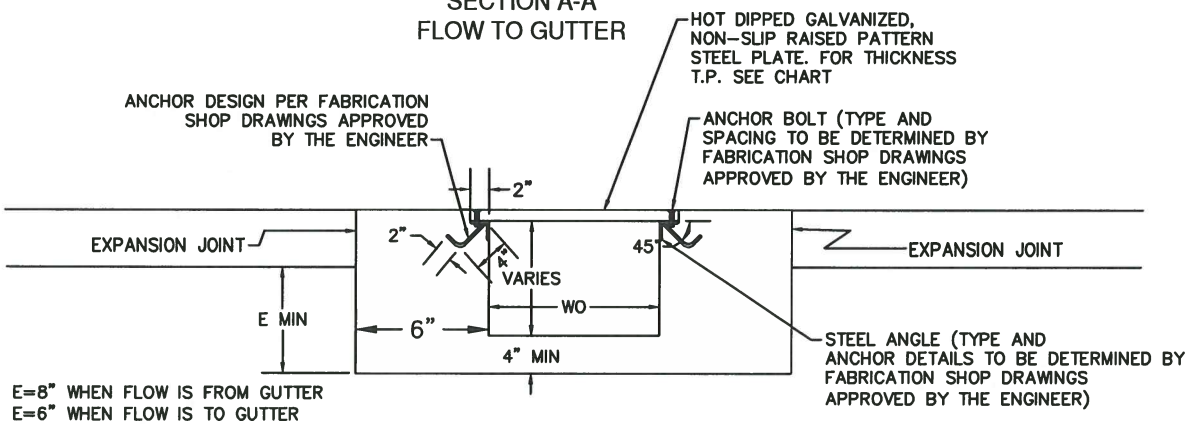
Drawing Number:
SP. 16a



SECTION A-A
FLOW FROM GUTTER

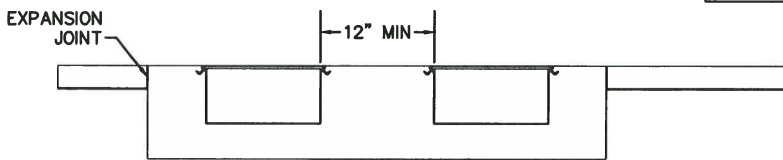


SECTION A-A
FLOW TO GUTTER



SECTION B-B
SINGLE CHASE

W.O. WIDTH OF OPENING	TP THICKNESS OF PLATE
12"	1/2"
12"-18"	5/8"



SECTION B-B
MULTIPLE CHASE
WHEN OPENINGS ARE LARGER THAN 18"

Drawn By: SBW/VT

Checked By:

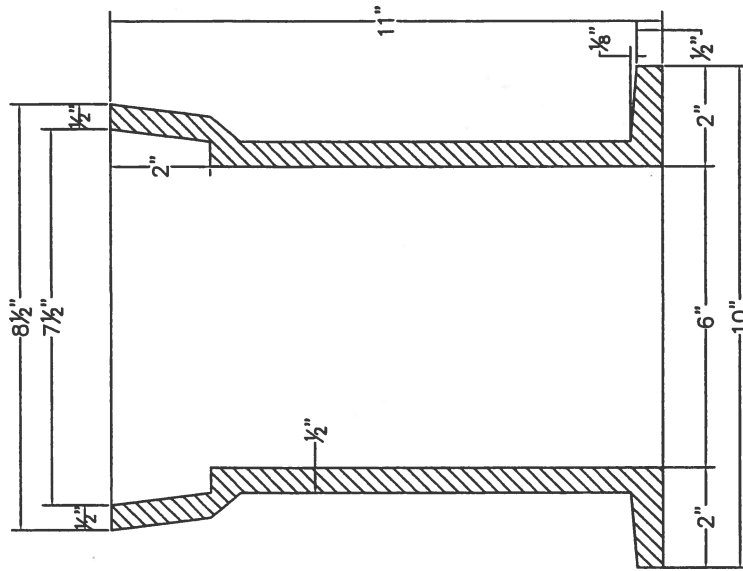
Approved By:

SIDEWALK CHASE
IF PERMITTED BY VARIANCE

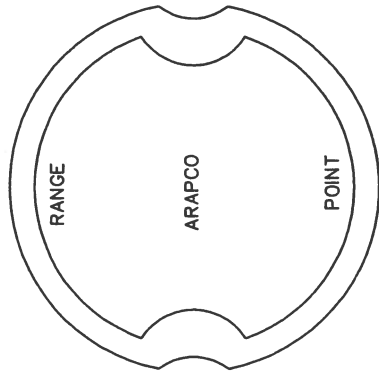
Issued: 5/10/05

Revised: 9/10/13

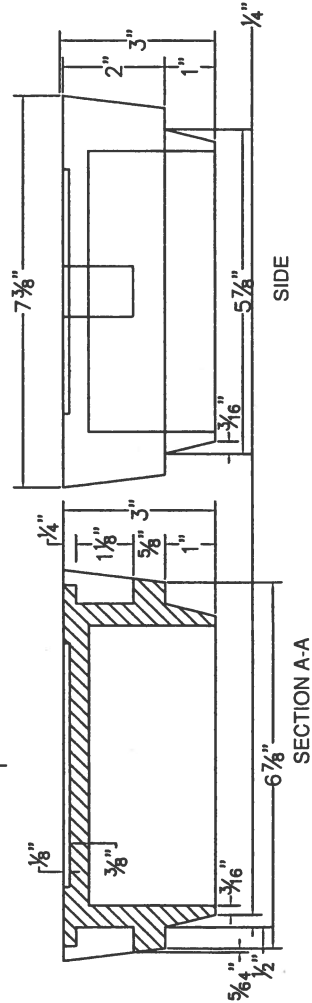
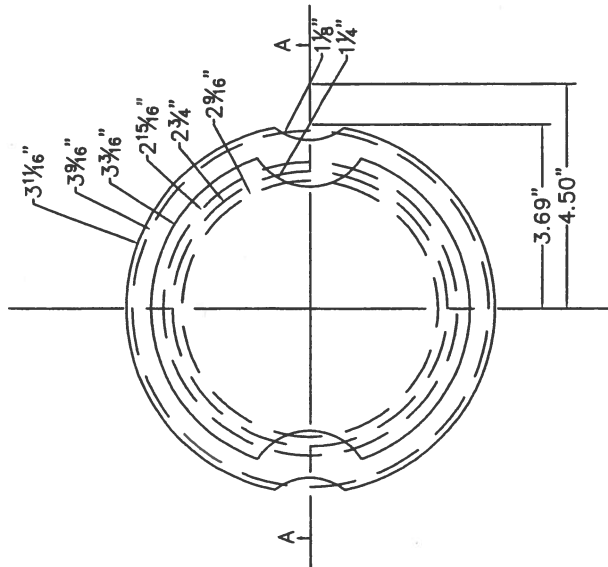
Drawing Number:
SP. 16b



NOTES:
 LETTERS SHALL BE NOT LESS THAN 5/8" HIGH &
 RAISED 1/8" ABOVE SURFACE
 ALL FILLETS & ROUNDS RADI=1/8"



REQUIRED LETTERING FOR
 BOX COVER



Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

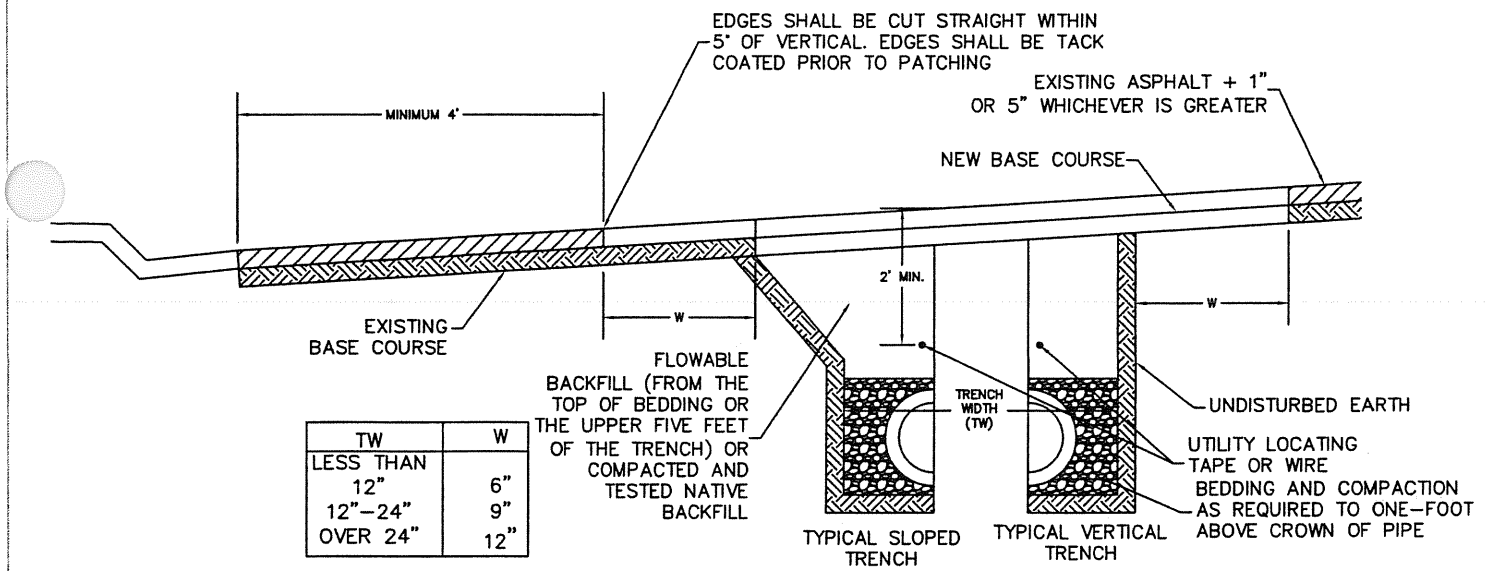
Approved By: *[Signature]*

RANGE BOX

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
 SP. 17



NOTES:

1. THIS TRENCH PATCHING DETAIL SPECIFIES REQUIREMENTS IN ADDITION TO THOSE SPECIFIED IN THE MGPEC STANDARDS AS ADOPTED.
2. ANY UTILITY INSTALLED WITHIN THE RIGHT-OF-WAY (ROW) OR EASEMENTS SHALL HAVE UTILITY LOCATING TAPE OR WIRE OVER THE TOP OF THE UTILITY LOCATED A MINIMUM OF 2'-0" BELOW FINAL GRADE OR LOCATED ON UTILITY IF MINIMUM DEPTH CANNOT BE ACHIEVED
3. A CONSTRUCTION TRAFFIC CONTROL PLAN SHALL BE SUBMITTED TO AND APPROVED BY ARAPAHOE COUNTY PRIOR TO ISSUANCE OF CONSTRUCTION PERMITS IN THE RIGHT-OF-WAY.
4. TRENCH SHALL BE BRACED OR SHEETED AS NECESSARY FOR THE SAFETY OF THE WORKMEN AND PROTECTION OF OTHER UTILITIES OR STRUCTURES IN ACCORDANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL SAFETY REGULATIONS.
5. THE TRENCH WIDTH SHALL BE CONFINED TO THOSE MINIMUM DIMENSIONS, WHICH WILL PERMIT PROPER INSTALLATION AND ACCEPTABLE PIPE LOADING, AS ESTABLISHED BY CURRENT ACCEPTABLE ENGINEERING PRACTICES.
6. EXISTING ASPHALT OR PAVEMENT SHALL BE CUT BACK A MINIMUM OF W (SEE ABOVE) BEYOND THE TRENCH LIMITS OR TO SOUND PAVEMENT WHICHEVER IS GREATER. IF ENCROACHMENT INTO THE OUTSIDE 4-FOOT ZONE OR IF AN ISLAND IS LOCATED INSIDE THE 4-FOOT ZONE, THE 4-FOOT ZONE SHALL BE INCLUDED IN THE REQUIRED PATCH.
7. BACKFILL SHALL MEET MGPEC STANDARDS, ITEM 18, SECTIONS 19.1, 19.2, 19.3, 19.4, 19.5, 19.6 AND 19.7.4 EXCEPT WHERE THESE STANDARDS DICTATE OTHERWISE.
8. FULL DEPTH ASPHALT CAN BE USED AS AN ALTERNATIVE TO BASE COURSE. A RATION OF 3 INCHES OF BASE COURSE TO 1 INCH OF ASPHALT SHALL BE USED IN THE SUBSTITUTION.
9. A TEMPORARY COLD-MIX PATCH, 4-INCHES IN DEPTH, WILL BE REQUIRED FOR ALL STREET CUTS IF A PERMANENT HOT-MIX ASPHALT PATCH CANNOT BE APPLIED FOR ANY REASON IMMEDIATELY FOLLOWING CONSTRUCTION.
10. THE TEMPORARY PATCH SHALL BE MAINTAINED UNTIL THE PERMANENT HOT-MIX ASPHALT PATCH IS APPLIED WITHIN A MAXIMUM OF 7 CALENDAR DAYS.
11. COMPACTION TESTING RESULTS SHALL BE A MINIMUM OF 95% COMPACTION WITHIN THE LIMITS OF THE ROADWAY AND 90% WHEN OUTSIDE THE LIMITS OF THE ROADWAY.

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

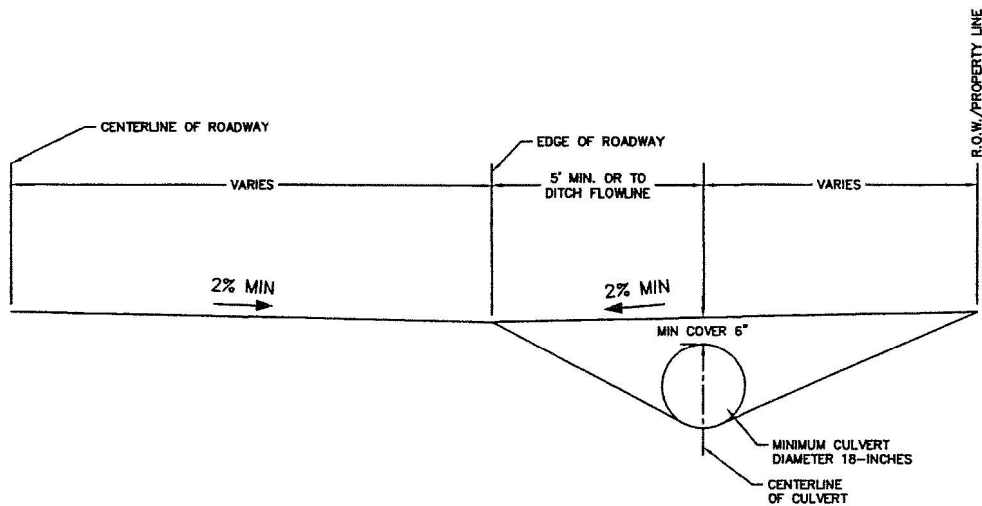
Approved By: *[Signature]*

TRENCH PATCHING
DETAIL

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 18



NOTES:

1. A CONSTRUCTION PERMIT IS REQUIRED FROM THE DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT THE RURAL DRIVEWAY CULVERT SHALL BE INSTALLED IN ACCORDANCE WITH THE PROVISIONS OF THE LATEST EDITION OF THE "INFRASTRUCTURE DESIGN AND CONSTRUCTION STANDARDS".
2. UNLESS OTHERWISE NOTED, COVER SHALL BE A MINIMUM OF 6-INCHES OF ROAD BASE.
3. THE DRIVEWAY SLOPE SHALL BE EITHER +2% OR -2% FOR A MINIMUM OF 5-FEET FROM THE EXISTING EDGE OF ROADWAY.
4. CULVERT SHALL BE A MINIMUM OF 18-INCHES DIAMETER CORROGATED METAL PIPE (CMP) 16-GUAGE, WITH FLARED END SECTIONS ON EACH END.
5. CULVERT SHALL HAVE A MINIMUM 2% LONGITUDINAL GRADE TO CONVEY THE DITCH FLOWS.
6. THE MINIMUM LENGTH OF THE CULVERT SHALL BE 24-FEET.
7. DRIVEWAY SHALL BE CROWNED IN THE CENTER WITH A MINIMUM CROSS SLOPE OF 2% TO EACH EDGE.

Drawn By: SBW *SBW*

Checked By: *Ch*

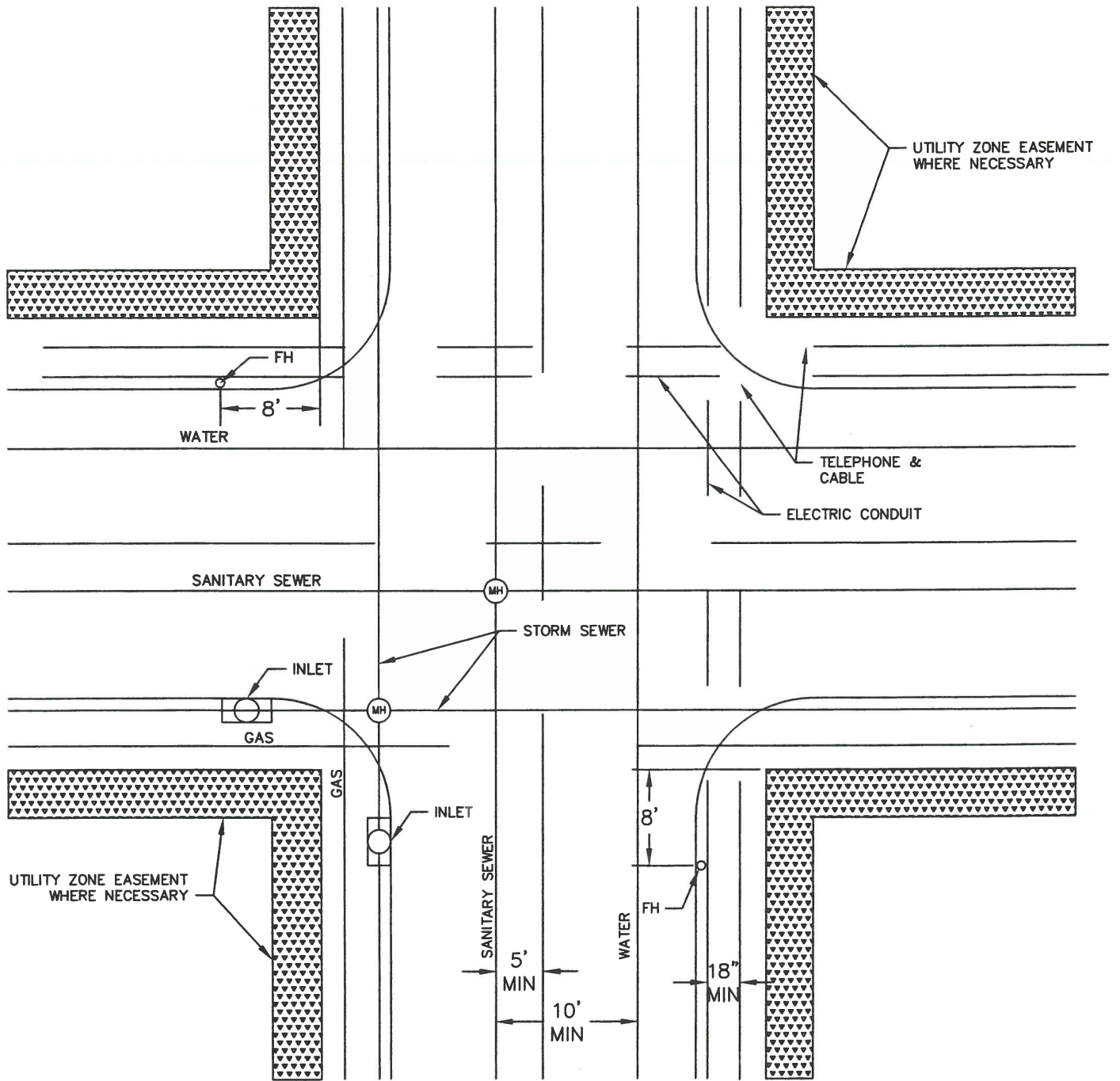
Approved By: *JSP*

DRIVEWAY CULVERT DETAIL FOR
NON-CURBED RURAL AREAS

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 19

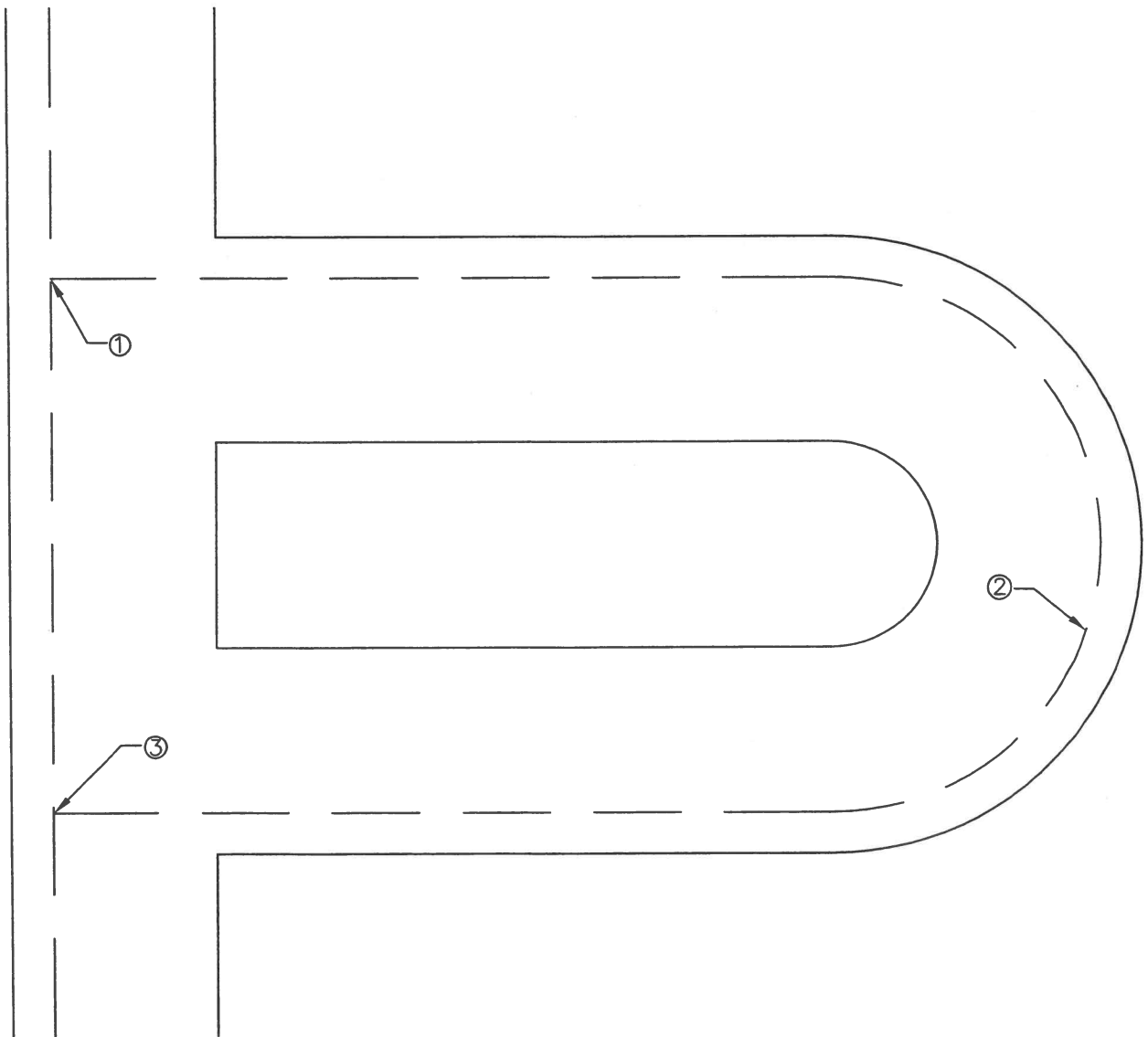


NOTE:
 THIS STANDARD IS A GUIDE ONLY AND DEVIATIONS WILL BE ACCEPTABLE
 WHERE CONDITIONS DICTATE. DIMENSIONS SHOWN ARE DESIRABLE BUT DO
 NOT GOVERN. THE INTENTION IS TO SHOW THE RELATIVE POSITION OF ALL
 UTILITIES.

Drawn By: SBW
 Checked By: _____
 Approved By: _____

UTILITY LINE LOCATION
 GENERAL

Issued: 5/10/05
 Revised: 8/31/06
 Drawing Number:
 SP. 20



EXAMPLE OF A UTILITY RELOCATION
TO A NORMAL POSITION AT AN INTERSECTION

1. CARRY A UTILITY AROUND CORNER.
2. STAY ON SAME SIDE OF STREET.
3. RETURN UTILITY TO NORMAL SIDE OF STREET AT INTERSECTION.

Drawn By: SBW *[Signature]*

Checked By: *[Signature]*

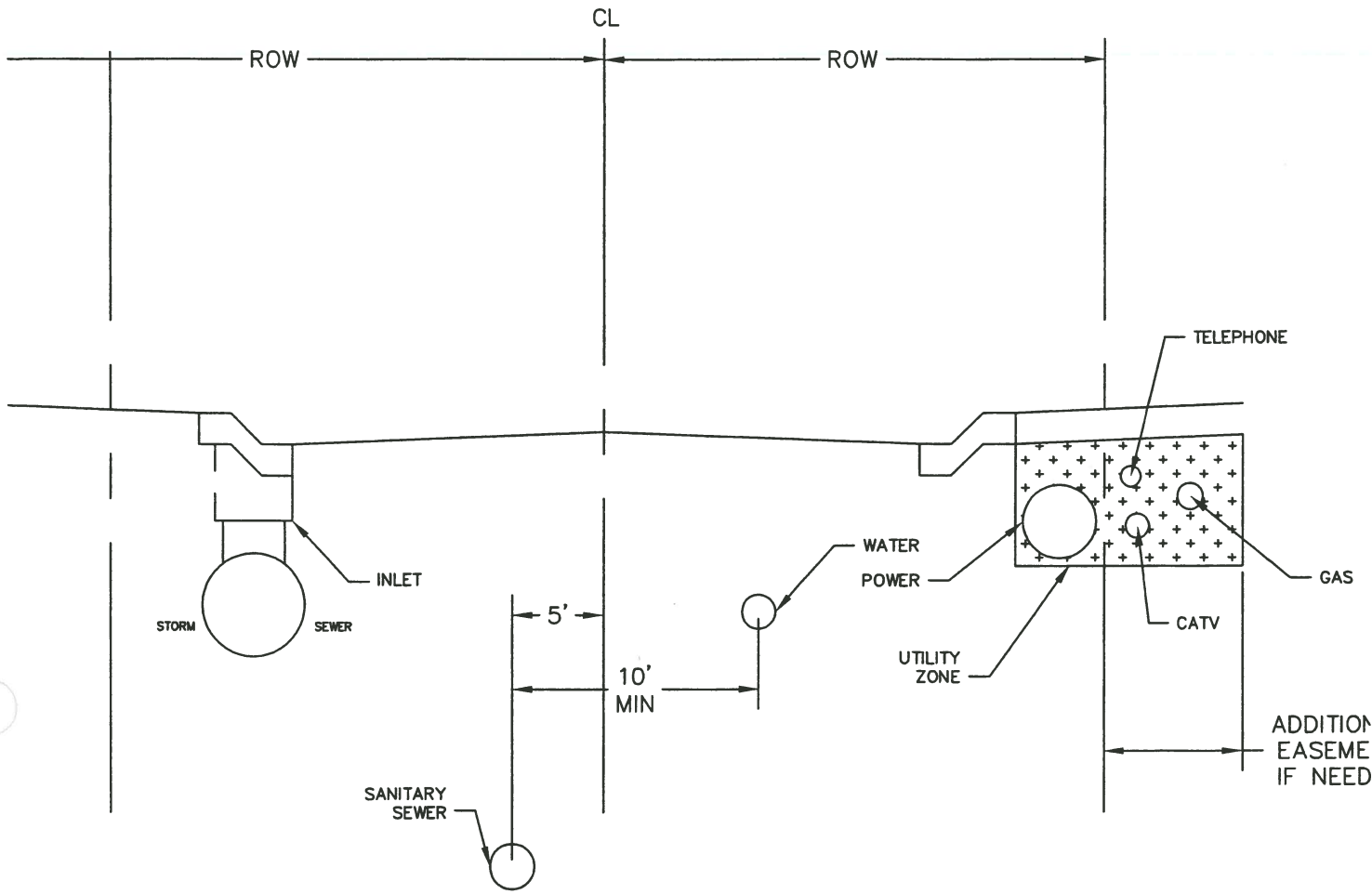
Approved By: *[Signature]*

UTILITY LINE LOCATION
GENERAL

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 21



MINIMUM ALLOWABLE DEPTHS

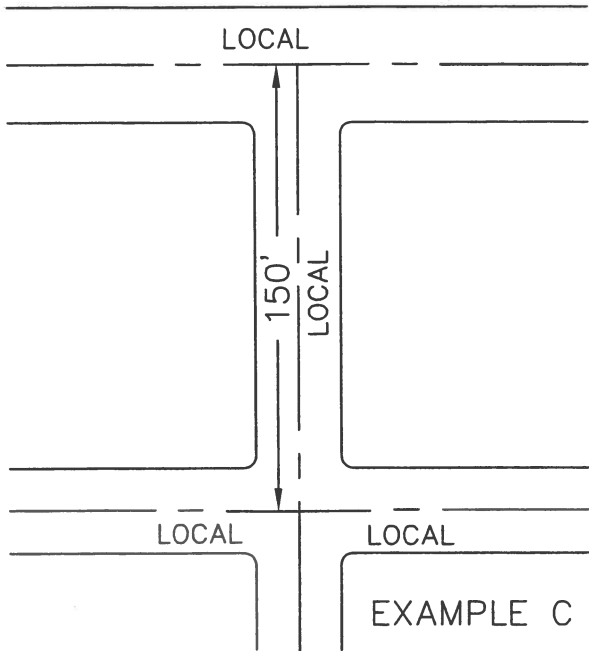
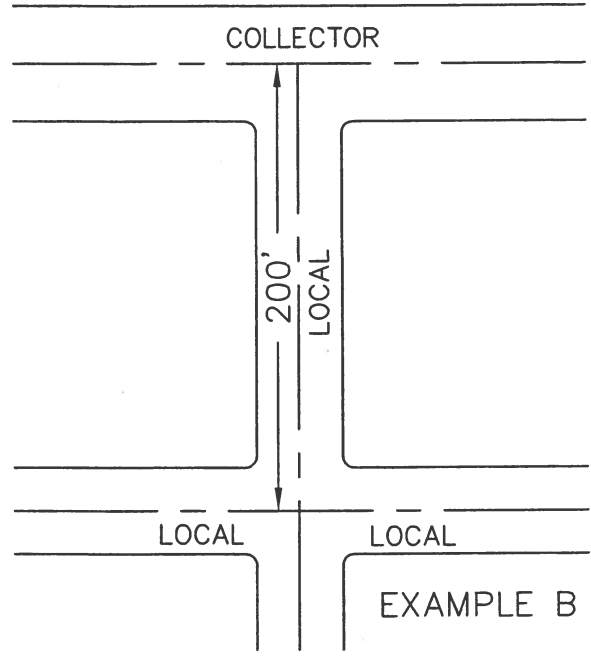
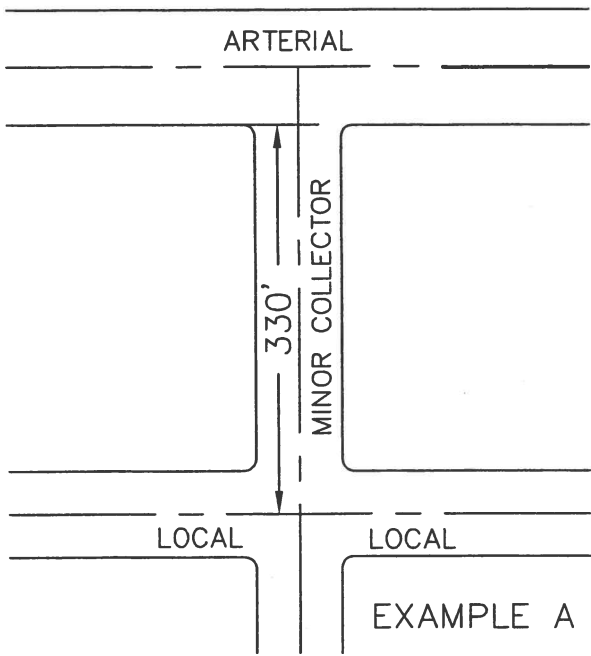
STREET LIGHTS	30" MIN
GAS	30" MIN
TELEPHONE	30-36" MIN
ELECTRIC POWER	42" MIN
STORM SEWER	40" MIN
SANITARY SEWER	60" MIN
CATV	24" MIN
WATER	54" MIN
FIBEROPTIC	36" MIN

NOTE: THE COUNTY WILL EVALUATE DRY UTILITY DEPTHS THAT ARE OUTSIDE THE TRAVELED ROADWAY ON A CASE BY CASE BASIS

Drawn By: SBW *[Signature]*
 Checked By: *[Signature]*
 Approved By: *[Signature]*

UTILITY LINE LOCATION
GENERAL

Issued: 5/10/05
 Revised: 8/31/06
 Drawing Number:
 SP. 22



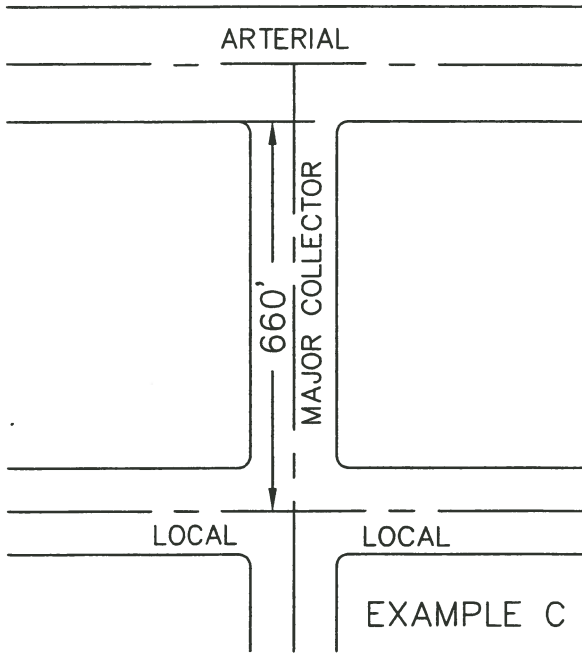
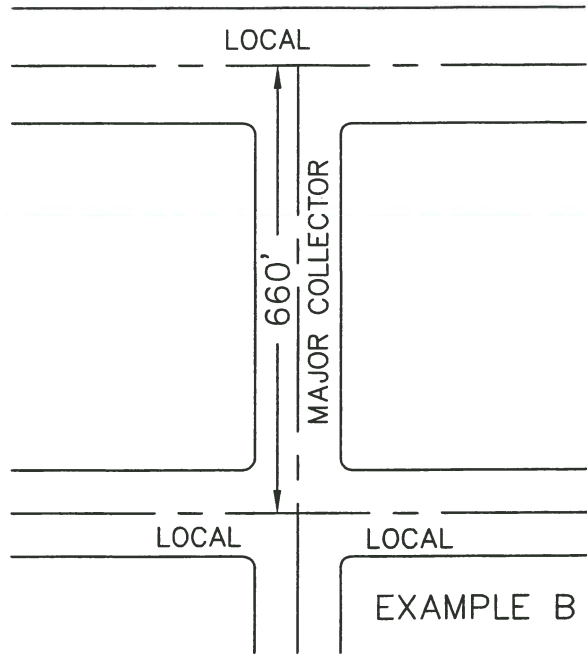
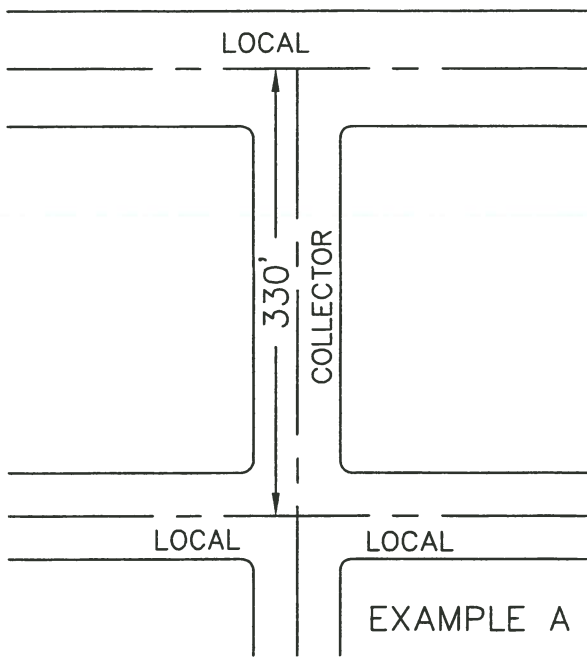
Drawn By: SBW *[Signature]*
 Checked By: *[Signature]*
 Approved By: *[Signature]*

INTERSECTION SEPARATION

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
 SP. 23A



Drawn By: SBW *SBW*

Checked By: *Ch*

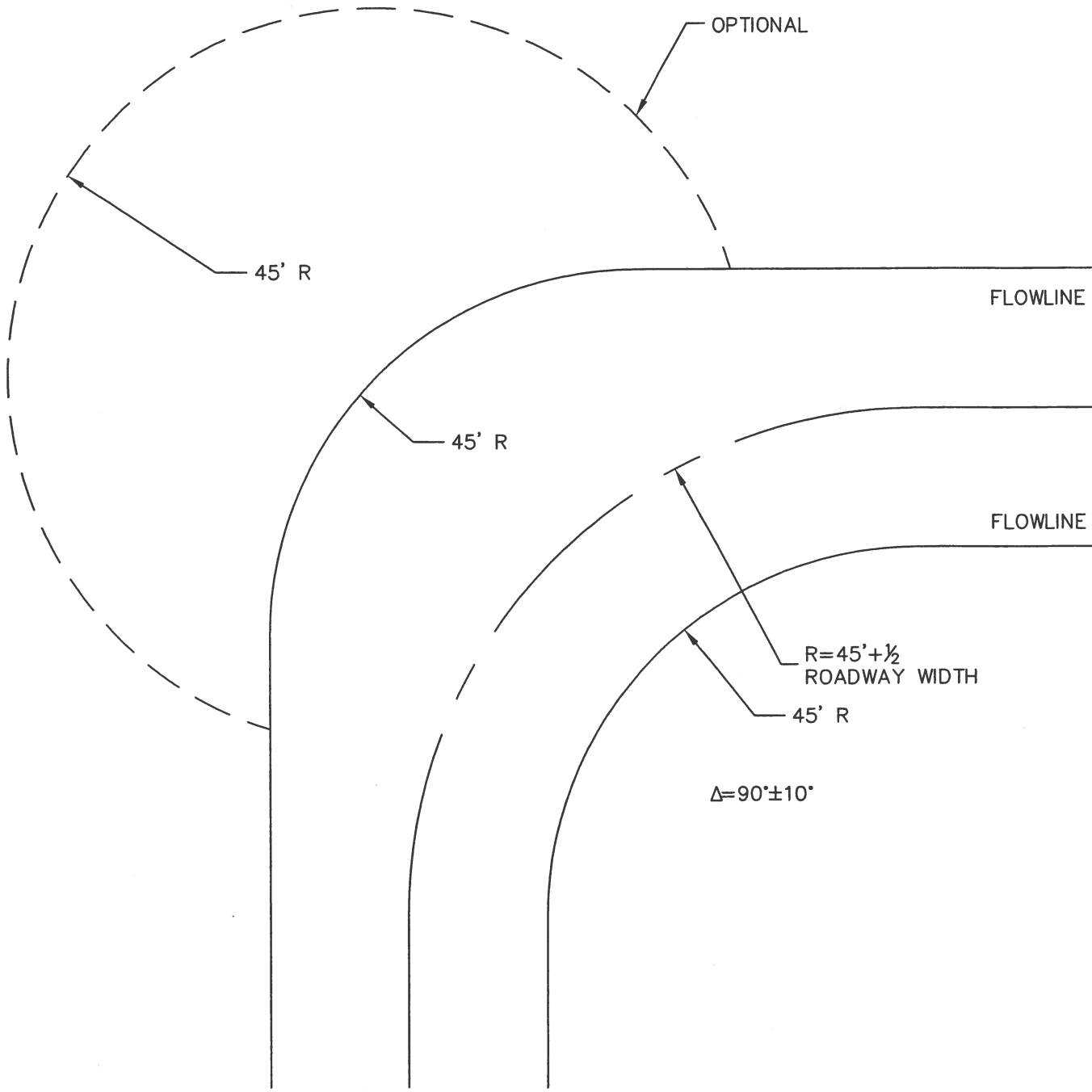
Approved By: *JSP*

INTERSECTION SEPARATION

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 23B



Drawn By: SBW *SBW*

Checked By: *[Signature]*

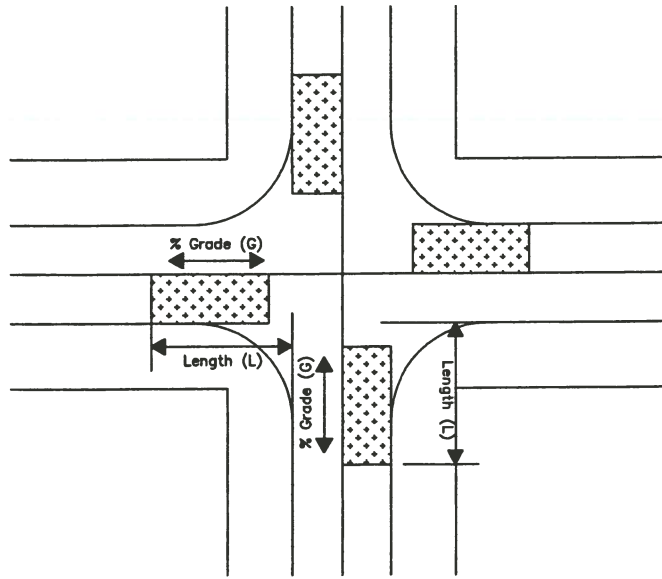
Approved By: *[Signature]*

KNUCKLES

Issued: 5/10/05

Revised: 8/31/06

Drawing Number:
SP. 24

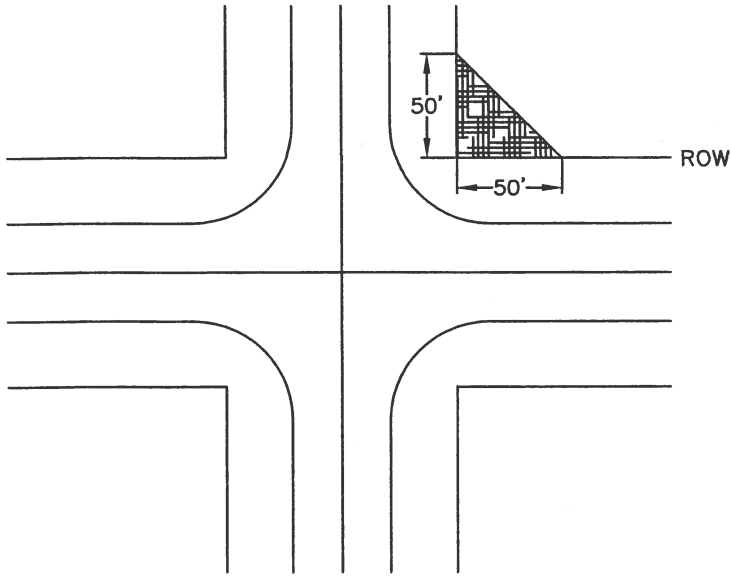


MINOR STREET \ MAJOR STREET	LOCAL	MINOR COLLECTOR	MAJOR COLLECTOR	MINOR ARTERIAL	MAJOR ARTERIAL
LOCAL	L=95' G=4%	L=100' G=4%	L=100' G=4%	L=- G=-	L=- G=-
MINOR COLLECTOR	L=- G=-	L=100' G=3%	L=120' G=3%	L=150' G=3%	L=150' G=3%
MAJOR COLLECTOR	L=- G=-	L=- G=-	L=120' G=3%	L=150' G=3%	L=200' G=3%
MINOR ARTERIAL	L=- G=-	L=- G=-	L=- G=-	L=200' G=2%	L=200' G=2%
MAJOR ARTERIAL	L=- G=-	L=- G=-	L=- G=-	L=- G=-	L=200' G=2%

Drawn By: SBW *SBW*
 Checked By: *MP*
 Approved By: *JEL*

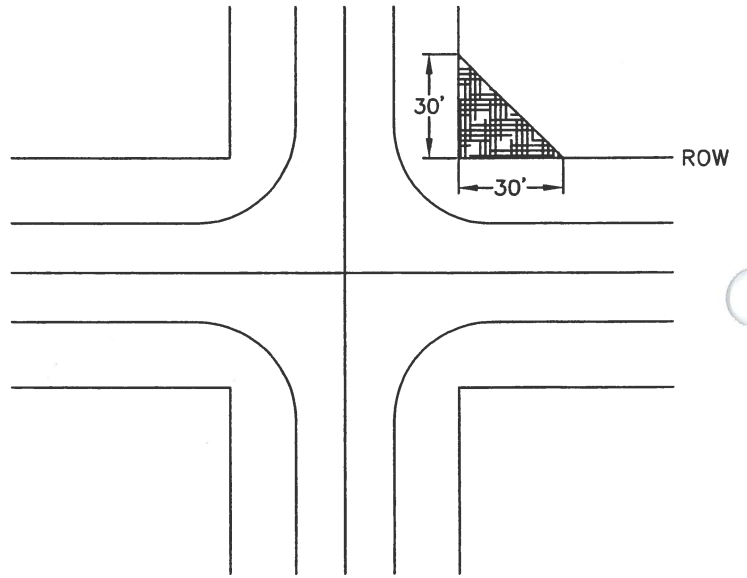
MAXIMUM PERMISSIBLE
 INTERSECTION GRADES

Issued: 5/10/05
 Revised: 8/31/06
 Drawing Number:
 SP-25



CASE 1 – INTERSECTIONS WITH NO TRAFFIC CONTROL

CASE 2 – INTERSECTIONS WITH TRAFFIC CONTROL ON MINOR STREET APPROACH, MAJOR STREET APPROACH HAS RIGHT-OF-WAY



Drawn By: SBW *SBW*
 Checked By: *MA*
 Approved By: *JSP*

SIGHT TRIANGLES

Issued: 5/10/05
 Revised: 8/31/06
 Drawing Number:
 SP-26

ARAPAHOE COUNTY TYPICAL PUBLIC AND PRIVATE ROADWAY CROSS SECTIONS

<i>SEA</i>	3/17/09
DRAWN BY	DATE
<i>PK</i>	3/19/09
CHECKED BY	DATE
<i>Luh</i>	3/19/09
APPROVED BY	DATE

REVISIONS			
NO	DATE	DESCRIPTION	BY

ARAPAHOE COUNTY, COLORADO
DEPARTMENT OF
PUBLIC WORKS AND
DEVELOPMENT

PREPARED BY THE ARAPAHOE COUNTY ENGINEERING DIVISION
10130 E. BIRCHWOOD AVE. - CENTENNIAL, CO 80112 - PH: 303-674-4500 - FAX: 303-794-2201

TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.	
1 OF 18	
ISSUED: 5-10-08	REVISION: 8-31-08

ROADWAY INDEX

TWO-LANE COLLECTOR _____	SHEET 3
FOUR-LANE COLLECTOR _____	SHEET 4
FOUR-LANE COLLECTOR AT INTERSECTIONS _____	SHEET 5
FOUR-LANE ARTERIAL - PAINTED MEDIAN _____	SHEET 6
FOUR-LANE ARTERIAL - RAISED MEDIAN _____	SHEET 7
SIX-LANE PRINCIPAL ARTERIAL _____	SHEET 8
EIGHT-LANE EXPRESSWAY _____	SHEET 9
PUBLIC URBAN LOCAL - ATTACHED WALK _____	SHEET 10
PUBLIC URBAN LOCAL - DETACHED WALK _____	SHEET 11
PRIVATE ALLEY _____	SHEET 12
PRIVATE PARKING BOTH SIDES _____	SHEET 13
PRIVATE PARKING ONE SIDE - DETACHED WALK _____	SHEET 14
PRIVATE PARKING ONE SIDE - ATTACHED WALK _____	SHEET 15
PRIVATE RURAL _____	SHEET 16
PUBLIC RURAL WITHOUT BIKE ACCOMMODATIONS _____	SHEET 17
PUBLIC RURAL WITH BIKE ACCOMMODATIONS _____	SHEET 18

<u>SPB</u> DRAWN BY	3/17/09 DATE
<u>Mh</u> CHECKED BY	3/19/09 DATE
<u>Mh</u> APPROVED BY	3/19/09 DATE

REVISIONS			
NO.	DATE	DESCRIPTION	BY

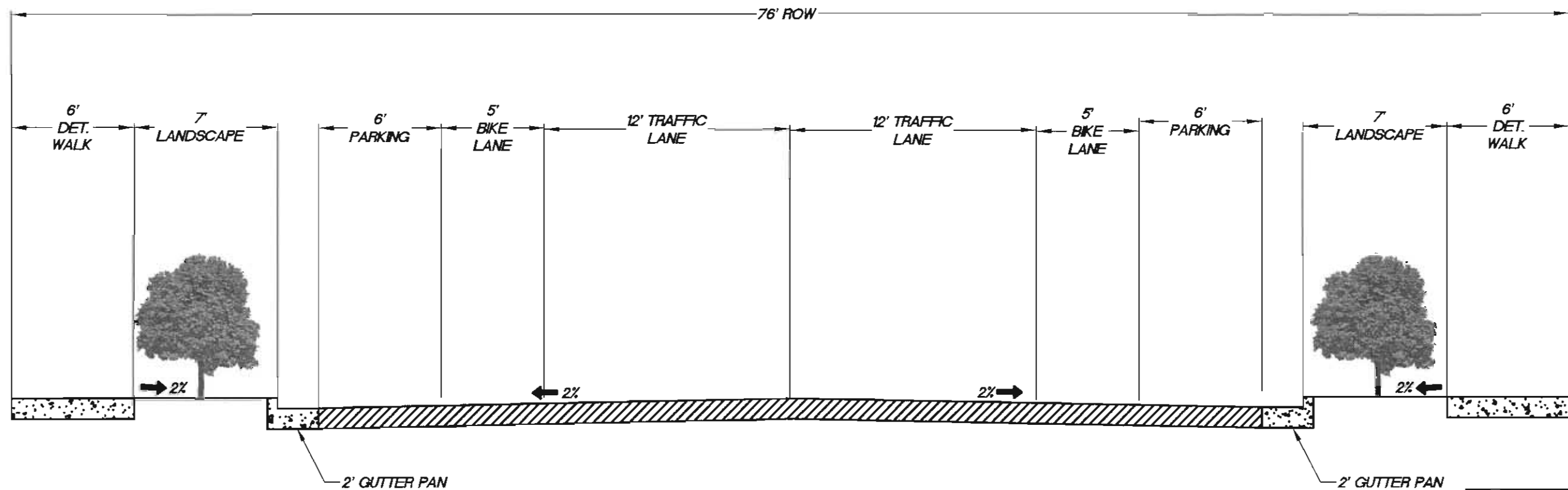
Arapahoe County ARAPAHOE COUNTY, COLORADO
 DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT
 Colorado's First
PREPARED BY THE ARAPAHOE COUNTY ENGINEERING DIVISION
 4700 E. WYANWOOD AVE. - CENTER FOR BUSINESS - DENVER, CO 80212 - TEL: 303-754-6600 - FAX: 303-754-0224

TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO. 2 OF 18
 ISSUED 5-10-08
 REVISED 8-31-08

TWO-LANE COLLECTOR



NOTE: AT INTERSECTIONS REMOVE ON-STREET PARKING AND UTILIZE THE CENTER 12-FOOT FOR DEDICATED LEFT TURN LANES

NOTE: DIRECT BACKING ACCESS (DRIVEWAYS) SHALL BE PROHIBITED ON COLLECTOR ROADWAYS.

NOTE: ON STREETS WHERE BIKE LANE MARKING/DESIGNATION HAS BEEN APPROVED, BIKE LANES AT INTERSECTIONS WHERE AUXILLIARY LANES ARE REQUIRED BIKE LANES SHALL CONTINUE THROUGH AND THE AUXILLIARY LANE VEHICLES SHALL YIELD TO BIKE TRAFFIC. REFER TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES WHERE APPLICABLE.

NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

<i>Stew</i>	3/17/09
DRAWN BY	DATE
<i>Ch</i>	3/19/09
CHECKED BY	DATE
<i>Ch</i>	3/19/09
APPROVED BY	DATE

NO.	DATE	DESCRIPTION	BY

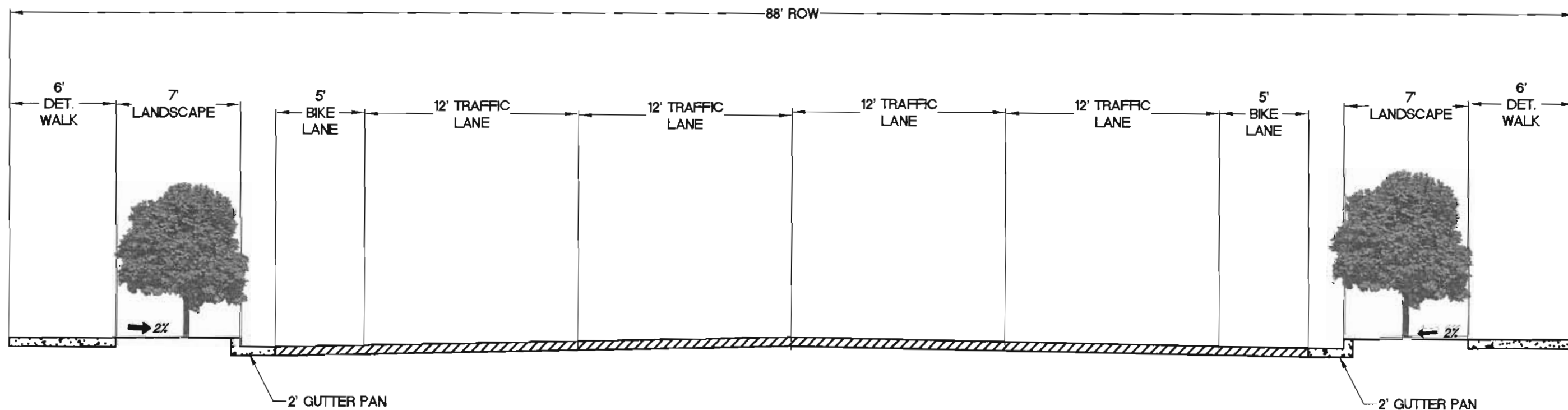
Arapahoe County ARAPAHOE COUNTY, COLORADO
 DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT
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 10134 E. BIRCHWOOD AVE. • GENTLEMAN, CO 80112 • PH. 720.474.4800 • FAX. 720.794.2214

TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.
3 OF 18

FOUR-LANE COLLECTOR



NOTE: DIRECT BACKING ACCESS (DRIVEWAYS) SHALL BE PROHIBITED ON COLLECTOR ROADWAYS.

NOTE: ON STREETS WHERE BIKE LANE MARKING/DESIGNATION HAS BEEN APPROVED, BIKE LANES AT INTERSECTIONS WHERE AUXILLIARY LANES ARE REQUIRED BIKE LANES SHALL CONTINUE THROUGH AND THE AUXILLIARY LANE VEHICLES SHALL YIELD TO BIKE TRAFFIC. REFER TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES WHERE APPLICABLE.

NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

<i>Spaw</i>	3/17/09
DRAWN BY	DATE
<i>Ah</i>	3/19/09
CHECKED BY	DATE
<i>Ah</i>	3/19/09
APPROVED BY	DATE

REVISIONS			
NO.	DATE	DESCRIPTION	BY

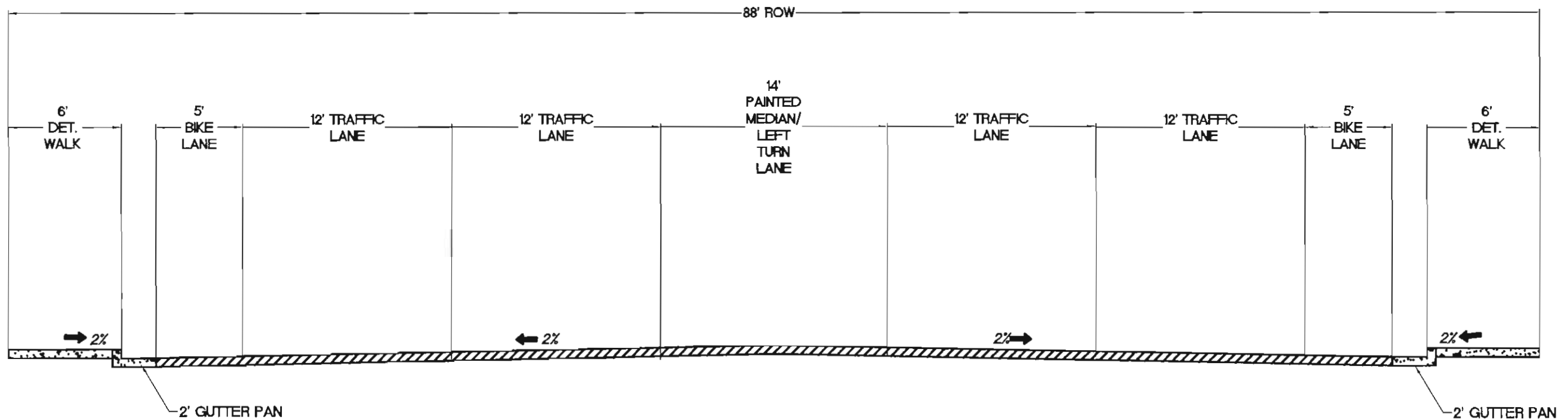
Arapahoe County ARAPAHOE COUNTY, COLORADO
 DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT
Colorado's first
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TYPICAL STREET CROSS-SECTION

NOTES:

FOUR-LANE COLLECTOR

AT INTERSECTIONS



NOTE: DIRECT BACKING ACCESS (DRIVEWAYS) SHALL BE PROHIBITED ON COLLECTOR ROADWAYS.

NOTE: ON STREETS WHERE BIKE LANE MARKING/DESIGNATION HAS BEEN APPROVED, BIKE LANES AT INTERSECTIONS WHERE AUXILLIARY LANES ARE REQUIRED BIKE LANES SHALL CONTINUE THROUGH AND THE AUXILLIARY LANE VEHICLES SHALL YIELD TO BIKE TRAFFIC. REFER TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES WHERE APPLICABLE.

NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

<i>[Signature]</i>	3/12/09
DRAWN BY	DATE
<i>[Signature]</i>	3/19/09
CHECKED BY	DATE
<i>[Signature]</i>	3/19/09
APPROVED BY	DATE

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TYPICAL STREET CROSS-SECTION

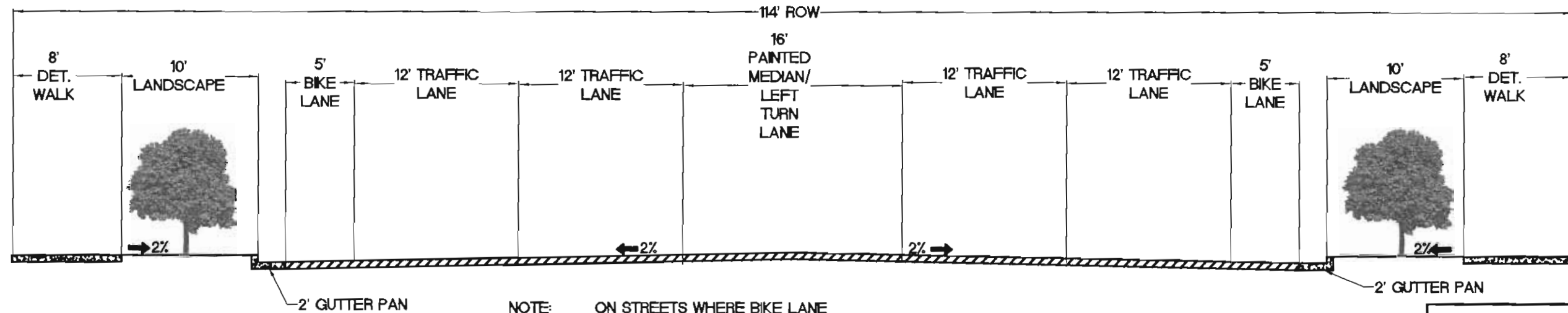
NOTES

SHEET NO.	5 OF 18
ISSUED	3-10-08
REVISED	8-21-08

FOUR-LANE ARTERIAL

WITH PAINTED MEDIAN

- NOTES:
1. FOR DESIGN SPEED OF 45 MPH OR ABOVE SUPERELEVATION IS REQUIRED.
 2. FOR DESIGN SPEED OF 45 MPH OR ABOVE MOUNTABLE CURB IS REQUIRED.
 3. MEANDERING SIDEWALK IS PERMISSIBLE PROVIDED IT REMAINS WITHIN RIGHT-OF-WAY OR ADEQUATE PUBLIC USE EASEMENTS ARE DEDICATED. SIDEWALKS OUTSIDE OF RIGHT-OF-WAY SHALL NOT BE MAINTAINED BY ARAPAHOE COUNTY



NOTE: ON STREETS WHERE BIKE LANE MARKING/DESIGNATION HAS BEEN APPROVED, BIKE LANES AT INTERSECTIONS WHERE AUXILLIARY LANES ARE REQUIRED BIKE LANES SHALL CONTINUE THROUGH AND THE AUXILLIARY LANE VEHICLES SHALL YIELD TO BIKE TRAFFIC. REFER TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES WHERE APPLICABLE.

NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

<i>[Signature]</i>	3/12/09
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<i>[Signature]</i>	3/19/09
CHECKED BY	DATE
<i>[Signature]</i>	3/19/09
APPROVED BY	DATE

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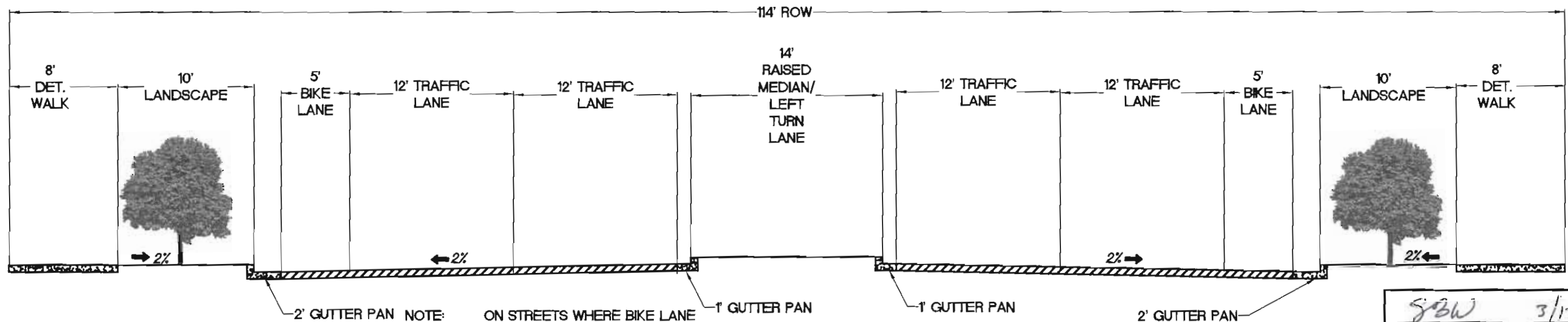
TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.	
6 OF 18	
ISSUED	3-1-09
REVISED	3-11-09

FOUR-LANE ARTERIAL WITH RAISED MEDIAN

- NOTES:
1. FOR DESIGN SPEED OF 45 MPH OR ABOVE SUPERELEVATION IS REQUIRED.
 2. FOR DESIGN SPEED OF 45 MPH OR ABOVE MOUNTABLE CURB IS REQUIRED.
 3. MEANDERING SIDEWALK IS PERMISSIBLE PROVIDED IT REMAINS WITHIN RIGHT-OF-WAY OR ADEQUATE PUBLIC USE EASEMENTS ARE DEDICATED. SIDEWALKS OUTSIDE OF RIGHT-OF-WAY SHALL NOT BE MAINTAINED BY ARAPAHOE COUNTY



2' GUTTER PAN NOTE:

ON STREETS WHERE BIKE LANE MARKING/DESIGNATION HAS BEEN APPROVED, BIKE LANES AT INTERSECTIONS WHERE AUXILLIARY LANES ARE REQUIRED BIKE LANES SHALL CONTINUE THROUGH AND THE AUXILLIARY LANE VEHICLES SHALL YIELD TO BIKE TRAFFIC. REFER TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES WHERE APPLICABLE.

NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

 DRAWN BY	3/17/07 DATE
 CHECKED BY	3/19/07 DATE
 APPROVED BY	3/19/07 DATE

NO.	DATE	DESCRIPTION	BY

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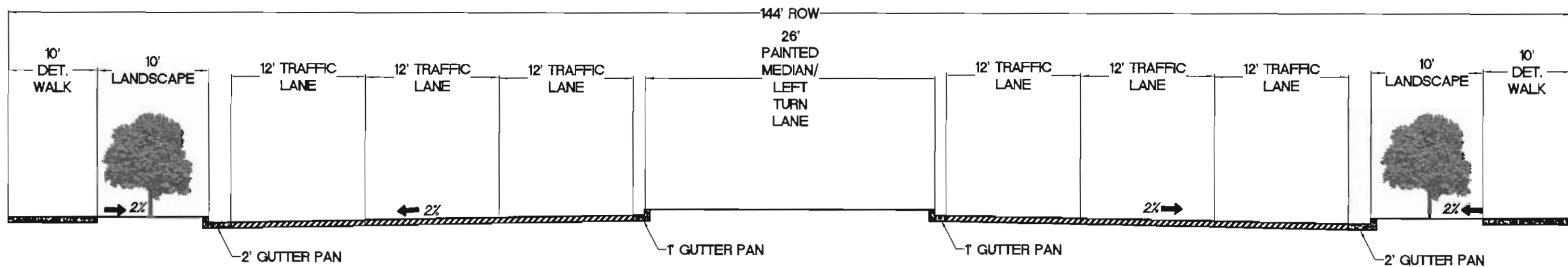
TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.	7 OF 18
ISSUED	8-10-05
REVISED	8-31-05

SIX-LANE PRINCIPAL ARTERIAL

- NOTES:
1. FOR DESIGN SPEED OF 45 MPH OR ABOVE SUPERELEVATION IS REQUIRED.
 2. FOR DESIGN SPEED OF 45 MPH OR ABOVE MOUNTABLE CURB IS REQUIRED.
 3. MEANDERING SIDEWALK IS PERMISSIBLE PROVIDED IT REMAINS WITHIN RIGHT-OF-WAY OR ADEQUATE PUBLIC USE EASEMENTS ARE DEDICATED. SIDEWALKS OUTSIDE OF RIGHT-OF-WAY SHALL NOT BE MAINTAINED BY ARAPAHOE COUNTY



NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

<i>SLB</i>	3/17/07
DRAWN BY	DATE
<i>Ph</i>	3/17/07
CHECKED BY	DATE
<i>Ph</i>	3/19/07
APPROVED BY	DATE

NO.	DATE	DESCRIPTION	BY

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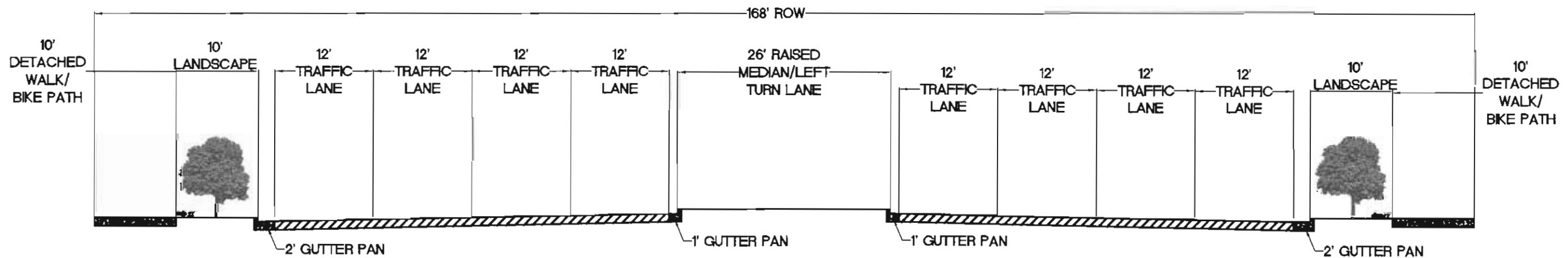
TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.	8 OF 18
ISSUED	3-15-07
REVISED	3-31-07

EIGHT-LANE URBAN EXPRESSWAY WITH RAISED MEDIAN

- NOTES:
1. FOR DESIGN SPEED OF 45 MPH OR ABOVE SUPERELEVATION IS REQUIRED.
 2. FOR DESIGN SPEED OF 45 MPH OR ABOVE MOUNTABLE CURB IS REQUIRED.
 3. MEANDERING SIDEWALK IS PERMISSIBLE PROVIDED IT REMAINS WITHIN RIGHT-OF-WAY OR ADEQUATE PUBLIC USE EASEMENTS ARE DEDICATED. SIDEWALKS OUTSIDE OF RIGHT-OF-WAY SHALL NOT BE MAINTAINED BY ARAPAHOE COUNTY



NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

<i>S.B. J</i> DRAWN BY	2/17/09 DATE
<i>M</i> CHECKED BY	3/19/09 DATE
<i>M</i> APPROVED BY	3/19/09 DATE

NO.	DATE	DESCRIPTION	BY

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10750 E. SPANWOOD AVE. • COLETS BLVD., CO 80112 • PH. 303-474-4800 • FAX 303-794-5200

TYPICAL STREET CROSS-SECTION

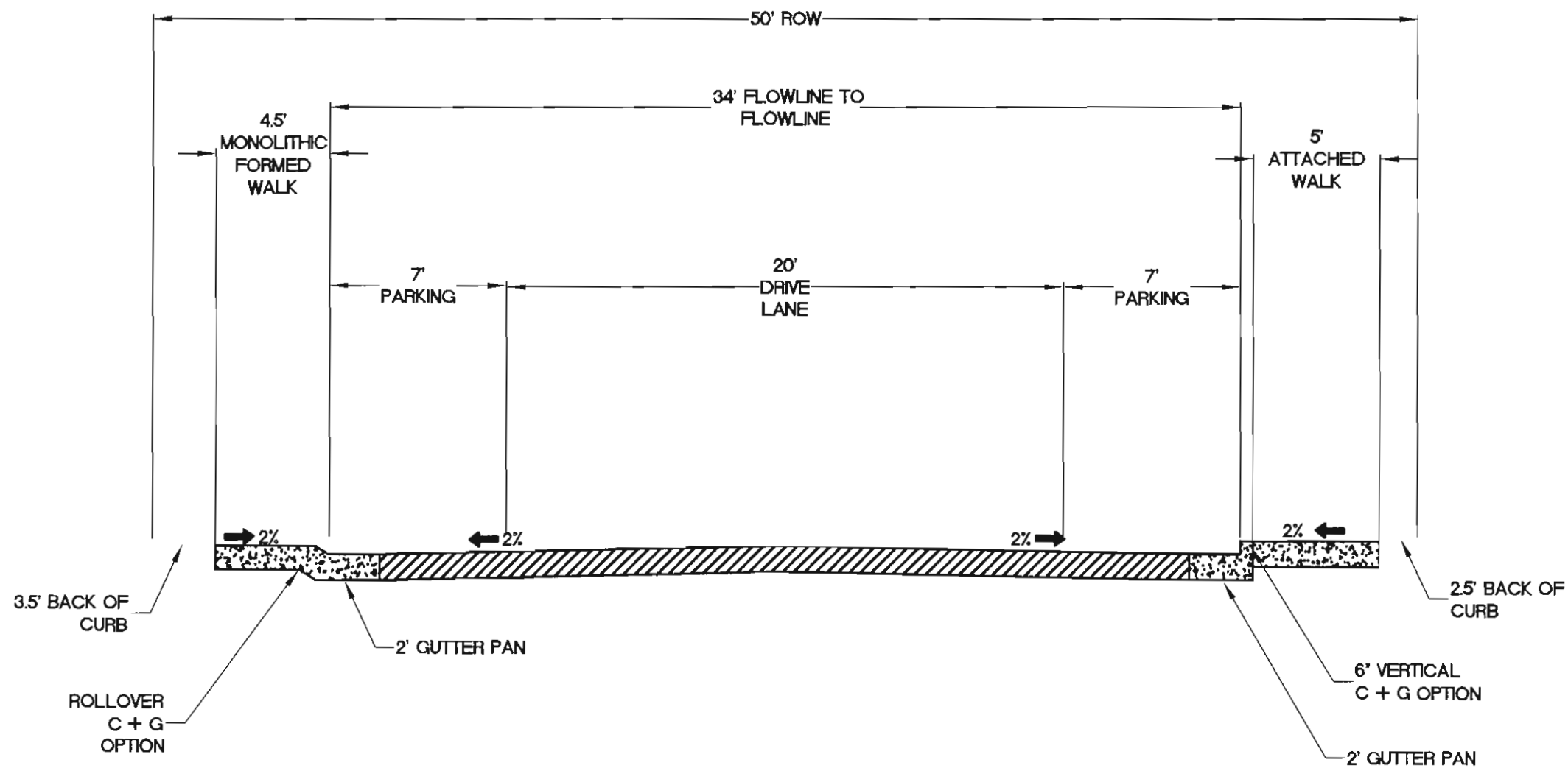
NOTES:

SHEET NO.	9 OF 18
ISSUED	8-15-08
REVISED	8-17-08

PUBLIC URBAN LOCAL ATTACHED WALK

NOTE: FOR VERTICAL CURB AND GUTTER OPTION
PREDETERMINED DRIVE CUTS SHALL BE
APPROVED BY ARAPAHOE COUNTY
PUBLIC WORKS AND DEVELOPEMENT PRIOR TO
ISSUANCE OF PUBLIC IMPROVEMENT PERMITS.

NOTE: PAVEMENT THICKNESS PURSUANT
TO DESIGN REPORT APPROVED BY
ARAPAHOE COUNTY PUBLIC WORKS
AND DEVELOPEMENT



<i>[Signature]</i>	3/17/09
DRAWN BY	DATE
<i>[Signature]</i>	3/19/09
CHECKED BY	DATE
<i>[Signature]</i>	3/19/09
APPROVED BY	DATE

REVISIONS			
NO.	DATE	DESCRIPTION	BY

Arapahoe County ARAPAHOE COUNTY, COLORADO
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 15750 E. SPRAYWOOD AVE. - CENTENNIAL, CO 80112 - PH: 720-874-8500 - FAX: 800/754-329

ALTERNATIVE STREET
CROSS-SECTION

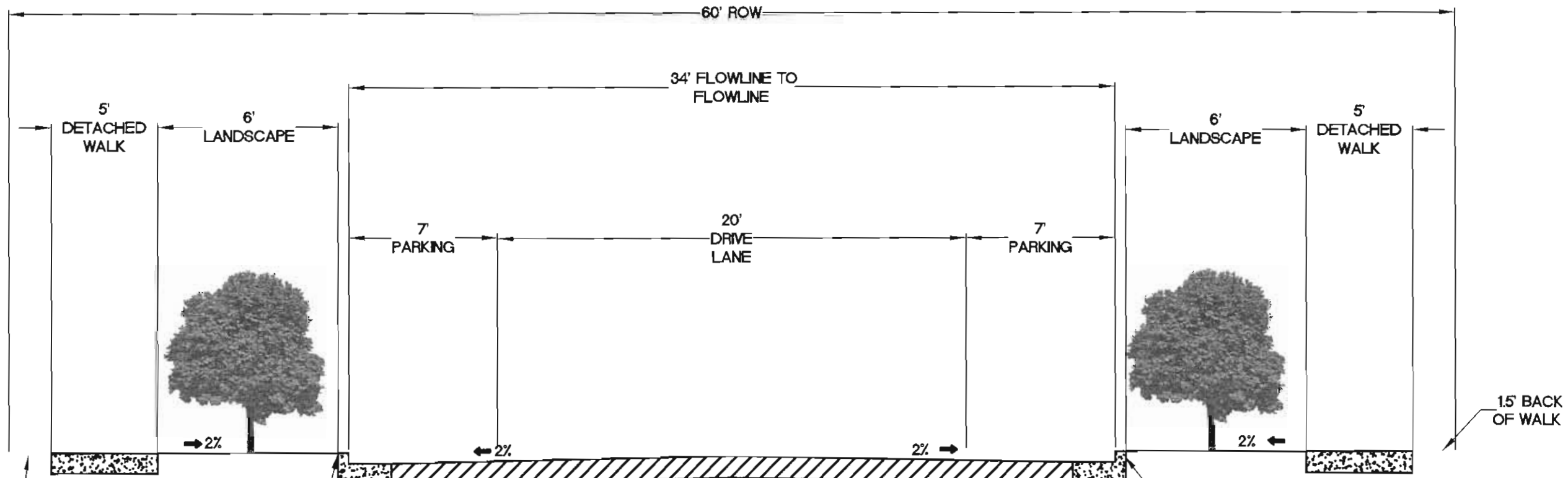
NOTES:

SHEET NO.
10 OF 18
 PUBLISHED: 8-10-08
 REVISED: 8-31-08

PUBLIC URBAN LOCAL DETACHED WALK

- NOTE: 1. DRIVEWAYS SHALL NOT EXCEED 2% UNTIL BACK OF WALK.
 2. ADDITIONAL REINFORCED ROLLOVER CURB AND GUTTER MAY BE USED IN-LIEU OF VERTICAL SECTION.
 3. DRIVEWAYS SHALL EXTEND 18- FEET FROM BACK OF WALK TO THE STRUCTURE

NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT



<i>[Signature]</i>	5/07/09
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<i>[Signature]</i>	3/19/09
CHECKED BY	DATE
<i>[Signature]</i>	3/19/09
APPROVED BY	DATE

NO.	DATE	DESCRIPTION	BY

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 10730 E. BIRCHWOOD AVE. CENTENNIAL, CO 80106 - PH: 720-874-6550 - FAX: 800-74-2334

STREET CROSS-SECTION

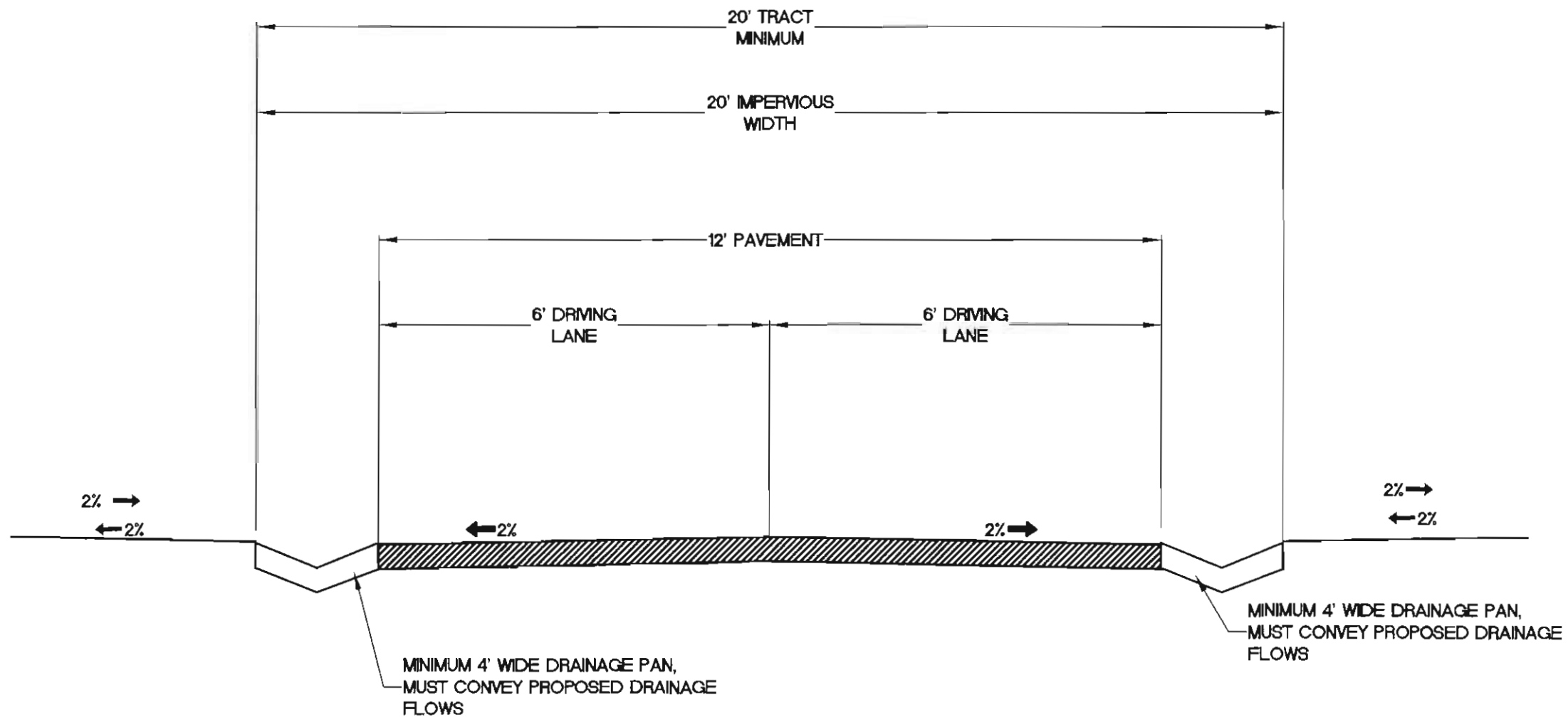
NOTES:

SHEET NO.
11 OF 18
ISSUED 5-15-08
 REVISED 8-31-08

PRIVATE ALLEY CROSS SECTION

NOTE: IF PRIVATE ALLEY IS PROPOSED AS A FIRE LANE IT MUST MEET A MINIMUM OF 24' DRIVABLE WIDTH AS DETERMINED BY THE RESPECTIVE FIRE DISTRICT

NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT



<i>SLW</i>	3/17/09
DRAWN BY	DATE
<i>AK</i>	3/19/09
CHECKED BY	DATE
<i>AK</i>	3/19/09
APPROVED BY	DATE

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NO.	DATE	DESCRIPTION	BY

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 10730 S. BERRINGWOOD AVE. • COVINGTON, CO 80021 • PH: 719-474-6600 • FAX: 719-474-3200

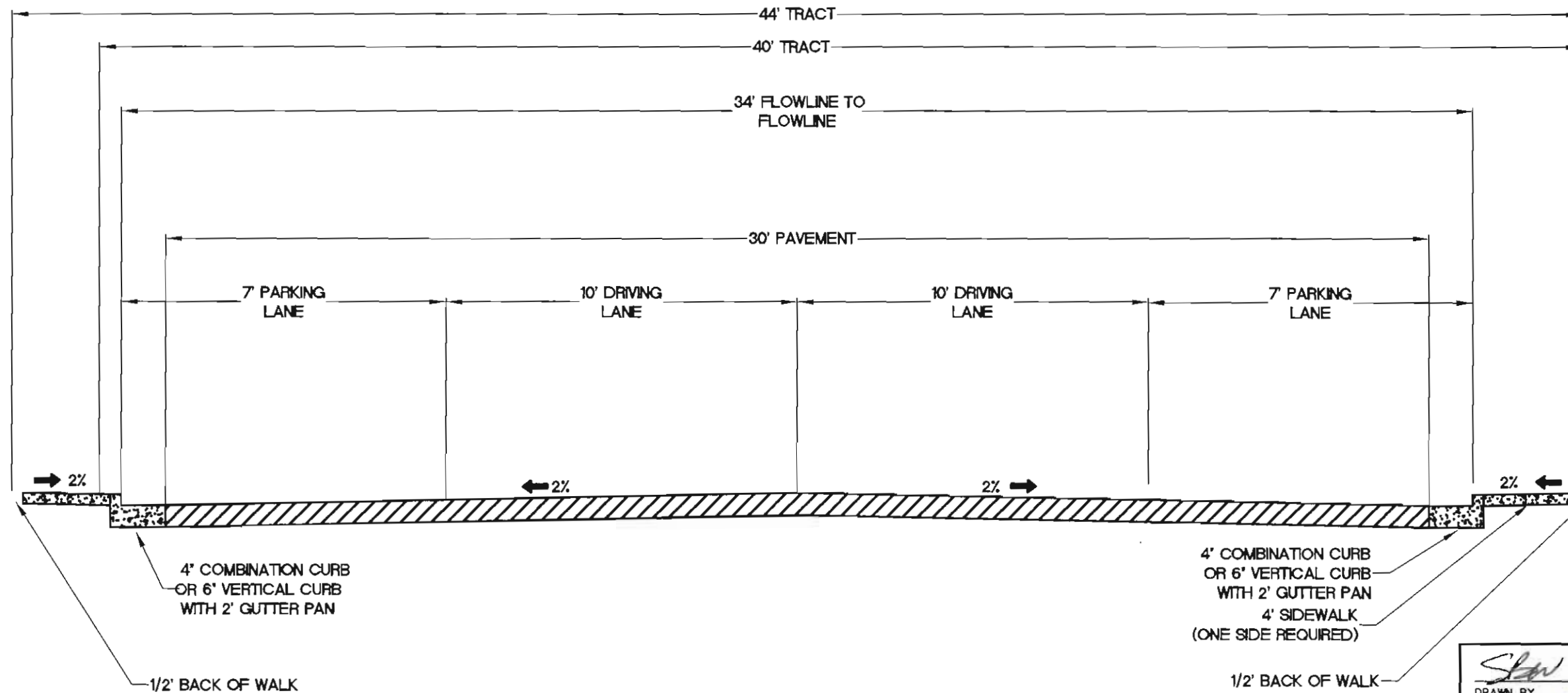
ALTERNATIVE STREET
CROSS-SECTION

NOTES:

SHEET NO.
12 OF 18
 DESIGNED 5-10-06
 REVISED 8-31-06

NOTE: REQUIRES APPROVAL FROM FIRE DISTRICT

PRIVATE ROADWAY ALTERNATIVE PARKING BOTH SIDES



NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

NOTE: DEVELOPER SHALL BE RESPONSIBLE FOR DEDICATION OF DRY UTILITY EASEMENTS WITHIN EACH LOT

NOTE: SIDEWALKS ARE STRONGLY RECOMMENDED ON BOTH SIDES OF PRIVATE ROADS

<i>Slaw</i>	3/17/09
DRAWN BY	DATE
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CHECKED BY	DATE
<i>Ph</i>	3/19/09
APPROVED BY	DATE

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NO.	DATE	DESCRIPTION	BY

Arapahoe County ARAPAHOE COUNTY, COLORADO
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 10730 E. SPRINGWOOD AVE. • CENTRAL, CO 80112 • PH. 719-874-4950 • FAX. 719-874-4921

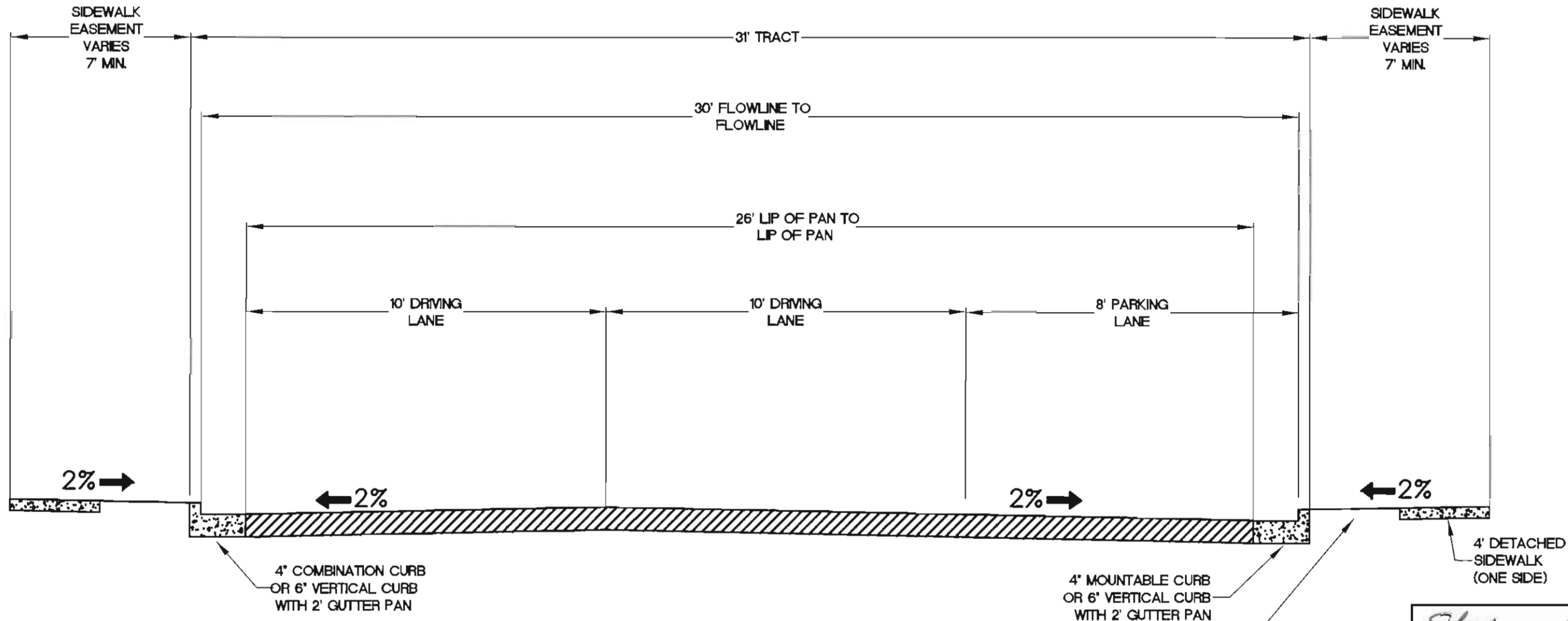
TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.
13 OF 18
 ISSUED 5-10-06
 REVISED 8-31-08

NOTE: REQUIRES APPROVAL FROM FIRE DISTRICT

PRIVATE ROADWAY PARKING ONE SIDE DETACHED WALK



NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

NOTE: DEVELOPER SHALL BE RESPONSIBLE FOR DEDICATION OF DRY UTILITY EASEMENTS WITHIN EACH LOT

NOTE: SIDEWALKS ARE STRONGLY RECOMMENDED ON BOTH SIDES OF PRIVATE ROADS

DRAWN BY <i>Skw</i>	DATE 3/17/09
CHECKED BY <i>Mh</i>	DATE 3/19/09
APPROVED BY <i>Mh</i>	DATE 3/19/09

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INSPIRED BY THE ARAPAHOE COUNTY ENGINEERING DIVISION
11750 E. SPRINGWOOD AVE. - DENVER, CO 80231 - PH: 720-861-4000 - FAX: 720-794-0201

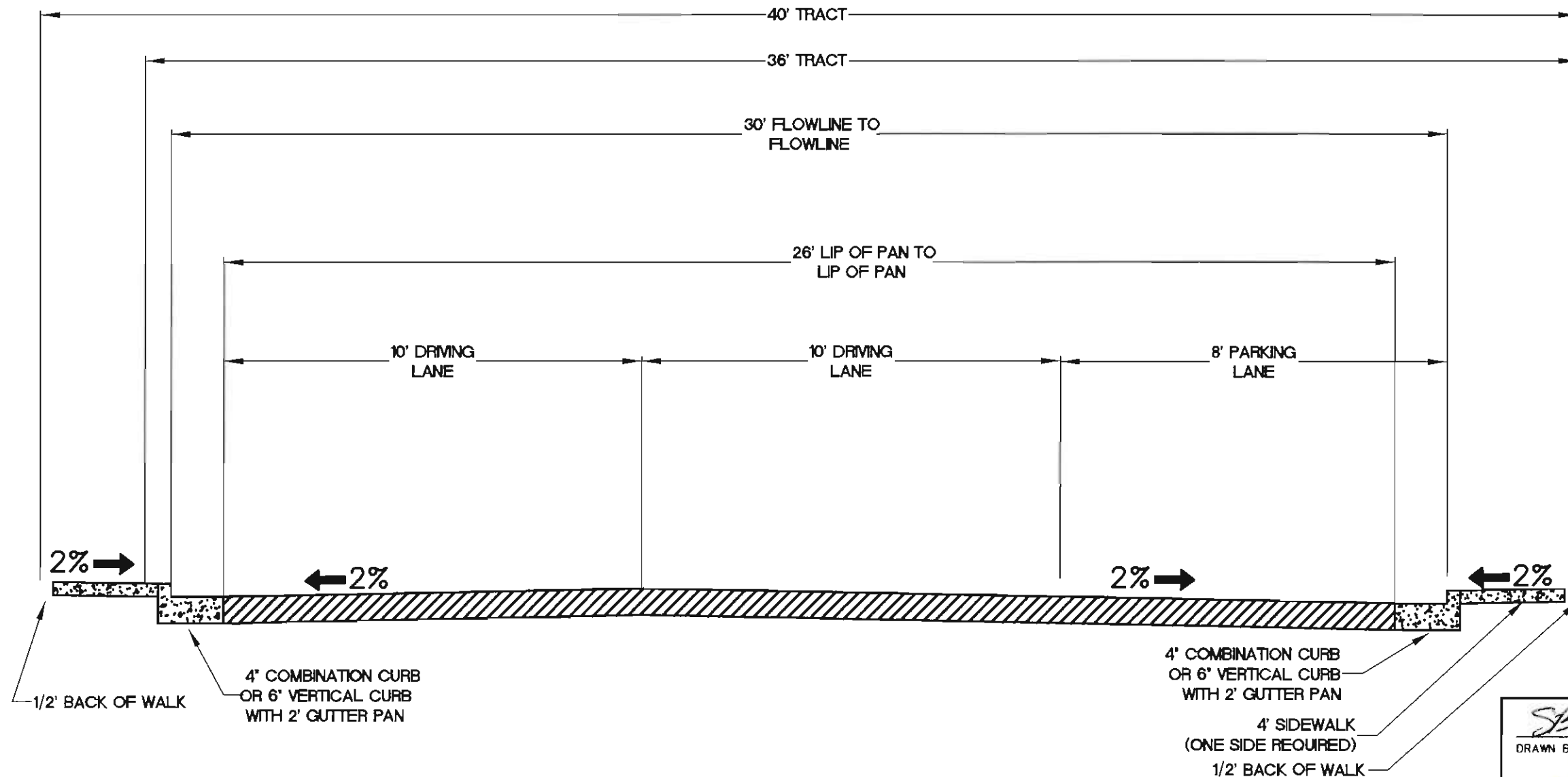
TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.
14 OF 18
ISSUED: 8-10-05
REVISED: 8-31-08

NOTE: REQUIRES APPROVAL FROM FIRE DISTRICT

PRIVATE ROADWAY PARKING ONE SIDE



NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

NOTE: DEVELOPER SHALL BE RESPONSIBLE FOR DEDICATION OF DRY UTILITY EASEMENTS WITHIN EACH LOT

NOTE: SIDEWALKS ARE STRONGLY RECOMMENDED ON BOTH SIDES OF PRIVATE ROADS

<i>SLW</i>	3/17/09
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CHECKED BY	DATE
<i>PK</i>	3/19/09
APPROVED BY	DATE

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INFRASTRUCTURE MANAGEMENT
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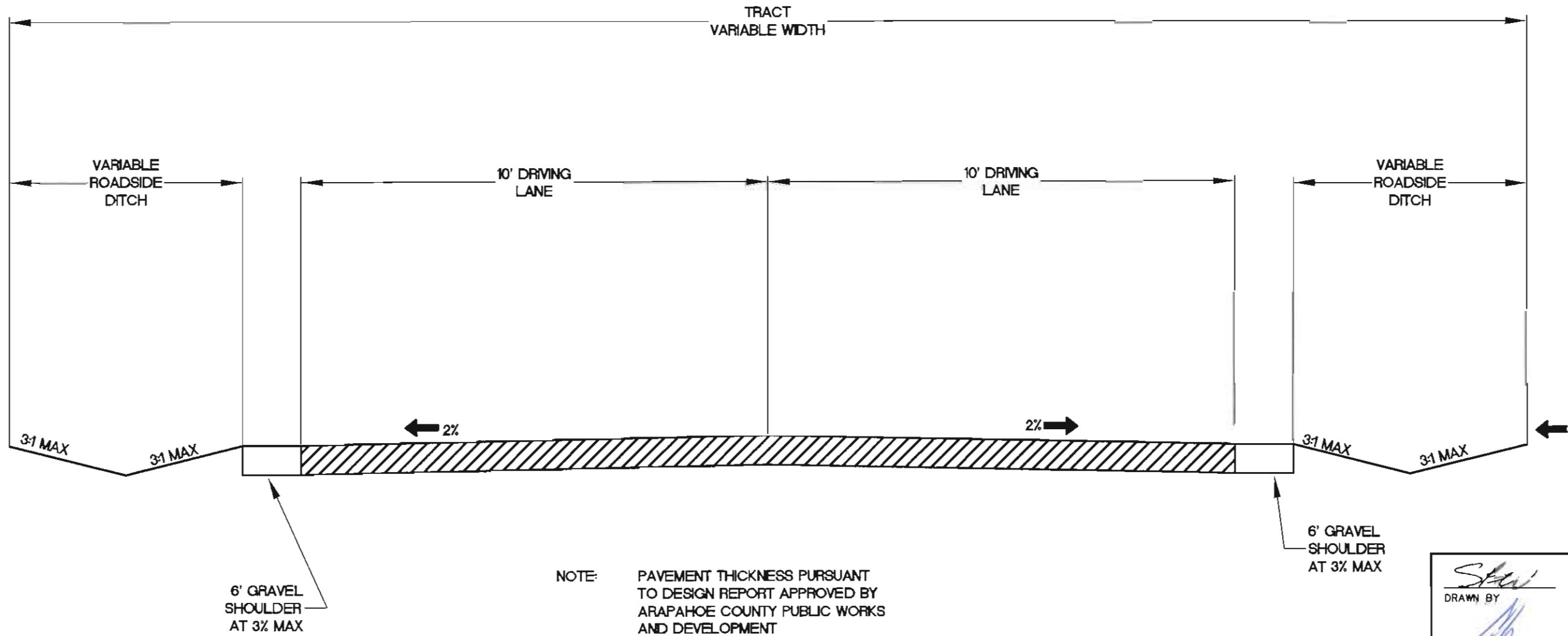
TYPICAL STREET CROSS-SECTION

NOTES:

SHEET No.
15 OF 18
ISSUED 5-10-05
REVISED 8-31-06

NOTE: REQUIRES APPROVAL FROM FIRE DISTRICT

PRIVATE ROADWAY RURAL CROSS SECTION



<i>Stew</i>	3/17/09
DRAWN BY	DATE
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CHECKED BY	DATE
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APPROVED BY	DATE

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NO.	DATE	DESCRIPTION	BY

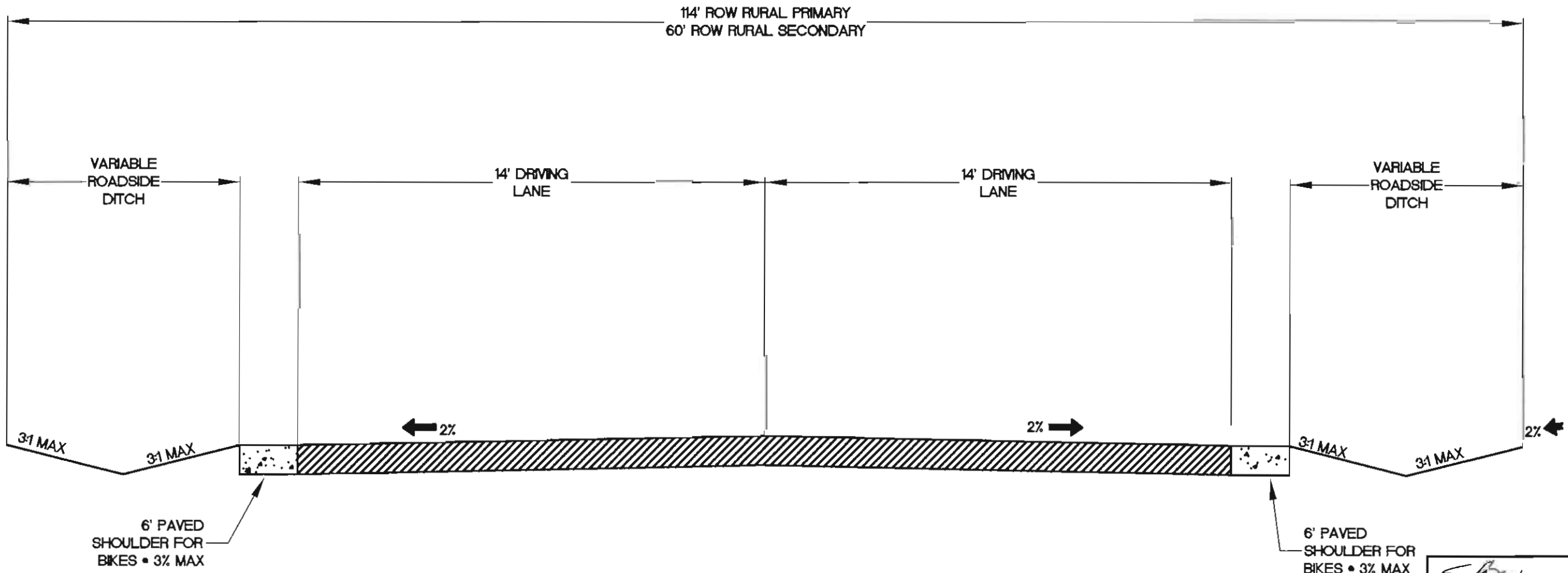
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DEPARTMENT OF
PUBLIC WORKS AND
DEVELOPMENT
Colorado's First
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TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.
16 OF 18
ISSUED 07-10-05
REVISED 08-01-06

RURAL PUBLIC CROSS SECTION WITH BIKE ACCOMMODATIONS



NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

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[Signature] 3/19/07
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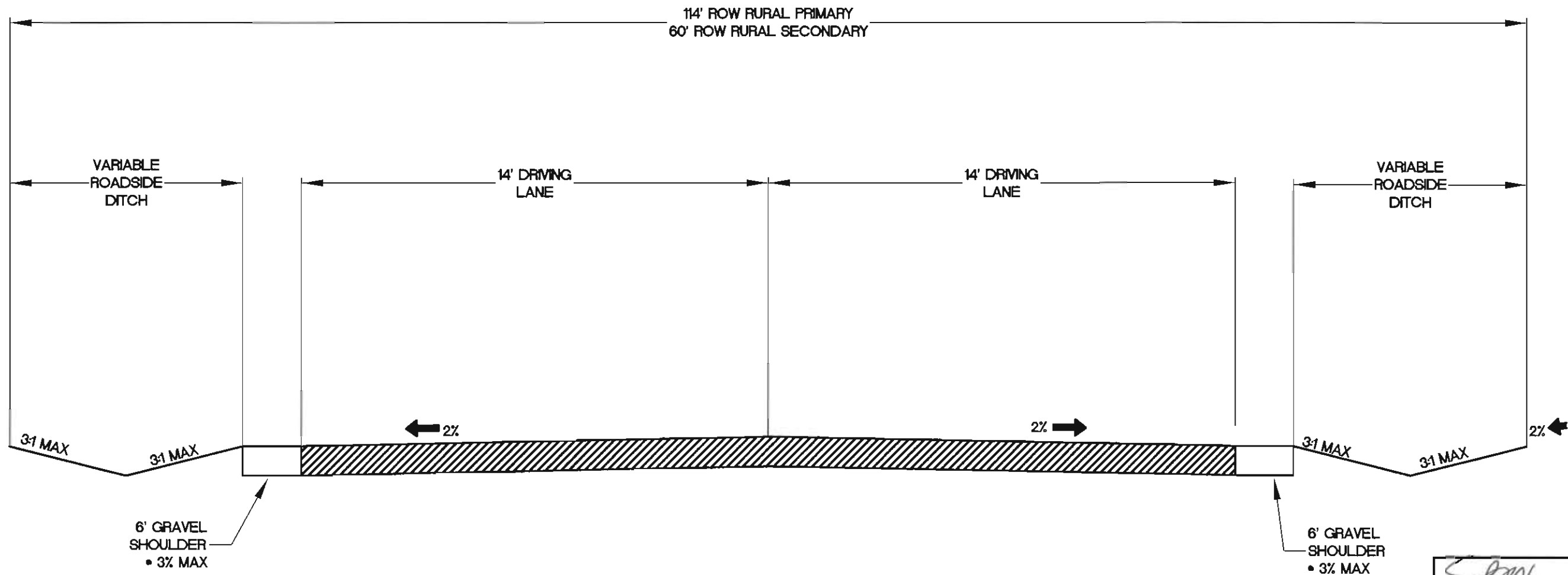
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TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO.
 18 OF 18
 REVISIONS
 8-10-05
 8-31-06

RURAL PUBLIC CROSS SECTION WITHOUT BIKE ACCOMMODATIONS



NOTE: PAVEMENT THICKNESS PURSUANT TO DESIGN REPORT APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT

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<i>MB</i>	3/17/09
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<i>MB</i>	3/17/09
APPROVED BY	DATE

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TYPICAL STREET CROSS-SECTION

NOTES:

SHEET NO	17 OF 18
ISSUED	8-10-08
REVISED	9-31-08

APPENDIX B – GUIDELINES FOR TRAFFIC IMPACT STUDIES

APPENDIX B



ARAPAHOE COUNTY
COLORADO'S FIRST

**Arapahoe County
Public Works and Development
Engineering Services Division
Guidelines for Traffic Impact Studies**

Revised _____

Via Resolution # _____

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Introduction

This document contains guidelines for conducting Traffic Impact Studies (TIS) for submittal to Arapahoe County Public Works and Development. These guidelines are required to ensure consistent and proper traffic planning and engineering practices when land use actions are being considered within Unincorporated Arapahoe County. These guidelines provide standard process, set of assumptions, set of analytic methods, and presentation format to be used in the preparation of such traffic impact studies.

The procedures contained herein:

- Assists developers through the approval process by outlining the requirements and level of detail for traffic analysis,
- Standardizes the type and detail of analysis required in assessing traffic impacts for developments of similar size and intensity, and
- Ensures consistency in the preparation and review of a TIS through standardization of the studies.

When is a TIS required?

Traffic Impact Studies are generally required for all new land development proposals. TIS requirements for redevelopment or change in use of existing sites will be determined on a case-by-case basis. Mitigation or improvements by the Developer may be required regardless of if a TIS is required.

The need for a TIS should be assessed as early as possible in the development process to ensure maximum flexibility for eliminating traffic-related problems. The TIS is dependent on-site specific characteristics such as location, trip generation, existing road conditions, and type of development proposed, as such the requirements of a TIS may vary from site to site.

The need for a TIS, TIS update or TIS waiver will be determined by the Department of Public Works and Development, Engineering Services Division in accordance with the intent of these guidelines. The County reserves the right to waive or modify the requirements of a TIS as outlined within these guidelines. However, **the Developer may still be required to mitigate traffic delays or complete roadway improvements necessary to ensure acceptable traffic operations, regardless of whether a TIS is required.**

Waiver Requirements

A TIS requirement may be requested to be waived if **all** the following conditions are met:

- The average trip generation of the proposed project is less than 250 trips per day and 25 trips in the peak hour,
- The combination of the proposed development traffic plus existing traffic does not exceed an average of 150 vehicles per day on any unpaved road, and
- Access is not being requested to either a State Highway or County arterial roadway No current traffic problems or local area concerns, such as an offset intersection or a high accident data.

If the conditions listed above are met, the applicant may submit a waiver request to Engineering Services Division Case Engineer. The TIS waiver request must be prepared by the Developer's Transportation Consultant Engineer (stamped by a Colorado Professional Engineer).

The waiver request shall include the following:

- The trip generation of the development,
- recent traffic counts along the immediately adjacent roads (less than one year old),
- conclusion that no adverse transportation impacts are anticipated as a result of the proposed project.

Waiver response will generally be provided within 10 business days.

Pre-Study Meeting

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A Pre-Study Meeting shall be held with a representative of the Engineering Services Division. The purpose of the Pre-Study Meeting is to determine the level of detail and extent to which the TIS for the specific development project addresses these guidelines. The Developer's Transportation Consultant Engineer should attend this meeting.

The Developer will be notified of the Pre-Study Meeting requirements at the Pre-Submittal Meeting and given a list of items to provide for the Pre-Study Meeting in the Pre-Submittal Meeting notes.

The Developer must provide the following information **prior to** the Pre-Study Meeting:

- Project description, including type of land uses (single family, fast food, etc.), and size (number of dwelling units, square footage, etc.),
- Preliminary project site plan, showing proposed access locations, land uses, and preliminary internal circulation,
- Estimates for the number of vehicle trips generated by the overall proposed development with no trip reductions applied (Average Daily Traffic and peak hour traffic based on the latest ITE Trip Generation Manual),
- Vicinity Map showing the location of the site and its relationship to adjacent properties and their existing access(s) with the local and regional road network surrounding the proposed site (area based on the expected Analysis Category from the overall development trip generation estimate)
- Potential pedestrian and bicycle generators, such as schools, parks, playgrounds, municipal buildings, shopping centers, other commercial areas, or shared-use paths within ¼ mile (½ mile for schools), shown on the Vicinity Map for the site,
- Request for DiExSys traffic crash data for the most current three-year period available, and
- Anticipated project completion date and project phasing.

The information must be received by the Engineering Services Division before scheduling the meeting and a **minimum of 5 business days prior** to the scheduled Pre-Study Meeting date. Contact the Case Engineer listed on the pre-submittal notes to schedule the pre-study meeting.

The Analysis Category for the study will be discussed at the Pre-Study Meeting for concurrence by the Engineering Services Division. The need to establish a Trip Generation Budget for the development will be determined. The level of detail to be utilized in the TIS will be established including study area boundaries, scope of traffic data collection, study intersections, study time periods, and the background committed transportation network.

The results of the discussion will be documented by Engineering Services Staff on the 'Pre-Study Summary' worksheet. This worksheet will be signed for concurrence by County Staff and the Developer's Transportation Consultant to represent a general agreement between the County and the Consultant for the initial submittal requirements of the TIS, but may not be all inclusive. The County retains the right to require additional information and/or analysis if found that the level of detail was insufficient for a complete evaluation of the proposed development. The signed worksheet will be included within an appendix of the TIS.

The Engineering Services Division has the authority to waive the Pre-Study Meeting requirement. If the Pre-Study Meeting was conducted more than 6 months prior to submittal of the actual case, the County Case Engineer may require another Pre-Study Meeting.

Analysis Categories

The specific analysis requirements and level of detail for a TIS are determined by Analysis Categories. In order to determine the analysis category, the Developer must first estimate an overall number of vehicle trips generated by the proposed development with no trip reductions applied. The Analysis Category will be determined at the Pre-Study Meeting with agreement of the Transportation Engineer and Engineering Services Division.

Table 1. Analysis Category Definitions

Analysis Category	Development Characteristic (a)	Study Horizons (b)	Recommended Study Area (d)
I	Small Development 250 – 499 daily trips	<ul style="list-style-type: none"> Opening year 	<ul style="list-style-type: none"> Site access drives Adjacent roadways Adjacent signal controlled intersections within ¼ mile and/or major street intersections without signal control and driveways within 500 feet
II	Moderate Development 500 – 999 daily trips	<ul style="list-style-type: none"> Opening year 5 years after opening 	<ul style="list-style-type: none"> Site access drives Adjacent roadways All signal controlled intersections within ½ mile and/or major street intersections without signal control and major driveways within ½ mile
III	Large Development 1,000 – 1,500 daily trips	<ul style="list-style-type: none"> Opening year 5 years after opening 20 years after opening (or regional planning horizon^(c), if longer) 	<ul style="list-style-type: none"> Site access drives Adjacent roadways First signalized intersection in each direction from the site All signal controlled intersections within 1 mile and major street intersections and driveways without signal control within 1 mile
IV	Regional Development > 1,500 daily trips	<ul style="list-style-type: none"> Opening year 5 years after opening 20 years after opening (or regional planning horizon^(c), if longer) 	<ul style="list-style-type: none"> Site access drives Adjacent roadways First signalized intersection in each direction from the site Key signal controlled intersections and major street intersections without signal control within 3 miles

^(a) The number of trips includes all trips generated by the site, including pass-by trips, with no internal trip reduction.

^(b) Developments may require assessment of additional horizon years due to surrounding land use availability and timing of development as directed by the County.

^(c) Regional planning horizon based on the current Denver Regional Council of Governments (DRCOG) Regional Transportation Plan.

^(d) An adjusted study area may be required when the identified minimum study area does not provide sufficient information to meet the intent of the Traffic Impact Study guidelines.

Analysis Category I TIS may also be required for sites generating less than 250 average trips per day for any of the following reasons:

- The existence of any current traffic problems or concerns in the local area, such as an offset intersection or a high number of traffic accidents
- The proximity of site drives to other drives or intersections
- Other specific problems or concerns that may be aggravated by the proposed development

No matter what Analysis Category, developments may require assessment of additional horizon years due to surrounding land use availability and timing of development as directed by the County.

Analysis Approach and Methods

The TIS shall be prepared by or under the supervision of a Colorado-registered Professional Engineer with a background in traffic engineering.

The validity of a traffic study shall expire 18 months after the study is received by the County. If a project has not been approved in that timeframe, a new traffic study with updated count information and project area assumptions will be required.

E.1 Project Information

The project description will include a summary of current and proposed zoning. The trip generation of the site under the existing zoning will be provided in a table. The land use and zoning discussion will also include areas that are within the study area, but are not part of the development for which this TIS is being prepared. Specific attention should be paid to property adjacent to the site and any undeveloped land in the study area, including land in other jurisdictions. Location of parking areas and parking capacity should be discussed. The mixture or variable combination of land uses and the flexibility/interchangeability of land uses within the overall site will be discussed, if applicable. Any proposed project construction phasing will be discussed with the anticipated completion date(s).

A site plan and vicinity map shall be included showing proposed land use with access locations and types (signalized, right-in/right-out, etc.) and distances between adjacent and opposing site accesses illustrated.

E.1.a Study Area

The study area shall be determined by the proposed development size and overall trip generation, in accordance with the criteria in Table 1. An enlarged study area may be required when the identified minimum study area does not provide sufficient information to meet the intent of the Traffic Impact Study guidelines. For example, a large (Category III) development in a rural area located two miles from a freeway interchange from which most of the trips are anticipated to access the development may require an enlarged study area to include the assessment of the freeway interchange.

The limits of the study area will be determined at the TIS Pre-Study Meeting with concurrence provided by the Engineering Services Division.

E.1.b Study Horizon Years

The study horizon years shall be determined by the project type and size in accordance with the criteria in Table 1. The specific study years will be determined by the Engineering Services Division with concurrence provided at the TIS Pre-Study Meeting.

E.1.c Analysis Time Periods

Both the morning (AM) and afternoon/evening (PM) weekday peak hours shall be analyzed. If the proposed project is expected to generate no trips, or a very low number of trips, during either the morning or evening peak periods the requirement to analyze one or both of these periods may be waived by the Engineering Services Division.

Where the peak traffic hour in the study area and/or peak hour traffic from the site's proposed land uses occur during a different time period other than the normal AM or PM peak travel periods (for example, midday), or occurs on a weekend, or if the proposed project has unusual peak characteristics, these additional peak hours shall also be analyzed and discussed under Special Analysis Issues section of the TIS. The Engineering Services Division reserves the right to request additional analysis.

E.1.d Seasonal Adjustments

When directed by the Engineering Services Division, the traffic volumes for the analysis hours should be adjusted for the peak season, in cases where seasonal traffic data is available.

E.2 Data Collection (Existing Conditions)

All data shall be collected in accordance with the latest edition of the *Institute of Transportation Engineers Manual of Transportation Engineering Studies* or as directed by the Engineering Services Division.

E.2.a Intersection Traffic Volumes

Turning movement counts shall be obtained for all existing cross-street intersections in the study area during the approved analysis time periods for a minimum of two hours for each time period and shall include fifteen

(15) minute count data to clearly identify the peak hours. Turning movement counts may be required during other periods as directed by the Engineering Services Division.

Available turning movement counts may be used for the analysis provided the date of the collected information is **no more than one year** from the date of the initial report submittal with written concurrence from the Engineering Services Division.

Raw traffic count data shall be provided in the appendices of the TIS. A graphic of the existing turning movements at all study intersections shall be included.

E.2.b Roadway Traffic Volumes

The current daily traffic volumes on the arterial and collector roadways within the study area shall be presented in the report. Available daily traffic count data may be obtained from previous transportation and traffic studies provided the date of the collected information is **no more than one year** from the date of the initial study submittal with written concurrence from the Engineering Services Division.

Where daily count data are not available, or such counts are over one year old, new counts shall be required. New traffic counts shall include a breakdown of traffic by types of trucks and buses on each roadway, reported by standard FHWA Vehicle classification types. Raw traffic count data shall be provided in the appendices of the TIS.

E.2.c Crash Data

DiExSys request should be made to the Engineering Services Division prior to the Pre-Study Meeting. DiExSys traffic crash data shall be obtained for the most current three to five year period available. Discuss measures to alleviate potential safety issues. DiExSys crash report to be included in the appendix of the TIS Report.

E.2.d Roadway and Intersection Geometrics

Roadway geometric information shall be obtained and discussed in the TIS. This includes, but is not limited to, roadway classification, roadway width, number of lanes, auxiliary lanes, vertical grade, posted/design speed limit(s), location of driveways, pedestrian and bicycle facilities, and lane configuration at intersections.

Sight distance at intersections to be impacted by the development shall be evaluated per the *Arapahoe County Infrastructure Design and Construction Standards*.

E.2.e Traffic Control Devices

The location and type of traffic control shall be identified. Existing signal timing for each traffic signal within the study area shall be obtained from the agency maintaining the signal. Verification document to be placed in the Appendix of the Report.

E.3 Multimodal Components

The types of multimodal facilities that exist or are planned within the study area shall be described. This includes, but is not limited to, transit routes, bus stops, shared-use paths/trails, and sidewalks. Potential pedestrian and bicycle generators, such as schools, parks, playgrounds, municipal buildings, shopping centers, other commercial areas, or shared-use paths within ¼ mile (½ mile for schools), shall be shown on the Vicinity Map for the site. When directed by the Engineering Services Division, bicycle and pedestrian volumes shall be collected.

E.4 Trip Generation (Proposed Conditions)

The latest edition of the *Institute of Transportation Engineers (ITE) Trip Generation* shall be used for selecting trip generation rates. Other rates may be used with the prior approval of the Engineering Services Division in cases where the *ITE Trip Generation* does not include trip rates for a specific land use category, or includes only limited data, or where local trip rates have shown to differ from the ITE rates. A variance would be required to establish alternative trip generation rates. Refer to the *Arapahoe County Infrastructure Design and Construction Standards* for variance request criteria and process.

Site traffic shall be generated for daily, AM, and PM peak hour periods. When proposed by the Developer's traffic engineer and approved by the County adjustments for pass-by and internal traffic volumes shall follow the methodology outlined in the latest edition of the *ITE Trip Generation Handbook*. A pass-by traffic volume discount may only be applied with prior approval from Arapahoe County. For commercial centers, the discount **will in no case exceed 25%** unless approved by the Engineering Services Division. Reduction due to internal interactions applied to mixed-use development in the estimated trip generation **will in no case exceed 10%** unless approved by the Engineering Services Division.

A trip generation summary table shall be prepared showing proposed land use, trip rates used, and vehicle trips for daily and peak hour periods. The *ITE Trip Generation* land use type, with number, shall be provided for each land use.

For modal split, any assumptions regarding trips that will access the site using transit, pedestrian or bicycle modes shall be described. Justifications for the reasonableness of these assumptions are to be provided and resulting trip reductions must be approved by the Engineering Services Division.

For studies submitted with preliminary site plans or developments proposing a variable combination of land uses, trip generation shall be based on the maximum dwelling units permitted and/or the maximum trip generation, non-resident development allowed for the proposed development. With final site planning, trip generation shall be based on actual dwelling unit counts and square footage indicated in the final plan.

E.4.1 Trip Generation Budget

It is imperative that the TIS be sufficiently conservative to account for the full impact of the proposed development. To assure that a TIS submitted with preliminary site plans adequately addresses the full impact of the development, the trip generation of the proposed development in the TIS will establish a Trip Generation Budget defining the maximum number of trips permitted by the development. The Trip Generation Budget will be tracked by the daily and/or peak hour trip generation of each land use. The Trip Generation Budget shall be documented on the preliminary Site Plans and updated with **each** individual final Site Plan. The TIS shall either establish the Trip Generation Budget or document where the development is within a previously established Trip Generation Budget.

Specific mitigation measures for development impacts shall be identified for each expected phase of development. If the Trip Generation Budget is reached prior to full occupancy, the County reserves the right to request supplemental traffic analysis and/or additional mitigation prior to granting full occupancy permits. If the project is fully occupied and it is determined that the development traffic exceeds the Trip Generation Budget established in the TIS, then the property owner may be required to conduct additional traffic analysis and provide additional mitigation.

Not every development will require a Trip Generation Budget. The need for establishing a Trip Generation Budget shall be discussed at the Pre-Study Meeting.

E.5 Trip Distribution and Assignment

Projected trips shall be distributed and added to the projected background (non-site) traffic on the study area roadways and intersections for the study years. Trip distribution may be based on regional traffic forecasts, market analysis, existing traffic flows, census data, and professional judgment. The specific assumptions and data sources used in deriving trip distribution and assignment shall be documented in the TIS.

A figure will be required showing site-generated daily and peak period turning movement volumes for each study intersection. In addition, a figure shall be prepared showing the background volumes with site-generated traffic added to the roadway network. The total projected traffic volumes on the roadway network for each study year shall be shown in a table, including the traffic volume in each direction with estimates of the breakdown of future traffic by types of trucks and buses, based on the existing vehicle classification data and future land uses. The

number of future RTD buses that can be expected on a roadway (assuming the roadway is or may become an RTD bus route) should be included in the breakdown of vehicle types.

Trips shall not be assigned to roadways that are not yet constructed or roadways that will be improved and/or constructed after the analysis year. Trip distribution may be permitted on roadways expected to be improved by other developments, provided such is documented and evaluated as an alternate scenario.

E.6 Existing and Committed Transportation Network (Future Conditions)

The applicant shall obtain from the Engineering Services Division any current or planned transportation improvement projects expected to occur during the study horizon years within the study area. These improvement projects will be added to the existing roadway network to define the Existing and Committed Transportation Network to be used for the traffic analysis of future conditions. Alternative transportation network scenarios may be required for analysis.

E.7 Background Traffic Volume Forecasts

Future traffic volumes should be estimated using information from transportation models or applying an annual growth rate to the existing traffic volumes. The future background traffic volumes (without project traffic) should represent the horizon year for the project development. If the annual growth rate method is used, the County must give prior approval for the growth rate.

In addition, traffic forecasts for any nearby area proposed development projects, other recent transportation studies, and forecasts within the latest version of the *Arapahoe County Master Transportation Plan* should be taken into consideration when forecasting future traffic volumes. Background volumes may come from the application of growth rates to existing volumes, traffic models or a combination of the two.

Any change in the percent of daily traffic occurring in the peak hour from the existing traffic counts to the horizon year(s) background traffic forecasts must be discussed in the TIS with analytic support.

E.8 Capacity Analysis (Traffic Evaluation)

The operational analysis will show impacts on the existing roadway system and the expected future roadway system. The latest version of the *Highway Capacity Manual* methods for operational analysis shall be used to evaluate intersection and roadway operations. Worksheets from the operational analysis software illustrating the inputs and outputs are to be included in the appendices of the TIS. Electronic input/output files shall also be included with the TIS submittal.

Level of Service (LOS) shall be calculated for each of the following conditions:

- Existing peak hour traffic volumes (illustrated in a figure)
- Horizon year(s) traffic volumes without Project (background traffic) (illustrated in a figure)
- Horizon year(s) traffic volumes with Project (illustrated in a figure)
- LOS and delay results for each traffic volume/network scenario (shown in a table)

The existing conditions analysis will include only the existing transportation network. Each of the future conditions analyses will include the Existing and Committed Transportation Network, which includes any current or planned transportation improvement projects expected to occur during the study horizon years, as provided by the Engineering Services Division. Several scenarios for the transportation network may be required for analysis.

The LOS table will include LOS results for the AM and PM peak hours and additional analysis time periods, if applicable. The table will show overall LOS conditions with the corresponding vehicle delays at signalized intersections and LOS conditions for the critical movements at unsignalized intersections. For signalized intersections, the LOS conditions and average vehicle delay should be provided for each movement and the overall intersection.

The operational analysis of existing signalized intersections for existing traffic conditions should utilize existing phasing, timing, splits, and cycle lengths as obtained from the agency maintaining the signal. The timing sheet from the controller showing the existing signal timing shall be included in the appendices of the TIS.

If the new development is scheduled to be completed in phases, the TIS will include a LOS analysis for each separate development phase in addition to the analysis for each horizon year. A figure will be required for each horizon year of phased development.

E.8.a Intersections

Level of Service (LOS) shall be computed for signalized and unsignalized intersections, including roundabouts, in accordance with the latest edition of the *Highway Capacity Manual (HCM)*. Traffic analysis software that implements HCM methods, such as Synchro, is acceptable as long as the electronic files are included with the TIS submittal. Pedestrian and/or bicycle movements will need to be considered in the LOS evaluation for intersections. **Peak hour factors for future conditions shall not exceed 0.90.** The use of peak hour factors based on existing traffic counts, or the consideration of special land uses (such as schools or event centers) will require prior approval by the Engineering Services Division.

The following peak hour factors shall be used unless otherwise approved by the Engineering Services Division:

- PHF = 0.80 for < 75 vehicles per hour (vph) per lane
- PHF = 0.85 for 75 – 300 vph per lane
- PHF = 0.90 for > 300 vph per lane

E.8.b Roadways

For urban roadways and rural highways where signalized intersections are less than one mile apart, the capacity of the roadway is generally dominated by the capacity of the adjacent signal controlled intersections. Roadway LOS need not be computed for these facilities.

For rural highways where signal controlled intersections are more than one mile apart, the LOS on the highway may be estimated in accordance with the latest edition of the *Highway Capacity Manual* or by evaluating the roadway volume-to-capacity (v/c) ratio. The v/c ratio evaluation shall use the capacities defined in the current *Arapahoe County Master Transportation Plan* considering the surrounding area and roadway classification. These capacities have been defined as the maximum daily traffic volumes on roadways to achieve the established Arapahoe County LOS criteria.

E.9 Traffic Signal Needs and Access Locations

A traffic signal warrant study based on the *Manual on Uniform Traffic Control Devices (MUTCD)* shall be conducted for all arterial/arterial, arterial/collector, and collector/collector intersections within the study area for the opening year. If the warrants are not met for the opening year, they will be evaluated for each horizon year. Warrant analysis for additional years may be required, as determined by the Engineering Services Division.

Traffic signal progression is of paramount importance to roadway corridor capacity. Consequently, potential signalized intersections should not be placed any closer than at ½-mile intervals on arterials and at ¼-mile intervals on non-residential collectors. Signal separation will be measured from each road edge of right of way. Other locations will be considered based on progression analysis with the following criteria:

- Progression band width will be 40-second minimum in both directions,
- Cycle length will be 120 seconds or as directed by Engineering Services Division,
- Progression speed will be the speed limit of the study roadway,
- Minimum splits for left turns shall be 11 seconds,
- Minimum splits for through movements shall be 15 seconds, and
- Minimum yellow time shall be 3 seconds.

A time-space diagram for each analysis period shall be prepared and included in the appendix of the TIS if new signals or modifications are expected.

E.10 Safety Analysis

If directed by the Engineering Services Division, an analysis of three years of crash data shall be conducted to determine if the level of safety will deteriorate due to the addition of site traffic or if special traffic safety concerns may result in an increase in traffic crash rates for a roadway segment or intersection.

This section will identify traffic safety hazards in the area which may be adversely affected or created by the layout or traffic volumes of the project site. The evaluation of safety should consider such items as driveway approach grades, angles of road intersections, weaving and merging, pedestrian and bicycle crossings, and backing of vehicles. Potential traffic hazards affecting pedestrian and bicycle movements should also be identified.

E.11 Queuing Analysis

Queuing analyses will be completed to identify appropriate vehicle storage at all intersections within the study area. **The queuing analyses must indicate that vehicle storage will be provided for adequate storage in turn lanes 95 percent of the time during peak hours.** For closely spaced intersections or other complex analysis, micro-simulation of queuing characteristics during peak hours may be required.

If additional turn, acceleration, or deceleration lanes are recommended, include calculations for the length of the auxiliary lanes in Proposed Mitigation Measures section of report. See the Improvement Analysis section of these guidelines for further guidance.

E.12 On-Site Circulation

This section will identify the main circulation patterns within the site and focus on the site design elements that will minimize impacts to the County transportation network. Based on the type of land use, this will include discussions of design elements to reduce the potential for vehicular queues reaching external roadways, truck delivery routes and access, emergency access, pedestrian/bicycle crossings, access to adjacent developments, and the potential for cut through traffic. Parking locations and drive aisles within the site will also need to be considered in relation to any traffic signals and/or external intersections.

E.13 Improvement Analysis

The proposed improvements for the study area transportation facilities (including roadways, intersections, and multimodal infrastructure) required to mitigate the operational, safety, and physical impacts of the development shall be clearly identified within the Proposed Mitigation Measures section of the TIS. The mitigation measures shall ensure that the roadway or intersection will operate at a level of service (LOS) at or above the desired level of service thresholds established in the current *Arapahoe County Master Transportation Plan*. Where it is shown that a study area roadway or intersection will operate below the established LOS threshold in the horizon year(s) without the development, the traffic impact of the development shall be mitigated to provide the same LOS in the horizon year(s) with an increase in overall intersection vehicular delay of no more than 10%. A Proposed Improvements Summary Table shall list all proposed improvements, including who is responsible and the timing for each improvement.

E.13.a Level of Service

The roadways and intersections within the study area shall be analyzed with and without the proposed development to identify any projected impacts regarding level of service (LOS) and safety. The LOS and delay under each condition and horizon year shall be summarized for the overall intersection and each movement. The *Arapahoe County Master Transportation Plan* contains established LOS and associated delay thresholds for road segments and intersections by roadway classification and area type. **Where a roadway or intersection will operate at a LOS below the desired LOS thresholds established in the current *Arapahoe County Master Transportation Plan*, improvements which mitigate these impacts shall be identified as part of the study.**

If using the volume-to-capacity (v/c) ratio for the LOS evaluation of rural highways where signal controlled intersections are more than one mile apart, the capacity of the roadway shall be as defined in the current

Arapahoe County Master Transportation Plan considering the surrounding area and roadway classification. These capacities have been defined as the maximum daily traffic volumes on roadways to achieve the established Arapahoe County LOS criteria. Therefore, road segments with a v/c ratio greater than 1.0 operate below the established LOS threshold.

Where it is shown that a study area roadway or intersection will operate below the established LOS threshold in the horizon year(s) without the development, the traffic impact of the development shall be mitigated to provide the same LOS in the horizon year(s). At intersections, the traffic impact shall be mitigated with an allowable increase in overall intersection vehicular delay of no more than 10%.

Changes in the LOS and delay for individual intersection movements associated with the development shall be identified and discussed in the TIS. Mitigation requirements for impacts to intersection movements will be determined on a case-by-case basis.

Roundabouts may be considered at all locations under consideration for signalization. Refer to the *CDOT Roadway Design Guide* and *National Cooperative Highway Research Program (NCHRP) Report 672 – Roundabouts: An Informational Guide, Second Edition* for more information.

E.13.b Sight Distance

The intersection sight distance calculations shall be conducted at all project access and internal intersections. Sight distance shall be calculated based on the methods outlined in the latest version of the *Arapahoe County Infrastructure Design and Construction Standards*.

E.13.c Acceleration and Deceleration Lanes

Storage and taper lengths for acceleration and deceleration lanes shall be identified for the proposed lane configuration resulting from the queuing analysis at the study area intersections. In addition, all proposed development accesses shall be evaluated for required acceleration and deceleration lanes per the latest version of the *Arapahoe County Infrastructure Design and Construction Standards* and the most recent release of the Colorado Department of Transportation *State Highway Access Code* for those roadways classified as State Highways.

Acceleration and deceleration lane storage and taper lengths shall be based on the methods outlined in the latest version of the *Arapahoe County Infrastructure Design and Construction Standards*. All results should be rounded up to the nearest 25-foot interval. The minimum turn lane storage length shall be 50 feet.

E.13.d Multimodal Considerations

Pedestrian and bicycle connections are encouraged, and the location and circulation of these multimodal facilities should be identified. Design elements that will mitigate safety concerns with pedestrian/bicycle and vehicular conflicts, such as multi-use/shared-use path roadway crossings, should be discussed.

If transit use, pedestrian/bicycle connectivity, and/or Transportation Demand Management (TDM) actions are claimed as a trip reduction strategy, analytic support must be provided. Optimistic assumptions regarding transit use, pedestrian/bicycle volumes, and TDM actions will not be accepted unless accompanied by specific implementation plans that will become a condition of approval. Such implementation plans must have a reasonable expectation of realization within a five-year period after project initiation.

E.13.e Special Analysis/Issues

This section provides the County with opportunities to request specific traffic analyses relevant to the proposed development, such as access control, cut-through traffic and residential quality of life, event planning and management, safe routes to schools, emergency routes, or other conditions. This section may also contain environmental and regional air quality conformity analysis as necessary. Special conditions and analysis requirements shall be discussed at the Pre-Study Meeting.

Study Report Format (Outline)

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The TIS shall be typed, bound, and stamped by a Colorado-registered Professional Engineer with a background in traffic engineering. It shall contain a table of contents and lists of figures and tables. The TIS shall include the Arapahoe County Case Number (which will be given after the initial submittal) and report submittal dates on the cover sheet. These dates shall include the date of the original study submittal and each subsequent submittal.

It is incumbent on the Applicant to have all of the required data and information clearly identified in the appropriate sections of the report. It is very important that the information contained in the report be accurate and complete in every way. Text contained in the TIS shall discuss items as identified in these guidelines, be comprehensive and complete, yet be kept brief and to the point.

The TIS report shall follow this general outline and include the following figures and tables together with text as described above.

- Introduction/Project Description
 - Figure: Vicinity Map
 - Figure: Proposed Project Site Plan
- Existing Conditions
 - Figure: Existing Transportation Network and Traffic Volumes (daily & peak hour volumes)
 - Table: Existing LOS and Delay Summary (overall intersection & movements)
- Proposed Conditions
 - Site Trip Generation
 - Table: Trip Generation Summary (daily & peak hour trips)
 - Trip Distribution
 - Figure: Site Trip Distribution
 - Site Traffic Volumes
 - Figure: Projected Site Traffic Volumes (daily & peak hour volumes)
- Future Conditions
 - Background Traffic Volumes
 - Figure: Future Background Traffic Volumes (daily & peak hour volumes)
(Opening Year & Horizon Year(s), as applicable)
 - Total Future Traffic Volumes (background plus site traffic)
 - Figure: Total Future Traffic Volumes (daily & peak hour volumes)
(Opening Year & Horizon Year(s), as applicable)
- Traffic Evaluation
 - Level of Service (LOS)
 - Figure: LOS for Future Background Traffic Volumes (without Project)
(Opening Year & Horizon Year(s), as applicable)
 - Figure: LOS for Total Future Traffic Volumes (with Project)
(Opening Year & Horizon Year(s), as applicable)
 - Table: Future LOS and Delay Summary (overall intersection & movements)
 - Traffic Signal Needs and Access Locations
 - Safety Analysis
 - Queuing Analysis
 - On-Site Circulation
- Improvement Analysis
 - Roadway/Intersection Modifications
 - Figure: LOS for Total Future Traffic Volumes with Mitigation Measures
(Opening Year & Horizon Year(s), as applicable)
 - Table: Future LOS and Delay with Mitigation Measures Summary (overall intersection & movements)
 - Sight Distance
 - Acceleration and Deceleration Lanes
 - Table: Lane Storage and Taper Lengths

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- Multimodal Considerations
- Special Analysis/Issues
- Proposed Mitigation Measures
 - Table: Proposed Improvements (include who is responsible & timing for each improvement)
- Appendix
 - Traffic Impact Study Content Checklist – completed, signed and sealed
 - Pre-Study Summary Worksheet
 - Traffic Count Data (including vehicle classification and multimodal data, if applicable)
 - Lanes, Volume and Timing Report
 - Existing Signal Timing (sheets from maintaining agency)
 - Level of Service Analysis Reports (all horizon years and scenarios with and without Project) (input and output)
 - Time-Space Diagrams (if applicable, for any signal modifications or new signals)
 - Electronic files of input and output data

Acceptance

The Traffic Impact Study shall be submitted to the Department of Public Works and Development, Engineering Services Division for acceptance. TIS reviews will coincide with the associated land use documents, refer to planning workflows for additional details. The Engineering Services Division shall review the TIS for completeness and acceptance of the proposed mitigation measures. Written comments will be provided to the Developer or his/her authorized representative upon completion of any County reviews.

Once reviewed with no further comments, the County will request hard copies and an electronic portable document format (PDF) of the TIS with all tables and figures included in study. Once the hard copies and electronic document are received, the County Case engineer will issue a Letter of Acceptance for the TIS.

Traffic Impact Study Content Checklist

(See attached)

APPENDIX C – GUIDELINES FOR TRAFFIC CONTROL DURING CONSTRUCTION

GUIDELINES FOR TRAFFIC CONTROL DURING CONSTRUCTION

I. Introduction

For any construction done on, in, or to an existing County roadway and/or right-of-way, or for the construction of a new County roadway, appropriate traffic control during construction must be provided. For any such construction, a construction traffic control plan must be developed by the contractor and/or project engineer, and must be approved by the County Department of Public Works and Development, Engineering Division prior to issuance of a street cut permit or public improvement construction permit.

Where a roadway or pedestrian route does not currently exist, it is presumed that there is no motorist expectation of a travel route. A construction traffic control plan for construction of a new roadway should strive to alert the motorists and pedestrians that the road is not open to traffic. Construction traffic control plans must also be prepared for construction occurring on or in existing County roadways. Therefore, the motorist or pedestrian has an expectation of accessibility, and must be warned, advised, guided, or regulated through any construction activity.

II. Time of Submittal

A construction traffic control plan shall be submitted to the County, at earliest, with submittal of final construction plans and, or latest, with the application for street cut or public improvement construction permits. All final construction plans submitted to Arapahoe County that entail construction on, in, or to an existing County roadway or construction of a new County roadway must either:

1. Be accompanied by a construction traffic control plan, or
2. Include a note stating "A construction traffic control plan shall be submitted to Arapahoe County for approval before any permit for construction is issued. No street cut or public improvement construction permit will be issued without an approved construction traffic control plan.

III. Scope of Construction Traffic Control Plan

For construction of new roadways, traffic control during construction should strive to keep the motorist and pedestrians from entering the facility. The primary means to accomplish this are by use of temporary barricades, located in advance of the point where new construction joins old, and appropriate signing. New roadways shall not be open to general traffic, nor the construction traffic controls removed, without the approval of the Chief Engineering Inspector and the Traffic Engineer. One precondition of such an opening is that permanent signage and striping be in place.

For construction on or to an existing County roadway, the scope of the construction traffic control plan should bear a direct relationship to two items:

1. The nature and duration of the construction activity.
2. The nature of the roadway.

With respect to construction traffic control plans, projects should therefore be classified as minor or major, as follows:

1. Minor
 - a. Construction of a completely new roadway, where no travel way currently exists, or

- b. Construction on or to an existing roadway that does not entail either complete closure of the roadway, closure of one or more moving traffic lanes, or diversion of moving traffic lanes on arterials.
- 2. Major
 - a. Construction on or to an existing roadway that does not entail either complete closure of the roadway, closure of one or more moving traffic lanes, or diversion of moving traffic lanes on arterials.

IV. Elements of Construction Traffic Control Plan

- A. All construction traffic control plans shall contain the following information:
 - 1. Name of contracting firm, and (if different) the name of the firm responsible for traffic control devices.
 - 2. Name and phone number(s) of 24-hour contact person responsible for traffic control devices.
 - 3. Description of location of activity (roadway names, north arrow, etc.).
 - 4. Identification as “Minor” or “Major” project as defined above.
- B. For projects identified as minor, construction traffic control plans shall include, in addition to items listed in IV-A above, either one of the following:
 - 1. A neat sketch of the roadways and the proposed traffic control devices, or
 - 2. A copy of a “typical” schematic drawing of traffic device layout from an accepted source.
- C. For projects identified as major, construction traffic control plans shall include, in addition to items listed in IV-A above, the following:
 - 1. The proposed traffic control devices, specifically identified as to type, explicitly noted and dimensioned on as-builts, construction plan drawings, or other detailed drawing. This shall include all pedestrian detours.

V. Basis for Construction Traffic Control Plan

The Manual on Uniform Traffic Control Devices shall be the basis upon which the traffic control plan is designated, in concert with proper, prudent, and safe engineering practice. All necessary signing, striping, coning, barricading, flagging, etc., shall be shown on the plan. Other acceptable documents may be consulted or referenced, e.g. “Pavement Cuts for Utilities, A Guide for Their Management” (Arapahoe County PW & D), “Traffic Controls in Construction and Maintenance Work Zones” (FHWA), “Flagging and Traffic Control Supervisors Training Manual”(CDOH).

VI. Restrictions and Opportunities

In concept, County streets shall not be closed overnight, and work shall not force road or lane closures before 8:30 a.m. or after 3:30 p.m. (see Subdivision Regulations, Article VII, Section 1.5). If exceptions to this are required, this shall be so noted on the construction traffic control plan and must be specifically approved by the Director of Public Works and Development.

Travel way width may be restricted (minimum travel lane width in construction area can be 10 feet), but proper controls including flagging must be indicated. Prohibition of on-street parking should be considered, and noted where applicable.

VII. Approval

Staff of the County Public Works and Development/Engineering Division must approve (sign and date) all construction traffic control plans. In general, this responsibility rests with the P W & D Inspection Section. However, it is likely that most “major” plans will be referred to the Traffic Section for consideration. All complete road closures, and all partial road closures (removing one or more travel lanes) that are proposed for overnight, must be approved by the Director of Public Works and Development.

One copy of the approved plan shall remain with the Inspection Section, for their verification that the traffic control plan has been adhered to in the field. One copy shall be placed in the engineering case file. The contractor shall have one approved copy of the traffic control plan on-site at all times.

VIII. Modifications

Actual conditions in the field may necessitate modifications to the construction traffic control plan. Provided that the general intent of the original plan is satisfied, these modifications may occur without revision to the plan. The Inspectors shall be notified of any substantial changes, and may refer these to the Traffic Section as needed for consideration.

APPENDIX D – CONSTRUCTION SPECIFICATION TOLERANCES

**PUBLIC WORKS AND DEVELOPMENT/ENGINEERING DIVISION
ADMINISTRATIVE PROCEDURE DIRECTIVE 86-6**

Subject: Construction Specification Tolerances

Effected Area: Construction specification tolerances to be used for developer constructed streets.
To be used during the construction, probationary or final acceptance process.

Proposed By: Jeffrey L. Scott, Chief Engineering Inspector

Recommended By:

APPROVED:

Director, Public Works and Development

Date

CONSTRUCTION SPECIFICATION TOLERANCES

I. PURPOSE

Below is a construction specification tolerance list to aid in the construction of a subdivision improvement, and to provide technical guidelines for probationary and final acceptances by Arapahoe County Public Works and Development/Engineering Division. It is to be used by the owner/developer prior to any acceptance inspection for repairs or replacement of work to meet Arapahoe County standards and specifications. It will be used by Arapahoe County as guidelines during construction, probationary and final acceptances.

This list of construction specification tolerances are additions to the latest edition of the Colorado Department of Highways Standard Specification for Road and Bridge Construction, special provisions and revisions thereto and by the current subdivision regulations of Arapahoe County, Colorado.

II. TOLERANCES

- A. Curb, gutter and walk, crossspan, radii, etc.
 - 1. Any localized humps and or depressions greater than $\frac{1}{4}$ inch will require removal and replacement of the work in question.
 - 2. No ponding of water greater than $\frac{3}{8}$ inch shall be allowed.
 - 3. Combination curb, gutter and walk and/or vertical curb and gutter flowline depth shall not vary from adopted standards by more than $+\frac{1}{2}$ inch, measured vertically from the top of curb to the gutter invert.
 - 4. Pedestrian walks shall have a minimum of 1.0% and a maximum of 2.0% slope toward the roadway.
 - 5. Contraction and construction joints shall be placed at a standard spacing of 10 feet in curb, gutter, sidewalks, crossspans, trickle channel, etc. A minimum spacing of 5 feet will be allowed for repairs. Joints shall be less than $\frac{1}{2}$ " wide.
 - 6. Heave or settlement of sidewalk, relative to separate curb pour, greater than $\frac{1}{2}$ inch shall be cause for corrective action. This provision shall not apply to transverse sidewalk joints.

- B. Roadways
 - 1. Gravel Roadways
 - a) If a gravel surface is the final surface for the roadway or shoulder then the manholes, water valves, etc. shall be buried 6 inches + 1 inch below the final grade.
 - 2. Asphalt Roadways
 - a) All manholes, water valves, range boxes, etc. shall be $\frac{1}{2}$ inch to $\frac{3}{4}$ inch below the final paved grade. The finish grade of pavement shall be $\frac{1}{4}$ inch above the rim elevation with a two foot transition provided.
 - b) Any humps and depressions greater than $\frac{1}{4}$ inch in 5 feet as measured with a 10 foot straight edge shall be cause for corrective measures.
 - c) Additional asphalt thickness of up to $\frac{1}{2}$ inch will be permitted at the joint of the roadway and gutter pan and will be included in the actual asphalt thickness. Corrective action may be required for additional asphalt in excess of $\frac{1}{2}$ inch above

- the gutter pan be included in the asphalt thickness for acceptance purposes.
3. Concrete Roadways
 - a) All manholes, water valves, range boxes, etc. shall be flush to ¼ inch below the final surface roadway grade.
 - b) Where the departure from the design cross slope exceeds ½ inch in 10 feet the pavement shall be removed and replaced.
 - c) Areas showing high spots greater than 1/8 inch but less than ½ inch in 10 feet shall be ground to within 1/8 inch of design evaluation.

III. GENERAL SPECIFICATIONS

- A. Curb, gutter and walk, crossspans, radii, etc.
 1. No utility facilities shall be placed in curb, gutter or walk, crossspans, radii, etc. unless shown on the approved construction plans. This includes water stop box, manholes, power poles, fire hydrants, water valves, etc.
 2. Concrete Cracks
 - a) At the time of probationary acceptance inspection, the repair of cracks may be deferred if determined by Arapahoe County not to warrant immediate repairs.
 - b) At the time of final acceptance inspection, the repair of all cracks will be completed.
 - 1) Cracks that are less than ¼ inch wide, exhibit no horizontal or vertical shifting, and do not meet the conditions in 2), 3) and 4) below may, at the discretion of Arapahoe County, be sealed by routing approximately ¾ inch to 1 inch deep by ¼ inch wide and filling with Sikaflex 1-A or equal.
 - 2) Any crack that extends through a joint shall require removal and replacement of the entire cracked area.
 - 3) Any crack in a 4 inch thick walk will require removal and replacement of the entire cracked section between joints.
 - 4) Any longitudinal cracked section of concrete will require complete removal and replacement of that section between joints.
 - 5) Repair action for hairline cracks as determined in 1) above may be waived at the discretion of Arapahoe County. For the purpose of this section, a hairline crack is one that is reasonably immeasurable and without separation as determined by Arapahoe County.
 3. Final Grade
 - a) A light broom finish (not to expose the aggregate) to all concrete shall be required.
 - b) All concrete work shall have the proper finished grade. No reversal of the flow path will be accepted by Arapahoe County.
 - c) No abrupt changes in grade shall be allowed, i.e., curb returns from new to existing, driveway entrances, etc.
- B. Roadways
 1. Asphalt
 - a) All cracks in the asphalt shall be sealed with rubberized asphalt sealant approved by Arapahoe County, to include cracks or open sawed joints at patch areas (see Arapahoe County Department of Highways Procedure 85-13).
 2. Concrete
 - a) All construction, contraction and expansion joints shall be placed in accordance with the current Colorado Department of Highways Standards and Specifications M-412-

2.

- b) At the time of probationary acceptance inspection, the repair of cracks may be deferred if determined by Arapahoe County not to warrant immediate repairs.
- c) At the time of final acceptance inspection, the repair of all cracks will be completed.
 - 1) Cracks that are less than $\frac{1}{4}$ inch wide, exhibit no horizontal or vertical displacement and do not meet 2) and 3) below, can at the discretion of Arapahoe County, be sealed by routing approximately $\frac{3}{4}$ inch to 1 inch deep by $\frac{1}{4}$ inch wide and filling with Sikaflex 1-A or equal.
 - 2) Any crack from one section through another will require removal and replacement of both sections to beyond the extent of the crack.
 - 3) Any crack that intersects an expansion joint and/or a construction/contraction joint or any other combination will require removal and replacement of sections involved. Saw cuts to minimize removal may be approved by the Arapahoe County Inspection Section.
 - 4) Repair action for hairline cracks as determined in 1) above may be waived at the discretion of Arapahoe County. For the purpose of the above Sections, a hairline crack is one that is reasonably immeasurable and without separation as determined by Arapahoe County.
- d) All construction and contraction joints shall be sealed with rubberized asphalt sealant approved by Arapahoe County. (See Department of Highways Procedure 85-13 Sealant).

APPENDIX E - UTILITY LOCATE POTHOLE REPAIR PROCEDURE POLICY

UTILITY LOCATE POTHOLE REPAIR PROCEDURE POLICY

Exploratory test holes or potholes made to determine location of existing utilities are needed for companies that want to bore cables or install other utilities in Arapahoe County in order to avoid damaging existing utilities.

Permitee shall use the following procedure:

The potholes in the pavement may be temporarily repaired, meeting all applicable safety requirements for not more than seven (7) days as per Arapahoe County permit "Terms and Conditions".

I. Asphalt

All potholes in the pavement section shall be cored with a circular coring saw with a maximum diameter of ten inches (10"). The plug shall be removed carefully without damaging the saw cut edges of the asphalt.

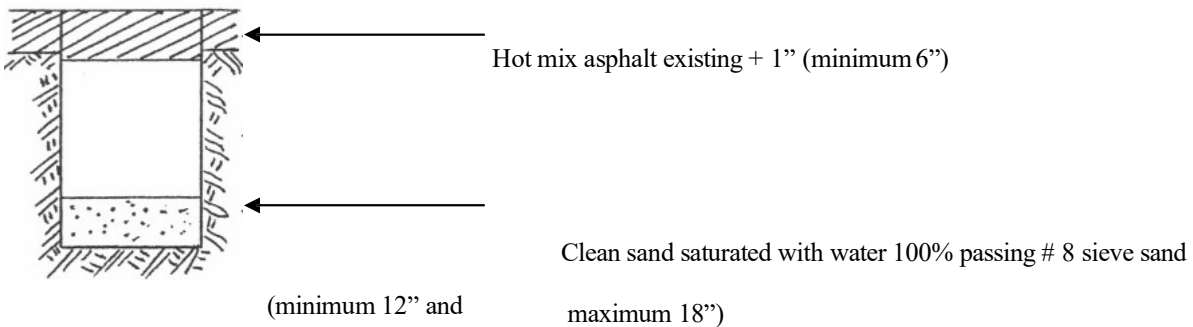
Larger exploratory holes will be reviewed on a case by case basis.

Potholes shall be backfilled with clean sand saturated with water 100% passing #8 sieve to one inch (1") below the existing thickness of the asphalt. **Native** material removed shall not be used to backfill the hole.

The pothole shall be patched with hot mix bituminous asphalt and compacted in a maximum of three (3) inch lifts using a pneumatic compactor (**pogo stick**) or equivalent compactor capable of fitting into the cored hole.

At Arapahoe County's discretion, localized **infrared** treatment may be required to blend the top mat of the asphalt together.

POTHOLE



II. Concrete

Damaged concrete pavement shall be removed and replaced as a **full** panel section extending to the existing joints. Partial section replacement shall not be permitted.

Concrete removed adjacent to asphalt pavements shall be saw cut along the material interface prior to removal. The concrete shall then be removed carefully without damaging the saw cut edge of asphalt.

The concrete (Class P), reinforcing, doweling and other materials shall be in accordance with CDOT standards. New concrete should meet or exceed original pavement strength.

Weather protection shall be provided in compliance with the CDOT Standards Specification Section 601.

III. Native Soil

Potholes made in native soil should meet the compaction requirements in accordance with Chapter 8.2 of Arapahoe County Infrastructure Design and Construction Standards.

Any damaged landscaping, lawns, shrubbery, trees hedges, walls, fences, etc. shall be replaced or restored prior to seven days after the completion of the job at the contractor's expense to the condition existing prior to the excavation.

Note:

Permitee is responsible for researching and locating all underground utility lines including storm sewer systems and related drainage facilities.

APPENDIX F - CONSTRUCTION DRAWINGS COMPLETENESS CHECKLIST



ARAPAHOE COUNTY

Construction Drawings Completeness Checklist

Yes No N/A Report Requirements

I. SECTION			
			1. Cover Sheet
			2. Arapahoe County Notes
			3. Existing Conditions and Demo
			4. Site and Horizontal Control Plan
			5. Overall Grading Plan
			6. Detailed Grading Plan
			7. Overall Utility Plan
			8. Roadway Plan & Profile
			9. Roadway Grading Details
			10. Storm Sewer Plan & Profile
			10. Detention/WQ Plan and Profile
			11. Detention/WQ Details
			12. Signing & Striping Plan
			13. Construction Details
			14. If applicable,
			a. Sanitary Sewer Plan & Profile
			b. Traffic Signal Plans & Details
			c. Trail Plan & Profile
			d. Irrigation & Landscape



ARAPAHOE COUNTY

Cover Sheet Completeness Checklist

Yes No N/A Report Requirements

I. SECTION			
			Project Legal Name (Subdivision, Filing, Lot , Block, Township, Range, Section, C
			Arapahoe County Standard Notes
			Approval Block (lower right)
			Sheet Index
			Vicinity Map
			North Arrow (top or right page orientation)
			Scale (1"=2000' Min)
			Size: 3" x 3"
			No Copyright
			Arterial Roadways Within 1 Mile
			Roadways Within Construction
			Major Drainageways
			Project Area Shaded
			Title Block (Along Right or Bottom Edge of Each Sheet)
			Project Name (Legal Name: Subdivision, Filing, Block, Lot, etc.)
			Engineer Seal & Signature
			Engineering Company (Name, Address, Phone)
			Date (Include Revision Dates For Resubmittals Until Release)
			Sheet Description & Number
			Project Datum/Basis of Bearings
			Arapahoe County Case Number (lower left)
			Design Engineer's Certification Statement
			Legend of Symbols
			Variance Summary Table (If Applicable)
			Contact Information
			Developer (Company, Address, Phone & Contact)
			Engineer/Surveyor (Company, Address, Phone & Contact)
			Arapahoe County Contacts (Company, Address, Phone & Contact)
			List of Public Utilities (Company, Address, Phone & Contact)
			Xcel/United Power
			Comcast
			CenturyLink
			Oil & Gas
			Fire District
			Water & Sanitation District
			List of Abbreviations
			Standard Construction Notes:



ARAPAHOE COUNTY

Cover Sheet Completeness Checklist

Yes	No	N/A	Report Requirements
			<p>1. The County - Stamp and Signature affixed to this document indicates the Department of Public Works and Development has reviewed the document and found it in general conformance with the Arapahoe County Subdivision Regulations or approved variances to those regulations. The County - through approval of this document, assumes no responsibility, other than stated above, for the completeness and/or accuracy of these documents. The owner and engineer understand that it is the policy and practice of Arapahoe County not to accept liability for facilities designed by others. The responsibility for the engineering adequacy of the facilities depicted in this document lies solely with the Registered Professional Engineer whose stamp and signature are affixed to this document.</p>
			<p>2. All roadway construction shall conform to the Arapahoe County Infrastructure Design and Construction Standards.</p>
			<p>3. All materials and workmanship shall be subject to inspection by the Arapahoe County Department of Public Works and Development. The County reserves the right to accept or reject any such materials and workmanship that does not conform to its standards and specifications.</p>
			<p>4. The contractor shall notify the Arapahoe County Department of Public Works and Development Inspection Section at 720-874-6500, a minimum of 48 hours and a maximum of 96 hours prior to starting construction.</p>
			<p>5. The contractor shall verify the location of existing utilities prior to actual construction. For information dial 811 or 800-922-1987 or through a website: www.co811.org</p>
			<p>6. The contractor shall have one (1) signed copy of the plans (approved by the Department of Public Works and Development) and one (1) copy of the Infrastructure Design and Construction Standards at the job site at all times.</p>
			<p>7. A plan for traffic control during construction shall be submitted to Arapahoe County for approval with the permit application. A Street Cut and Right of Way Use Permit or Public Improvement Construction Permit will not be issued without an approved traffic control plan for traffic control during construction.</p>
			<p>8. These construction plans shall be considered valid for a period of two (2) years from the date of County acceptance, after which time these plans shall be void and will be subject to additional review and acceptance by Arapahoe County.</p>



ARAPAHOE COUNTY

Cover Sheet Completeness Checklist

Yes	No	N/A	Report Requirements
			<p>9. Contractor shall notify the Arapahoe County Engineering Inspection Section when working outside of the public right-of-way on a facility, which will be conveyed to the County, MILE HIGH FLOOD DISTRICT, or other special district for maintenance (storm sewer, energy dissipaters, detention pond outlet structures, or other drainage infrastructure). Failure to notify the Engineering Inspection Section to allow for inspection of this construction may result in non-acceptance of the facilities by the County.</p>
			<p>10. The developer and/or the contractor shall submit all soils verification testing and final pavement reports prior to paving. Installation of the top lift of paving shall be installed prior to issuance of any applicable building permits.</p>
			<p>11. The owner/developer is responsible to obtain or acquire, by fee-simple, easement or by other written agreement, all necessary property rights needed to for temporary or permanent use or improvement of any land owned by adjacent property owner(s) prior to any off-site grading or construction.</p>
			<p>12. It is the responsibility of the Engineer of Record to accurately represent existing conditions, both on-site and off-site, on the construction plans. Any corrections or modifications to the approved plans and project work needed due to conflicts, errors and omissions, and/or changed conditions, either on-site or off-site, which arise during construction shall be considered the sole responsibility and expense of the Developer to remedy. All corrections and modifications shall be in conformance with County Standards.</p>
			<p>13. Paving of public roadways and private streets shall not start until a pavement design is approved by the County.</p>
			<p>14. All signage and striping shall be in accordance with the Manual on Uniform Traffic Control Devices, and any approved signing and striping plans, unless otherwise noted and/or approved by Arapahoe County in advance of installation.</p>
			<p>15. The contractor shall coordinate with the respective utility companies prior to removal and/or relocation of utilities. The contractor shall coordinate with the utility company concerning portions of work which must be performed by the utility company's forces.</p>



ARAPAHOE COUNTY Cover Sheet Completeness Checklist

Yes	No	N/A	Report Requirements
			16. The contractor shall not deviate from the plans without first obtaining written approval from the owner and the design engineer. The contractor shall contact the design engineer immediately upon discovery of any errors or inconsistencies.
			17. The contractor is responsible for the safety of all personnel, site visitors, and the traveling public who may be impacted or affected by the construction.
			18. The contractor shall be responsible for protecting existing facilities from damage caused during the performance of the work. Any damage to existing facilities shall be repaired by the contractor to equal or better conditions to the satisfaction of the County. It shall be the Contractors sole responsibility to document existing conditions prior to the commencement of construction.
			19. The contractor shall take all reasonable precautions preserve and protect all existing landscaping and irrigation not identified on the plans for removal and/or restoration. The contractor shall restore, repair, and replace-in-kind all landscaping and irrigation disturbed, damaged, or otherwise affected by the work at their sole expense to the satisfaction of the County.
			20. Arapahoe County requires a pre-construction, project kick-off meeting with all parties, after construction contract award, to discuss the project scope, schedule, traffic control, inspection requirements, communication with the public, process for dealing with complaints, and other construction related matters pertinent to the work. Please contact Engineering Services Inspector at (720) 874-6500 to coordinate this meeting.
			21. As-built drawings are required after probationary acceptance by the County



ARAPAHOE COUNTY

Existing Conditions/Demo Plan Checklist

Yes No N/A Report Requirements

I. GENERAL INFORMATION			
			Title Block (Along Right Edge of Each Sheet)
			Project Name (Legal Name: Subdivision, Filing, Block, Lot, etc.)
			Engineer Seal & Signature
			Engineering Company (Name, Address, Phone)
			Date (Include Revision Dates For Resubmittals Until Release)
			Sheet Description & Number
			North Arrow
			Scale
			Approval Block (lower right)
			Arapahoe County Case Number (lower left)
			Key Map
			Min 1"=500'
			Roadway Names
			North Arrow
			Legend of Symbols
			Existing Utilities (water, sanitary, storm, gas, telephone, irrigation ditches, drainageways, etc.)
			Existing Improvements (curbs, sidewalks, pans, concrete/asphalt, etc.)
			Existing Structures (walls, buildings, RTD pads/stops, etc.)
			Existing Grading
			Property Lines (Label Properties w/in & Adj to Site)
			Ex. Street Names
			Ex. Right-Of-Way (w/ Width)
			Easements w/ Width Dimensions
			Identify items "to be removed"
			Services & Utilities to be Removed &/or Abandoned
			Define Approx./Anticipated Concrete/Asphalt Removal Limits
			Signage & Striping Removals/Relocations



ARAPAHOE COUNTY Grading Plan Checklist

Yes No N/A Report Requirements

I. GENERAL INFORMATION

			Title Block (Along Right Edge of Each Sheet)
			Project Name (Legal Name: Subdivision, Filing, Block, Lot, etc.)
			Engineer Seal & Signature
			Engineering Company (Name, Address, Phone)
			Date (Include Revision Dates For Resubmittals Until Release)
			Sheet Description & Number
			North Arrow
			Scale
			Approval Block (lower right)
			Arapahoe County Case Number (Lower Left)
			Key Map
			Min 1"=500'
			Roadway Names
			North Arrow
			Legend (Line types, hatching, & symbols)
			Project Datum/Basis of Bearings
			Location & Elevation of County or USGS Benchmarks
			Boundary/Property/ROW/Tract Lines/Easements (Existing & Proposed)
			Label properties (Filings, Lots, Etc.) w/in & Adj to Site
			Label ROW & Easement Widths
			Site & Adjacent Infrastructure w/in 150' (Existing & Proposed: Roadways, Parking Lots, Etc.)
			Curb, Flowline, Gutter Lip, Sidewalk, Cross-pans, Medians, Etc.
			Structures w/in 150' (Existing & Proposed: Bldgs., Fences, Retaining Walls, Utility Boxes, Etc.)
			Existing Utilities (Water, Sanitary Sewer, Etc.)
			Existing Trees & Areas/Vegetation to be Protected
			Existing and Proposed 100 Year Floodplain Limits (FHAD, FEMA, other 100yr)

II. GENERAL GRADING



ARAPAHOE COUNTY Grading Plan Checklist

Yes	No	N/A	Report Requirements
			Existing & Proposed Contours (2' min, Minor & Major Differentiated)
			Proposed Contours Tie Into Existing
			Contours (100' outside boundary)
			Limits of Grading/Disturbance (Including borrow and stockpile areas)
			Detention/WQ Pond (Provide Detention Pond Plans for Detail - See Detention Pond Cklist)
			Max WSE & Limits
			Maximum & Minimum Slopes
			3:1 Maximum (> 4:1 requires Erosion Control Blankets)
			Excessive in Height Should be Evaluated by a Geotech (10' or more)
			Slope from ROW to Back of Curb (Typical 2% Min - 5% Max Toward Street)
			Concrete FL's Slopes (1.0% min)
			Positive Flow in Landscaped Areas (Min 2%)
			Identify Swales/Ditches
			Setback Dimensions (Horizontal Distances Perpendicular to Site Boundary)
			Provisions for the control of surface waters
			Identify Protection of Adj Structures
			Flow Direction Arrows
			High/Low Pts. (Spot Elevations)
			Irrigation Ditches
			Retaining Walls (Proposed & Existing)
			Top of Wall & Bottom of Wall (@ finished grade)
			Tiered Walls Have Proper Separation (to not act as a single wall)
			Greater than 4' in Height from the bottom of the footing - Requires Separate Design & Approvals (Provide note on plans)
			Walls & Reinforcement Outside of ROW & Easements
			No Retaining Walls at or below EURV in Drainageways/facilities (TYP)
			Sidewalks & Trails (Proposed & Existing)
			Proposed 2% Max. Cross Slope and meets ADA requirements
			Railings are provided at all drops 30-inches or greater



ARAPAHOE COUNTY Grading Plan Checklist

Yes	No	N/A	Report Requirements
			Shoulder on trails per Arapahoe County Bicycle and Pedestrian Design Guide,
			The design for Trails should follow Arapahoe County Bicycle and Pedestrian
			The design for Sidewalk should be based on the roadway classification - See
			Residential (SFD/Duplex Lot) - Overlot Grading
			Spot Elevations at Lot Corners
			No More Than 1 Lot Drains To Another
			Tracts & ROW Do Not Drain To Lots
			Clogged Sump Inlet WSE & Limits (W/in & adj to residential only)
			No Impact to Residential Lots
			Sump Inlet Emergency Overflow Spillway(s)
			Flow path Grading Defined & Marked
			Sump Overflow X-Section(s) - Dimensions, Slopes, Flow Depth, Freeboard
			Ditches, Swales, Channels/Drainageways, Overflows, & Facilities Outside of Lots
			Need Finished Floor Elevations
III. COMMERCIAL, MULTI-FAMILY, OTHER - SITE DETAILED GRADING			
			Parking Lot C&G - All Critical Points (PC's, PT's, PCR's, Angle Pt's, Grade Breaks, HP's, LP's)
			Finished Floor Elevations
			Finish Grade Elevations At/Around Structures/Buildings (Proposed and ex. to remain)
			Slopes Along Building/Structures (Perpendicular & parallel to bldg.)
			Grade Breaks (Max 1% Diff)
			Parking Lot & Drive Aisle
			Longitudinal Slopes (7% max, Parking Adj - 5% Max, 1.0% min)
			2% max ADA access aisles & stalls
			Driveway/Access Information
			Cross Slopes (4% max)
			Commercial/Non-Residential Driveway ROW Approach 4% Max for 50'
			Provide Plan & Profiles Where Necessary (See Roadway Plan & Profile Cklist)



ARAPAHOE COUNTY Grading Plan Checklist

Yes	No	N/A	Report Requirements
			Walks Elev & Grades (5% maximum or 8.33% w/landings & handrail, 2% max cross slopes)
			Critical Point Elevations (PCR, PT, PC, PCC, FLPI, HP, & LP)
			Ditches, Swales, Channels/Drainageways, Overflows, & Facilities w/in Easements
			Inlet Ponding Limits & WSE's (Non-Residential Sites/Roadways)
IV. DRAINAGE			
			Drainage Infrastructure (Existing & Proposed)
			Inlets - Size, & Type (& # if proposed)
			Drainage Pipes - Size & Type
			Manholes - Size (& # if proposed storm sewer)
			Roadside Ditches
			Typical Cross Section(s)
			Ditch Depth, Width
			Flow Depth, 1' Freeboard, Q5 5ft/s Max
			Side slopes 3:1 max
			Swales (Proposed & Existing) - Provide Plan & Profile if Necessary
			Typical Cross Section(s) (Sections at regular intervals may also be required)
			Depth, Width, 1' Freeboard
			Flow Depth, 1.0' Freeboard
			Bottom Width (2' Min)
			Side slopes 4:1 max



ARAPAHOE COUNTY

Roadway Detailed Grading Checklist

Yes No N/A Report Requirements

I. GENERAL INFORMATION

			1. Title Block (Along Right Edge of Each Sheet)
			a. Project Name (Legal Name: Subdivision, Filing, Block, Lot, etc.)
			b. Engineer Seal & Signature
			c. Engineering Company (Name, Address, Phone)
			d. Date (Include Revision Dates For Resubmittals Until Release)
			e. Sheet Description & Number
			2. Key Map
			a. Min 1"=500'
			b. Roadway Names
			c. North Arrow
			3. North Arrow
			4. Scale (20:1 or Larger)
			5. Approval Block (lower right)
			6. Project number in lower left
			7. Legend (Line types, hatching, & symbols)
			8. Project Datum/Basis of Bearings
			9. Location & Elevation of City or USGS Benchmarks
			10. Street Names (w/in & Adjacent to the site)

II. TYPICAL

			1. Curb Type (Catch & Spill)
			2. Street Names (w/in & Adjacent to the site)
			3. R-O-W, Easements, & Property Lines
			4. Inlets (#, STA, OS, & ELEV)

III. ROADWAY INTERSECTION GRADING

			1. CL & FL Grades (Through Street & Approach)
			2. Intersection Approach - Cross Slopes, CL STA and CL & FL/Lip ELEV (OS as needed)
			a. At 25' Min Intervals Up to TYP Crown
			3. Critical Point STA/EL PC's, PCC's, PT's, PCR's, FLPI's, HP's, & LP's (w/in Detail Limits)
			4. Detailed Curb Returns (Spot Elevations & Slopes)



ARAPAHOE COUNTY

Roadway Detailed Grading Checklist

Yes	No	N/A	Report Requirements
			5. Ramp (Center Point Top & Bottom ELEV, and Center Point STA)
			6. See Section 4.6.6 for additional intersection requirements
IV. CUL-DE-SAC/ROUND-ABOUT/KNUCKLE GRADING			
			1. Define Critical Points STA/EL (OS & STA Equations Where Applicable)
			2. Outer Curb Return &/or Curve FL Profile (VC/GB Info)
			3. Minimum 1% FL Grade
			4. 2% Crown to Cul-de-Sac Midpoint (CL STA/EL to FL/Lip EL)
			5. Typical 2% X-Slope to Round-About Island (CL STA/EL to FL/Lip EL)
			6. Min 2% from Roadway CL to Outer FL
V. MISCELLANEOUS (ANCILLARY ROADWAY REQUIREMENTS)			
			1. Driveway/Access Details
			2. Construction & Tie-in Info (Slopes, Material Types, Contours, EL's, Width/Length, Etc.)
			3. Curb Return Details or Profiles (Typically N/A to returns at x-pan locations)
			a. FL/STA Eqns, Critical Point/Grade Break EL's, FL Slopes



ARAPAHOE COUNTY

Roadway Plans and Profiles Checklist

Yes No N/A Report Requirements

I. GENERAL INFORMATION

			Title Block (Along Right Edge of Each Sheet)
			Project Name (Legal Name: Subdivision, Filing, Block, Lot, etc.)
			Engineer Seal & Signature
			Engineering Company (Name, Address, Phone)
			Date (Include Revision Dates For Resubmittals Until Release)
			Sheet Description & Number
			North Arrow
			Approval Block (lower right)
			Project Case Number on Lower Left
			Key Map
			Min 1"=500'
			Roadway Names
			North Arrow
			Legend (Line types, hatching, & symbols)
			Project Datum/Basis of Bearings
			Location & Elevation of City or USGS Benchmarks
			Street Names (w/in & Adjacent to the site)

II. PLAN VIEW

			Scale (1:50 Min)
			Roadway Notes
			Typical Roadway Cross-sections
			R-O-W (Min Per Typical Details), Easements, Property Lines
			Roadway Infrastructure (Existing & Proposed)
			Pavement Limits, Sidewalks, C&G (TBC, FL, & Gutter Lip), X-pans, Etc.
			Bridges, Culverts, Guard Rails
			FL - FL Width
			SW Width/Offset (Max & Min)
			Drainage Inlets #, STA, OS, & TFI ELEV's (Match profile & drainage report)



ARAPAHOE COUNTY

Roadway Plans and Profiles Checklist

Yes	No	N/A	Report Requirements
			Corresponds to LP EL & STA
			Verify Design Location & Capacity Intersection Approaches & Crown Transitions
			Verify Size Against Report
			Drainage Manholes & Pipe (To scale)
			Centerline Alignment
			Tangent Info (Bearing/Distance)
			Curve Information (R, L, CB, CD, & Delta)
			Verify Min Approach Tangent, Reverse Curve Tangent, Radii, Etc.
			Roadway Intersections & Driveways
			Provide CL STA Eqn (w/ N&E & EL) For All Roadway Intersections
			Provide CL STA/EL/OS for all Driveways/Access Points (Single Family Residential N/A)
			Intersection Station Equations (w/ Northings & Eastings)
			100' Approach Tangents (Verify SSD at Collector & Arterial Intersections)
			Verify Access Separation
			Thru Lanes must Align & Match Configuration Across Intersections
			Survey Line Ties to Section or Quadrant Corners (Consistent w/ Final Plat)
			Signals, Ped Poles, & Signal Boxes
			Critical Points - CL STA, CL or FL ELEV, OS (As applicable)
			PC's, PCC's, PT's
			PCR's & FLPI's
			LP's, HP's
			Curb Return Info (Curve table - length, delta, radii)
			Curb Return Profile/Details (In plan view or on referenced supplemental sheets)
			Median Cover (Parkway, arterial streets, & alt sections) - Identify Type & Define Limits
III. PROFILE GRADES			
			Define Median (Separate median plan sheets If needed for plan clarity)



ARAPAHOE COUNTY

Roadway Plans and Profiles Checklist

Yes	No	N/A	Report Requirements
			Radii
			Station, Elevation, & Offset
			Identify Median Trench Drain Location, Cleanouts, & Outfall Connections
			Curb Ramp Locations (CL STA/EL/OS at mid-point)
			Cross-pans
			Only @ Downgrades Intersecting a Through Street
			Only @ Stop Conditions
			Not on Arterial & Not At Signalized Intersections
			Not Across Collectors
			Define Roadway & FL Transitions (Applicable STA, ELEV, OS, & Radii)
			Atypical Sections, Parking Pull-Outs, Cul-de-sacs, Knuckles, Turn-arounds, Etc.
			Acceleration/Deceleration Lanes
			Lane Shifts/Redirect Tapers
			Acceleration/Deceleration Turn Lanes (Verify length to match traffic reports)
			Storage/Length (Per CO State Access Code and approved Traffic Study)
IV. PROFILE VIEW			
			Vertical and Horizontal Grids with Scales (1"=5' vertical min, 1"=50' horizontal max)
			Existing Ground
			Intersection Approach Grades & Distance
			End Points (STA./Elevation)
			Roadway Cross Slopes (2% Normal Crown Typ., Super Elevation as necessary)
			Slope of the Profile
			Vertical Curves
			VPI, VPC, & VPT's
			K Value
			Length
			Low Point/High Points



ARAPAHOE COUNTY Roadway Plans and Profiles Checklist

Yes	No	N/A	Report Requirements
			Verify Sump Depth vs. Drainage Report
			Superelevation Diagram (If Applicable)
V. MISCELLANEOUS (ANCILLARY ROADWAY REQUIREMENTS)			
			Typical Roadway Section Info
			R-O-W, FL-FL, C&G, & Sidewalk (Width & Offset)
			Applicable Station Ranges
			Easements (Transportation & Utility if Applicable)
			Roadway Cross Slopes (2% Normal Crown Typ., Super Elevation as necessary)
			Landscape Area Cross Slope (TBL to R-O-W, 2% min, 5% max.)



ARAPAHOE COUNTY

Horizontal Control Plan Checklist

COMMERCIAL OR PARKING AREAS (e.g. multifamily)

Revised March 2024

Yes No N/A Report Requirements

I. GENERAL INFORMATION TITLE BLOCK (ALONG RIGHT EDGE OF EACH SHEET)

			Project Name (Legal Name: Subdivision, Filing, Block, Lot, etc.)
			Engineer Seal & Signature
			Engineering Company (Name, Address, Phone)
			Date (Include Revision Dates For Resubmittals Until Release)
			Sheet Description & Number
			North Arrow
			Scale
			Approval Block (lower right)
			Case Number (lower left)
			Key Map
			Min 1"=500'
			Roadway Names
			North Arrow
			Legend of Symbols (or master)
			Boundary
			Survey Line Ties to Section or Quadrant Corners (Consistent w/ final plat)
			Basis of Bearings
			Property Lines & Dimensions (Tangent & curve information)

II. SITE SURFACE IMPROVEMENTS

			Infrastructure (C&G, sidewalks, driveways, ramps, x-pans, etc.)
			Structures (Buildings, walls, fences, etc.)
			Adjacent Improvements/Structures (Roadways, parking lots, buildings, etc.)
			Boundary/Property/ROW/Tract Lines/Easements (Existing & Proposed)
			Label ROW & Easement Widths
			Drive Aisle Widths
			Parking Stall Dimensions



ARAPAHOE COUNTY
Horizontal Control Plan Checklist
COMMERCIAL OR PARKING AREAS (e.g. multifamily)

Revised March 2024

Yes	No	N/A	Report Requirements
			Sidewalk Widths
			Cross Pan, Valley Pan, & Chases Widths
			Opposite Corners of Building Envelope Tied to Boundary (N&E OK)
			Parking Lots & Private Drives (Curb Lines - Line & Curve Table Acceptable)
			Tied to Boundary (N&E OK, FL or TBC Referenced)
			Island Tie-downs
			Tangent Sections Lengths (& Bearings if not parallel to boundary)
			Curve Information (R, L, CB, CD, & delta)
			Existing and Proposed 100 Year Floodplain Limits (FHAD, FEMA, other 100yr) and call out the source of designation



ARAPAHOE COUNTY WCF Submittal Checklist

Revised March 2024

ARAPAHOE COUNTY
COLORADO'S FIRST

Yes No N/A Report Requirements

I. GENERAL INFORMATION

			Engineering Review and Approval Form
			Construction Document
			Clear Zone Analysis
			Review fee
			Building Permit - separate submittal
			Street Cut ROW Use Permit - separate submittal
			License Agreement (to be provided by County with first round of comments)

II. POLE LOCATION

			Confirm with all utility districts for any crossing restrictions
			Confirm location does not obstruct, impede, or hinder pedestrian or vehicular traffic
			Avoid planned roadway improvements/ development/ bike path
			Avoid drainage constraints (swale, roadside drainage, drainage easement)
			Preferably close to corner of two intersecting streets or closest to common side yard property line between adjacent adjoining properties
			Not to be located within 300' radially from an existing freestanding Small Cell
			Not to be located along the frontage of a historical landmark
			Not to be located in a manner that obstructs an adjacent property
			Not to be located in a valuable sightline of an adjacent property (window of a residence, mountain view, etc.)
			In alignment with existing street trees, utility/ street light poles
			Minimum 15' from existing trees so as not to disturb the root zone
			Minimum 5' from low pressure gas line or 15' from high pressure gas line

III. CONSTRUCTION DOCUMENT

			Cover Sheet
			Arapahoe County Case NO.
			Pole title, name, location, information, and photograph of the proposed location of pole
			Standard notes



ARAPAHOE COUNTY WCF Submittal Checklist

Yes No N/A Report Requirements

			Vicinity map with scale
			Project description
			Contact information including representative name, address, telephone number
			Sheet index
			PE stamp
			UNCC/811 Call Before You Dig
			An approval block, as shown in Figure 3.1 of the Arapahoe County IDCS shall be placed in the lower, right hand corner
			Location Map
			Proposed pole location on Arapamap background
			ROW lines, property lines
			Adjacent property owners and/or easements
			Streetnames, floodplain, parks
			Distance to back of curb, sidewalk, ROW
			Latitude and longitude of pole location
			Existing utilities including dry utilities, stormline, waterline, sewerline
			Existing vegetation
			Existing signage
			Sight triangles
			Proposed vault and route to power source



ARAPAHOE COUNTY WCF Submittal Checklist

ARAPAHOE COUNTY
COLORADO'S FIRST

Revised March 2024

Yes No N/A Report Requirements

			Elevation Plan
			Labeled and dimensioned
			Depth and diameter of foundation
			Pole dimension and height
			Distance to back of curb, sidewalk, ROW
			Existing vegetation
IV. CLEAR ZONE ANALYSIS			
			Arapahoe County Case NO.
			Vicinity map
			PE stamp
			Project description
			Clear Zone Parameters - see AASHTO Roadside Design Guide for recommended clearances based on speed, traffic volume, and roadside conditions
			Breakaway connection description if required
			Elevation Plan with distance to back of curb shown
			Site Plan with distance to back of curb shown
			Conclusion paragraph
			Photo simulation of pole at proposed location

APPENDIX G - TRAFFIC SIGNAL DESIGN STANDARD AND SPECIFICATIONS

STANDARD SIGNAL DESIGN

SHEET NO. CONTENTS

1	GENERAL NOTES, LEGEND, AND LIST OF MATERIALS
2	TYPICAL INTERSECTION LAYOUT
3	TYPICAL TRAFFIC SIGNAL MAST ARM DETAILS
4	POLE FOUNDATION DETAILS
5	PULL BOX DETAILS – ELECTRICAL
6	PULL BOX DETAILS – ITS
7	LOOPS AND CONDUIT TRENCH DETAILS
8	TRAFFIC CABINET DETAILS
9	PEDESTAL POLE AND FLASHING BEACON ASSEMBLY DETAILS
10	MISCELLANEOUS DETAILS



ARAPAHOE COUNTY

REVISIONS			
NO.	DATE	DESCRIPTION	
	11/2024	ORIGINAL	
ARAPAHOE COUNTY, COLORADO <small>DEPARTMENT OF PUBIC WORKS AND DEVELOPMENT</small>			
STANDARD SIGNAL DESIGN			
INDEX OF SHEETS			
<small>PROJECT NO.</small>	<small>DATE:</small>	<small>DESIGNED BY:</small>	<small>JOB NO.</small>
<small>PROJECT NAME:</small>	<small>SCALE:</small>	<small>DRAWN BY:</small>	<small>SHEET NO.</small> <small>INDEX</small>

GENERAL NOTES

- ALL TRAFFIC SIGNAL INSTALLATIONS AND MATERIALS SHALL MEET THE REQUIREMENTS OF THE PROJECT SPECIAL PROVISIONS, LATEST EDITIONS OF FEDERAL HIGHWAY ADMINISTRATION "THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES," COLORADO DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION," COLORADO DEPARTMENT OF TRANSPORTATION "LIGHTING DESIGN GUIDELINES," THE "NATIONAL ELECTRIC CODE," AND ALL OTHER ORDINANCES WHICH APPLY.
- THE LOCATION OF EXISTING UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION AND SHALL CONFORM TO COLORADO DEPARTMENT OF TRANSPORTATION SUBSURFACE UTILITY ENGINEERING (SUE) REQUIREMENTS. CONTACT COLORADO 811 AT LEAST 2 BUSINESS DAYS PRIOR TO STARTING CONSTRUCTION (NOT COUNTING THE DAY OF THE CALL).
- TRAFFIC SPAN WIRE POLES, SIGNAL POLES AND MAST ARMS SHALL BE DESIGNED TO MEET THE REQUIREMENTS OUTLINED IN THE "STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS," LATEST EDITION, PUBLISHED BY AASHTO, FOR A WIND VELOCITY OF 100 MPH. SHOP DRAWINGS SHALL BE SUBMITTED INDICATING CONFORMANCE WITH THE AASHTO 100 MPH REQUIREMENTS.
- ALL POLES, PEDESTALS, AND CABINETS SHALL BE PLACED A MINIMUM OF 3 FEET BACK FROM THE FACE OF THE CURB AWAY FROM THE ROADWAY. PRECISE LOCATION SHALL BE DETERMINED BY THE ENGINEER IN THE FIELD. POLES SHALL BE INSTALLED SO THAT THEY WILL BE PLUMB WHEN DEFLECTED BY THE INSTALLED LOAD.
- THE CONTRACTOR SHALL VERIFY THE LOCATION OF EXISTING UTILITIES PRIOR TO ACTUAL CONSTRUCTION.
- POLE FOUNDATIONS SHALL BE CLASS BZ WITH ENTRAINED AIR AS SPECIFIED IN THE LATEST EDITION OF THE "COLORADO DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OR AS SPECIFIED IN THE PROJECT SPECIAL PROVISIONS. ALL EXPOSED CONCRETE SURFACES SHALL BE FORMED, TROWELED, AND FINISHED TO PRESENT A NEAT APPEARANCE. STRUCTURE BACKFILL (FLOW-FILL) SHALL BE USED FOR CONDUIT TRENCH BASE FILL WITHIN PAVEMENT AREAS. TRENCHING WITHIN PAVEMENT MUST BE APPROVED BY ARAPAHOE COUNTY.
- ALL ELECTRICAL SYSTEMS SHALL BE PROPERLY GROUNDED IN ACCORDANCE WITH NATIONAL ELECTRIC CODE.
- ALL POLES AND ARMS SHALL BE HOT DIPPED GALVANIZED INSIDE AND OUTSIDE AFTER FABRICATION IN ACCORDANCE WITH ASTM A123, UNLESS PAINTING IS CALLED FOR ON THE PLAN. PAINTING SHALL CONFORM TO CDOT STANDARD SPECIFICATIONS SECTION 522 - DUPLEX COATING SYSTEMS. POLES AND MAST ARMS SHALL HAVE A POWER COAT FINISH. COLOR SHALL BE PROJECT DEFINED TOWARDS CONFORMANCE WITH ADJACENT SIGNALS. POLES AND ARMS SHALL INCLUDE ALL STEEL STRUCTURES INCLUDED IN THE PROJECT, INCLUDING PEDESTAL POLES, PEDESTRIAN POLES, AND PEDESTRIAN PUSH BUTTON POLES AND STATIONS.
- UNLESS OTHERWISE NOTED AND APPROVED BY ARAPAHOE COUNTY, PEDESTAL POLES SHALL BE 4" SCHEDULE 80 SPUN ALUMINUM PIPE.
- ALL SIGNAL HEADS SHALL BE THE POLYCARBONATE TYPE, BLACK IN COLOR.
- ALL OVERHEAD VEHICULAR SIGNAL HEADS SHALL HAVE ALUMINUM LOUVERED BACKPLATES WITH 3" WIDE 3M FLUORESCENT YELLOW DIAMOND GRADE RETROREFLECTIVE BORDER.
- ALL SIGNAL INDICATIONS SHALL BE "DIALIGHT," "GELCORE," OR APPROVED EQUIVALENT.
- WHERE AN OVERLAY IS PART OF THE WORK, ALL LOOP DETECTOR WIRE MUST BE IN PLACE BEFORE THE FINAL LIFT OF HOT BITUMINOUS PAVEMENT IS PLACED.
- WITH THE EXCEPTION OF LOOP DETECTOR SPLICES, ALL WIRE CONNECTIONS AND SPLICES SHALL BE MADE IN THE POLE BASES, CABINETS, SIGNAL FIXTURES, OR NEMA 3R OR NEMA 4 SURFACE MOUNT PULL BOXES AS APPROVED BY THE SYSTEMS MANUFACTURER, AND BE ABOVE GROUND LEVEL. LOOP DETECTOR SPLICES SHALL BE MADE WITHIN PULL BOXES BEHIND THE CURB AT SIDE-OF-ROAD AND SHALL BE MADE USING MANUFACTURED WATERTIGHT SPLICES.
- MOUNTING HARDWARE, SPACERS, TRUNNIONS, ETC. FOR EACH TRAFFIC SIGNAL SHALL BE FURNISHED BY THE MANUFACTURER, INCLUDING POLE PLATES FOR SIDE POLE MOUNTING.
- IN MAST ARM INSTALLATIONS, CONDUIT SHALL BE INSTALLED WITHIN THE INTERSECTION IN ORDER TO PROVIDE FOR THE UNDERGROUND WIRING OF ALL CORNERS. A MINIMUM OF TWO (2) - THREE INCH (3") CONDUIT (FOR THE SIGNAL WIRING AND 120 VOLT LOAD WIRING) AND TWO (2) - TWO INCH (2") CONDUITS (FOR LOW VOLTAGE DETECTOR WIRING AND LUMINAIRE POWER) SHALL BE INSTALLED. SEE THE INTERSECTION LAYOUT SHEET FOR APPROXIMATE LOCATION.
- THE CONTRACTOR SHALL HAVE ONE (1) SIGNED COPY OF THE PLANS, SPECIFICATIONS, AND PERMITS (APPROVED BY THE ARAPAHOE COUNTY DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT) AT THE JOB SITE AT ALL TIMES WORK IS BEING DONE.
- SIGNAL TIMING PLAN TO BE DETERMINED BY ARAPAHOE COUNTY IN COORDINATION WITH DRCOG FOR ROUTES ON THE NATIONAL HIGHWAY SYSTEM (NHS).
- A TRAFFIC CONTROL PLAN FOR THE HANDLING OF TRAFFIC DURING CONSTRUCTION SHALL BE SUBMITTED TO ARAPAHOE COUNTY DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT FOR APPROVAL PRIOR TO STARTING CONSTRUCTION. A STREET CUT PERMIT FOR CONSTRUCTION OF PUBLIC IMPROVEMENTS WILL NOT BE ISSUED WITHOUT AN APPROVED CONSTRUCTION TRAFFIC CONTROL PLAN.
- PRIOR TO ORDERING ANY EQUIPMENT, THE CONTRACTOR SHALL SUBMIT, ELECTRONICALLY, SHOP DRAWINGS, EQUIPMENT SPECIFICATIONS, AND OTHER DOCUMENTATION AS NECESSARY SHOWING COMPLIANCE WITH PROJECT SPECIFICATIONS TO ARAPAHOE COUNTY DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT FOR ACCEPTANCE OR REJECTION. THE CONTRACTOR SHALL NOTIFY ARAPAHOE COUNTY, IN WRITING, AT THE TIME OF SUBMITTAL OF ANY INFORMATION SUBMITTED THAT DEVIATES FROM THE REQUIREMENTS OF THE PLANS AND SPECIFICATIONS. IN ADDITION, SPECIFIC NOTATION OF THE DEVIATIONS OR CHANGES FROM THE PLANS AND SPECIFICATIONS SHALL BE PLACED ON THE SHOP DRAWING, WORKING DRAWING, OR OTHER SUBMITTAL.
- UPON COMPLETION OF THE WORK THE CONTRACTOR SHALL SUBMIT A SET OF RECORDED DOCUMENTS SHOWING THE "AS-BUILT" CONDITION OF THE WORK TOGETHER WITH ANY OTHER DATA RELATING TO THE WORK AS DIRECTED BY THE ENGINEER.
- ALL MATERIALS AND WORKMANSHIP SHALL BE SUBJECT TO INSPECTION BY THE ARAPAHOE COUNTY DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT. THE COUNTY RESERVES THE RIGHT TO ACCEPT OR REJECT ANY MATERIALS AND / OR WORKMANSHIP THAT DOES NOT CONFORM TO THE ARAPAHOE COUNTY STANDARDS, STANDARD SPECIFICATIONS OR PROJECT SPECIAL PROVISIONS. THE CONTRACTOR SHALL NOTIFY THE ARAPAHOE COUNTY DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT INSPECTION SECTION AT 720-874-6500 AT LEAST 2 BUSINESS DAYS PRIOR TO STARTING CONSTRUCTION.
- ELECTRICAL INSPECTIONS SHALL BE CONDUCTED IN ACCORDANCE WITH ARAPAHOE COUNTY STANDARDS, STANDARD SPECIFICATIONS AND PROJECT SPECIAL PROVISIONS AND SHALL MEET THE MINIMUM REQUIREMENTS OF THE ARAPAHOE COUNTY BUILDING DIVISION. CONTRACTOR SHALL CONTACT THE ARAPAHOE COUNTY BUILDING DIVISION AT 720-874-6600 PRIOR TO CONSTRUCTION TO DISCUSS THESE REQUIREMENTS.
- THE COUNTY, THROUGH APPROVAL OF THE STANDARD SIGNAL DESIGN SHEETS, ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS AND/OR ACCURACY OF THE PROJECT DOCUMENTS. IT IS THE POLICY AND PRACTICE OF ARAPAHOE COUNTY NOT TO ACCEPT THE LIABILITY FOR FACILITIES DESIGNED BY OTHERS. THE RESPONSIBILITY FOR THE ENGINEERING ADEQUACY OF THE FACILITIES DEPICTED ON THE

PROJECT DOCUMENTS LIES SOLELY WITH THE REGISTERED PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE ARE AFFIX TO PROJECT DOCUMENTS.

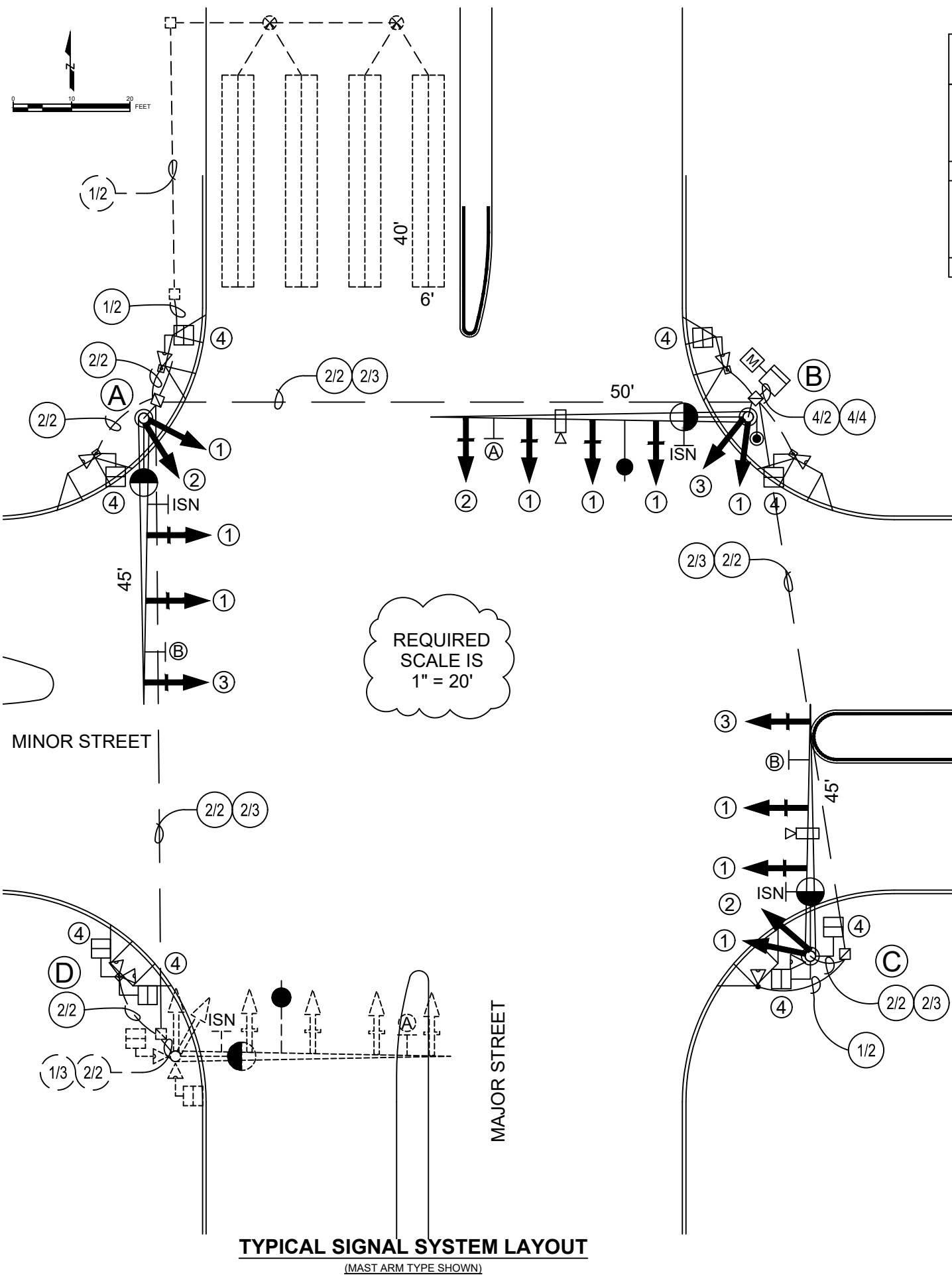
LEGEND

(ENGINEER SHALL ADD OTHER ITEMS AS NEEDED FOR SPECIFIC DESIGN)

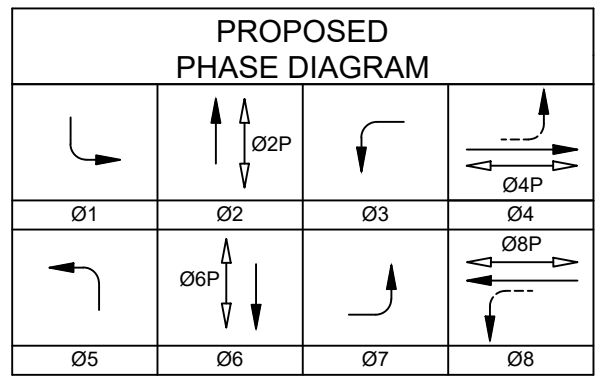
EXISTING	NEW	
		TRAFFIC SIGNAL POLE
		SPAN WIRE POLE
		TRAFFIC SIGNAL POLE AND MAST ARM
		TRAFFIC SIGNAL HEAD WITH BACKPLATE
		TRAFFIC SIGNAL HEAD
		PEDESTAL POLE
		PEDESTRIAN PUSH BUTTON POLE
		PEDESTRIAN SIGNAL FACE
		PEDESTRIAN PUSH BUTTON AND SIGN
		LUMINAIRE
		TRAFFIC SIGNAL CONTROLLER & CABINET
		POWER METER
		MAST ARM, POLE MOUNTED SIGN W / IDENTIFIER
		ILLUMINATED STREET NAME SIGN
		BLANK-OUT REGULATORY SIGN
		BLANK-OUT WARNING SIGN
		PLASTIC PULL BOX (TYPE 1 OR 2)
		PRECAST PULL BOX (TYPE 1, 2 OR 4)
		STREET PULL BOX
		LOOP DETECTOR (6'X30' OR 6'X40')
		LOOP DETECTOR (6'X6')
		QUANTITY / SIZE IN INCHES CONDUIT-SCHEDULE 80 PVC
		OPTICOM DETECTOR
		SCHOOL FLASHING BEACON
		SCHOOL FLASHING BEACON (OVERHEAD)
		WARNING FLASHING BEACON
		REGULATORY FLASHING BEACON
		VIDEO DETECTION
		MICROWAVE DETECTION
		PTZ CAMERA

LIST OF MATERIALS			
PAY ITEM	UNIT	PLAN QUANTITY	AS-CONSTRUCTED QUANTITY
<p>SAMPLE</p> <p>(ENGINEER SHALL ADD OTHER ITEMS AS NEEDED FOR SPECIFIC DESIGN)</p>			

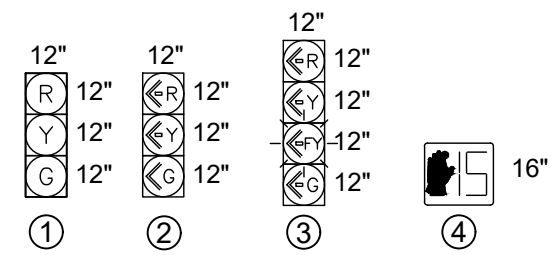
REVISIONS			
NO.	DATE	DESCRIPTION	
	11/2024	ORIGINAL	
<p>ARAPAHOE COUNTY, COLORADO</p> <p>DEPARTMENT OF PUBIC WORKS AND DEVELOPMENT</p> <p>STANDARD SIGNAL DESIGN</p> <p>GENERAL NOTES, LEGEND, AND LIST OF MATERIALS</p>			
PROJECT NO.	DATE:	DESIGNED BY:	JOB NO.
PROJECT NAME:	SCALE:	DRAWN BY:	SHEET NO.
			1 of 10



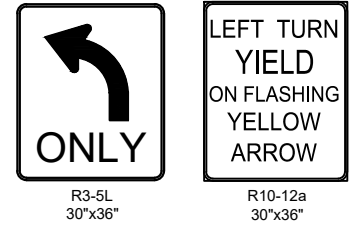
TYPICAL SIGNAL SYSTEM LAYOUT
(MAST ARM TYPE SHOWN)



SIGNAL PHASING

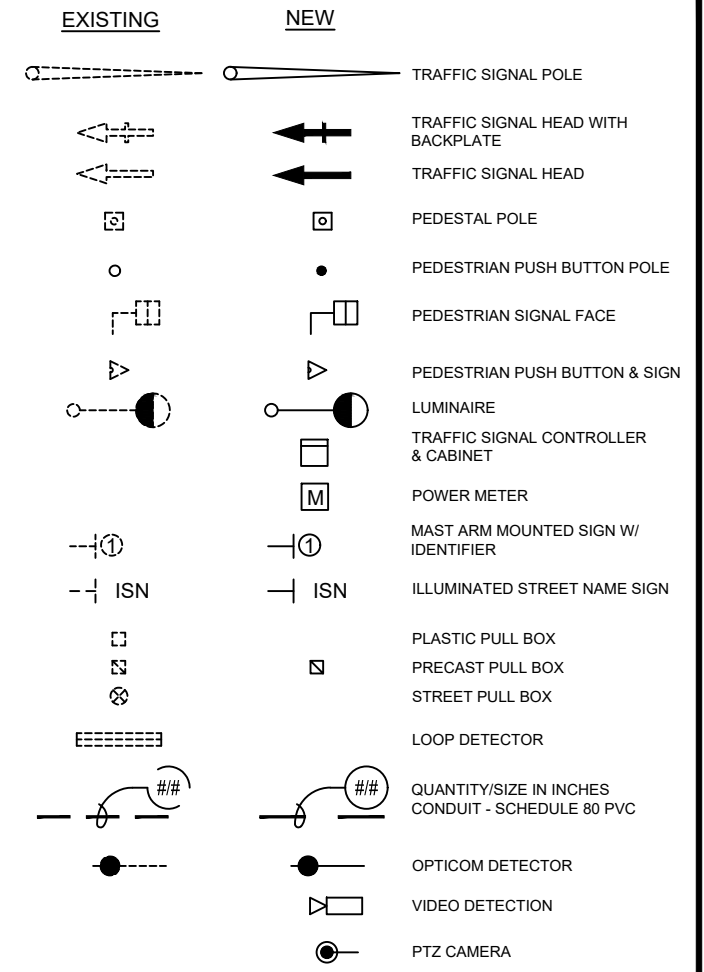


SIGNAL FACE DETAILS



SIGN DETAILS

LEGEND



THIS SHEET SHOWN FOR EXAMPLE- THIS INTERSECTION LAYOUT SHEET SHALL SHOW PROJECT SPECIFIC INFORMATION IN THE GENERAL FORMAT SHOWN. (EXAMPLE NOT TO SCALE)

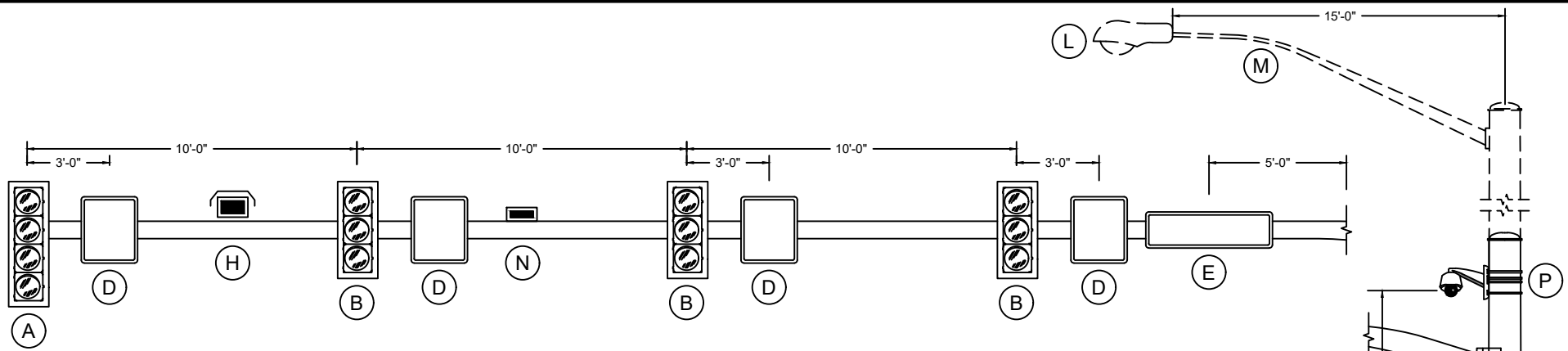
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		11/2024	ORIGINAL	

ARAPAHOE COUNTY, COLORADO
DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

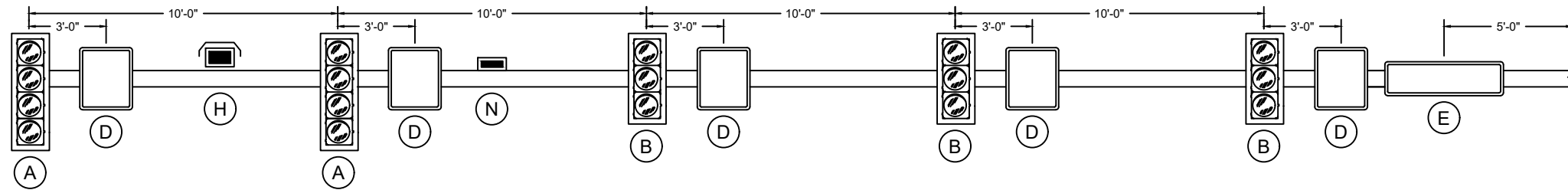
STANDARD SIGNAL DESIGN

TYPICAL INTERSECTION LAYOUT
(USE THIS SHEET TO LAY OUT SPECIFIC INSTALLATION)

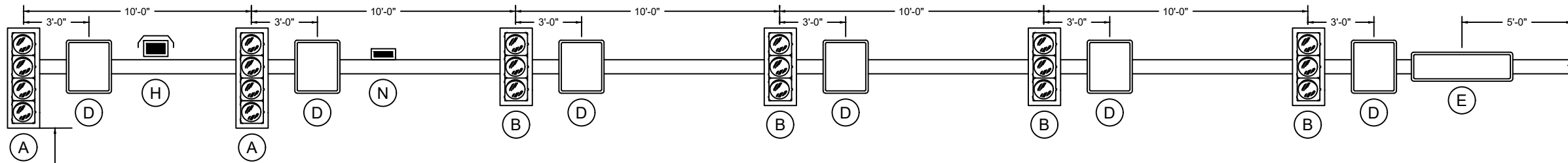
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PROJECT NAME:	SCALE:	DRAWN BY:	SHEET NO. 2 OF 10



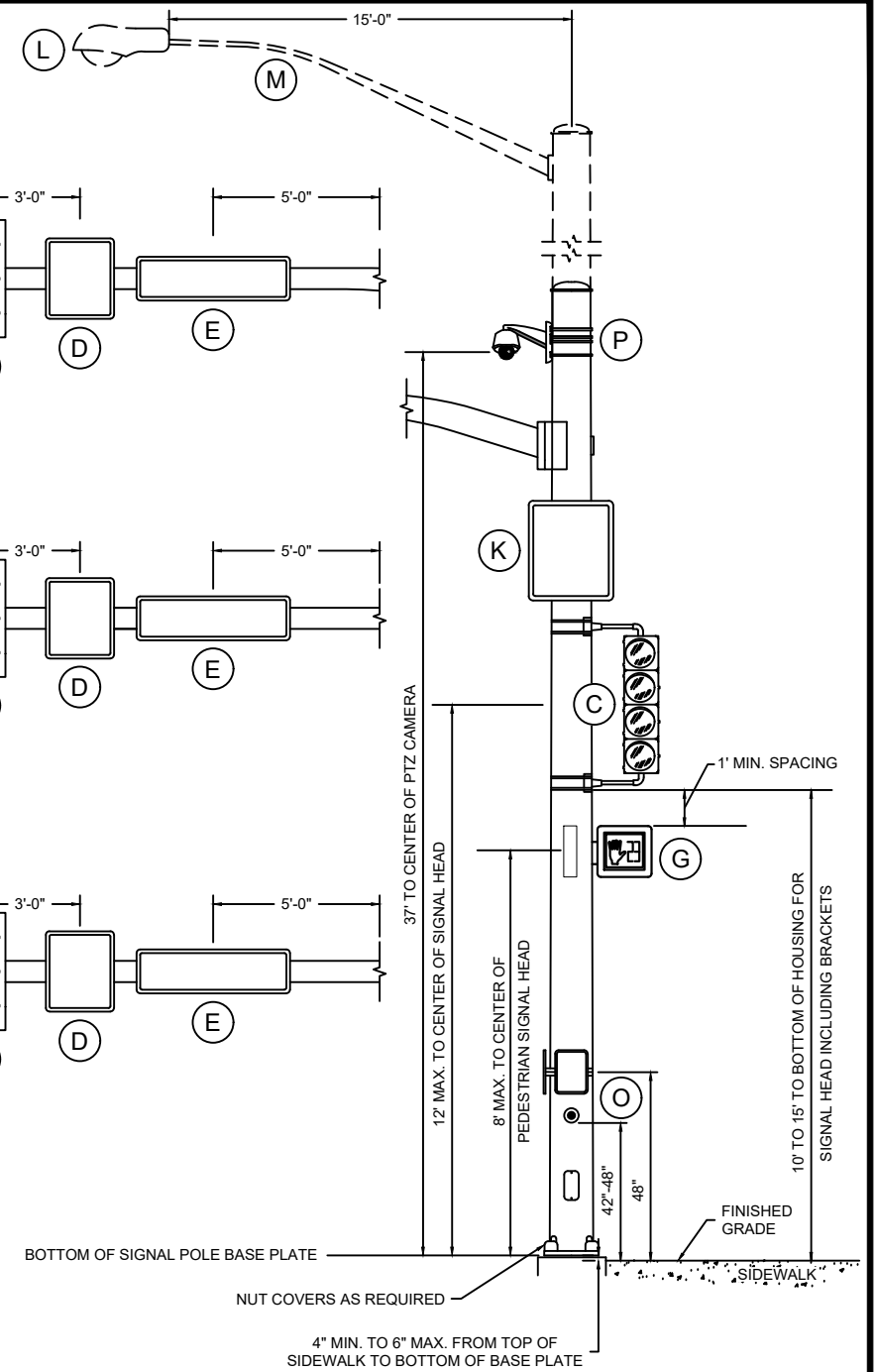
MAXIMUM LOADING FOR "MAST ARM UP TO 45 FEET" POLE FOUNDATION DETAIL



MAXIMUM LOADING FOR "MAST ARM 46 TO 60 FEET" POLE FOUNDATION DETAIL



MAXIMUM LOADING FOR "MAST ARM 61 TO 75 FEET" POLE FOUNDATION DETAIL



GENERAL NOTES

- SPACING BETWEEN CENTER OF SIGNAL HEADS SHALL BE MINIMUM OF 8'. DESIGNER IS REQUIRED TO PERFORM STRUCTURAL LOAD CALCULATIONS FOR FOUNDATION DESIGN IF LESS THAN 8' SPACING IS REQUIRED.
- ALL SIGNAL HEADS AND HARDWARE SHALL BE FIELD POSITIONED.
- ONE SIGNAL HEAD SHALL BE CENTERED OVER EACH EXCLUSIVE LEFT TURN LANE AND THROUGH LANE. SIGNAL HEADS ON MAST ARMS SHALL BE SPACED AT 8' MIN. RIGHT TURN LANE SIGNAL HEAD REQUIREMENTS SHALL BE DETERMINED ON A SITE SPECIFIC BASIS.
- POLE-MOUNTED SIGNAL HEADS FAR RIGHT AND FAR LEFT ARE REQUIRED.
- SIGNAL HEADS MOUNTED ON THE MAST ARM SHALL BE ATTACHED WITH ASTRO-BRAC, SKY BRACKET, OR APPROVED EQUAL MOUNTING HARDWARE.
- ALL VEHICLE SIGNAL HEADS SHALL BE POLYCARBONATE WITH 12" SECTIONS AND OPEN BOTTOM TUNNEL VISORS.
- ALL VEHICLE HEADS SHALL BE BLACK IN COLOR.
- ALL SIGNAL HEADS MOUNTED ON MAST ARMS SHALL HAVE ALUMINUM BLACK LOUVERED BACKPLATES WITH A 3" WIDE 3M FLUORESCENT YELLOW DIAMOND GRADE RETROREFLECTIVE BORDER.
- SIGNAL HEADS MOUNTED ON THE POLE SHALL BE ATTACHED WITH PIPE COUPLINGS OR APPROVED EQUAL, SIZED TO THE SPECIFIC SIGNAL HEAD ARRANGEMENT. PEDESTRIAN HEADS MOUNTED ON THE POLE SHALL BE CLAMHELL TYPE MOUNTS.
- THE BOTTOM OF ALL MAST ARM-MOUNTED SIGNAL HEADS SHALL BE ON THE SAME HORIZONTAL PLANE AND HAVE A MINIMUM CLEARANCE OF 17 FEET AND MAXIMUM OF 19 FEET ABOVE THE PAVEMENT SURFACE AT THE CENTER OF THE LANE, UNLESS OTHERWISE SPECIFIED.
- SIGNAL FACES MOUNTED AT SIDE OF ROADWAY AT LESS THAN 15 FEET FROM THE BOTTOM OF THE HOUSING AND ANY RELATED ATTACHMENTS SHALL HAVE A HORIZONTAL OFFSET OF NO LESS THAN 2 FEET FROM FACE OF CURB OR EDGE OF SHOULDER, IF NO CURB IS PRESENT.

DEVICE	DESCRIPTION	PROJ AREA (SQ FT)	WEIGHT (LBS)
A	12" - 4 SECTION SIGNAL WITH BACKPLATE	11	60
B	12" - 3 SECTION SIGNAL WITH BACKPLATE	8.67	45
C	12" - 4 SECTION SIGNAL WITHOUT BACKPLATE	8.25	60
D	30" X 36" REGULATORY SIGN	7.5	25
E	18" X 108" STREET NAME SIGN	13.5	45
G	DUAL 16" PED SIGNAL	9	120
H	DETECTION CAMERA	1	20
K	BLANK OUT SIGN	12.7	120
L	LUMINAIRE	3.3	75
M	STREET LIGHT DAVIT	5.5	100
N	FIRE PREEMPTION UNIT (OPTICOM)		2
O	PEDESTRIAN PUSH BUTTON AND SIGN	1.05	10
P	PTZ CAMERA		6

REVISIONS			
NO.	DATE	DESCRIPTION	
	11/2024	ORIGINAL	

**ARAPAHOE COUNTY,
COLORADO**
DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

STANDARD SIGNAL DESIGN

**TYPICAL TRAFFIC SIGNAL
MAST ARM DETAILS**

PROJECT NO.	DATE	DESIGNED BY	JOB NO.
PROJECT NAME	SCALE	DRAWN BY	SHEET NO.

3 OF 10

FOUNDATION NOTES

1. CONCRETE SHALL BE CLASS BZ WITH ENTRAINED AIR PER THE COLORADO DEPARTMENT OF TRANSPORTATION SPECIFICATION, SECTION 601.02 UNLESS OTHERWISE NOTED.
2. SHAFT FOR CONCRETE FOUNDATION TO BE DRILLED BY MECHANICAL AUGER OR USING HYDROVAC EXCAVATION. CASING IF USED IN PLACING CONCRETE SHALL BE REMOVED UPON COMPLETING POUR. CARE SHALL BE TAKEN TO PREVENT "MUSHROOMING" AT TOP OF CAISSON.
3. THE DESIGNS HEREIN ASSUMES THAT THE STREET LIGHTS OR SIGNALS ARE INSTALLED WITHIN THE ROADWAY EARTHWORK PRISM WITH THE FOLLOWING SOIL PARAMETERS:

SOIL DENSITY $\gamma = 120$ LBS/ CU FT
 SOIL ϕ ANGLE = 28° FOR MEDIUM DENSE COHENSIONLESS SOIL

THE AVERAGE FRICTIONAL RESISTANCE OF THE SOIL (AROUND THE SHAFT) = 750 LBS/SQ FT

A GEOTECHNICAL ENGINEER IS REQUIRED ONSITE DURING DRILLING OPERATIONS.

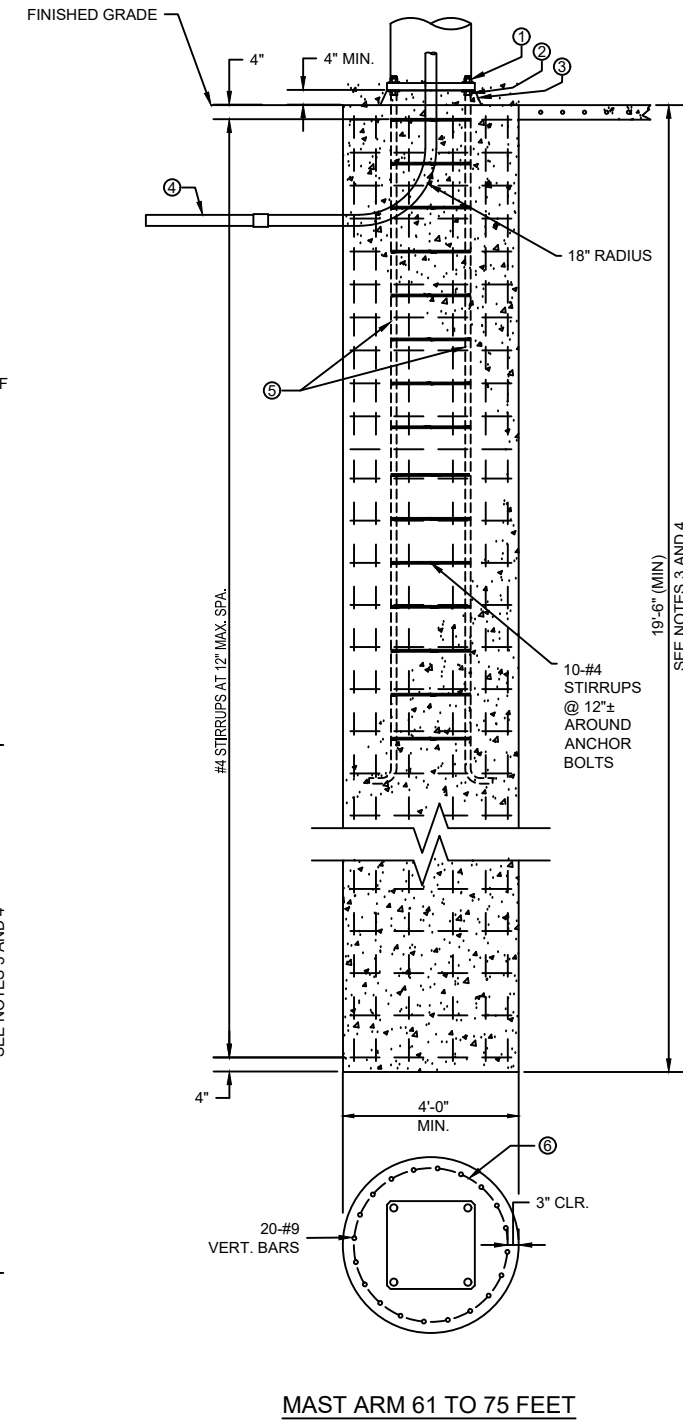
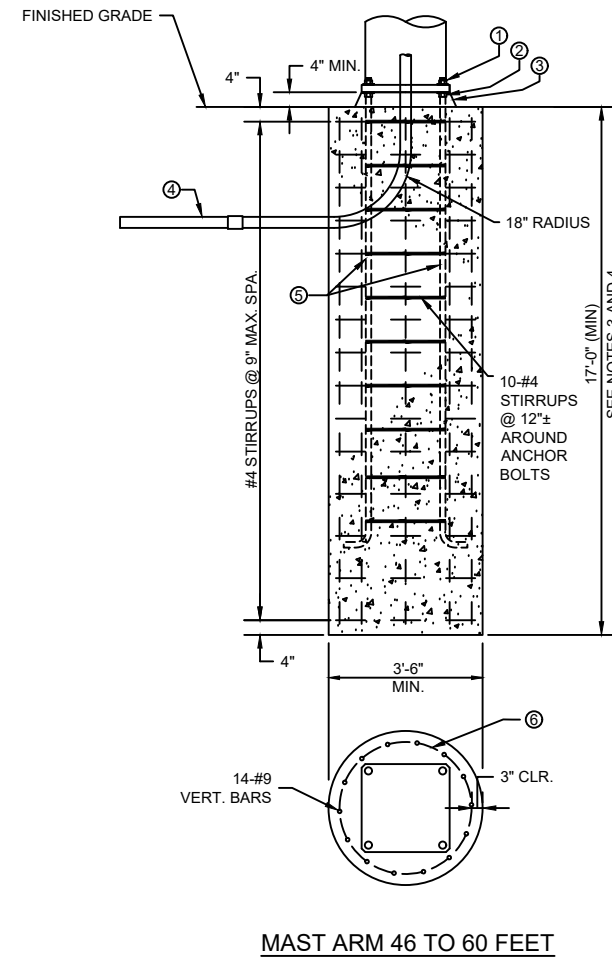
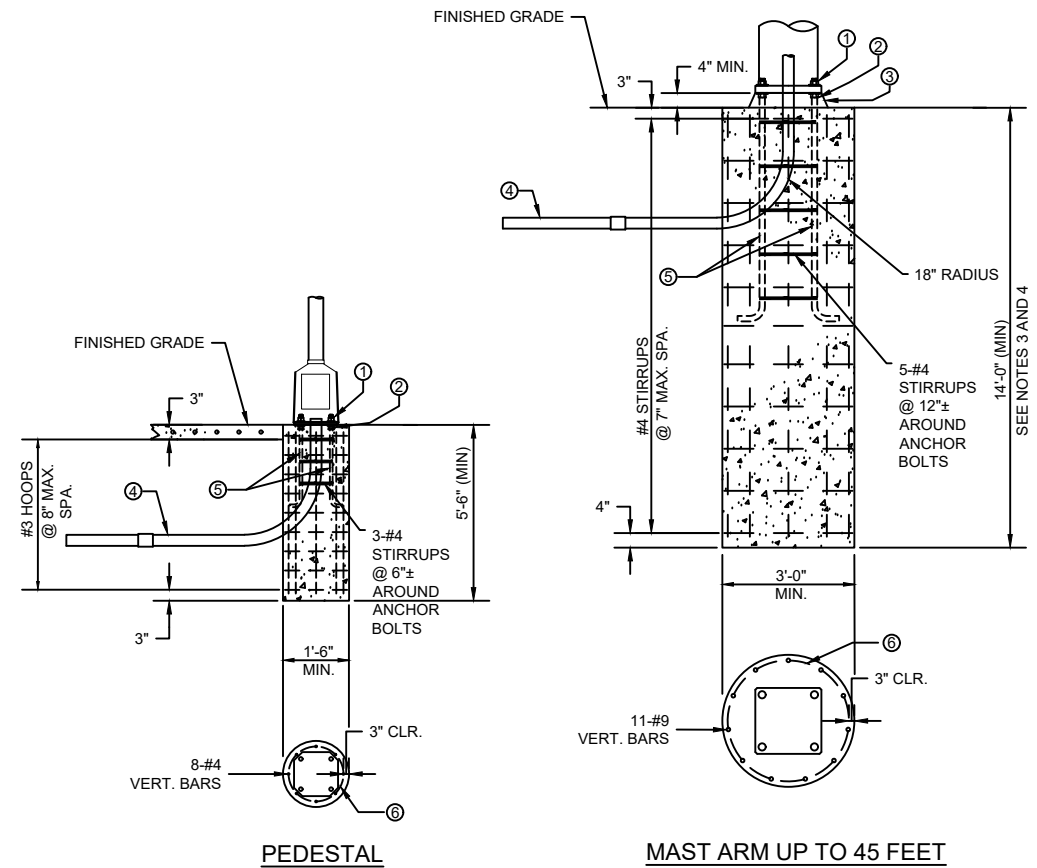
THE STANDARD FOUNDATION DESIGN SHOWN WILL NEED TO BE MODIFIED IF ANY OF THE FOLLOWING ARE ENCOUNTERED:

- A GEOTECHNICAL INVESTIGATION (CONDUCTED PRIOR TO, OR DURING, CAISSON CONSTRUCTION) INDICATES THE ABOVE NOTED REQUIREMENTS CANNOT BE MET.
- THE SOIL IS HIGH IN ORGANIC CONTENT.
- THE SOIL CONSISTS OF SATURATED SILT AND CLAY.
- THE SOIL CANNOT SUPPORT THE WEIGHT OF THE DRILL RIG.

4. SHOULD ROCK BE ENCOUNTERED, PRIOR TO ATTAINING REQUIRED FOUNDATION DEPTH, THE TOTAL SHAFT LENGTH REQUIRED SHALL BE THE SHORTER OF THE STANDARD SHAFT LENGTH OR A MINIMUM OF 6 FEET INTO ROCK SUBJECT TO THE APPROVAL OF THE ON-SITE GEOTECHNICAL ENGINEER.
5. CONTRACTOR SHALL CONSTRUCT THE FOUNDATIONS IN ACCORDANCE WITH THE REQUIREMENTS OF CDOT STANDARD SPECIFICATION 503 - DRILLED SHAFTS.
6. CONTRACTOR SHALL ESTABLISH TOP ANCHOR BOLT WITH RESPECT TO ADJACENT FINISHED GRADE.
7. REFER TO CDOT STANDARD PLAN S-614-45 FOR PEDESTRIAN PUSH BUTTON POST ASSEMBLY DETAILS.

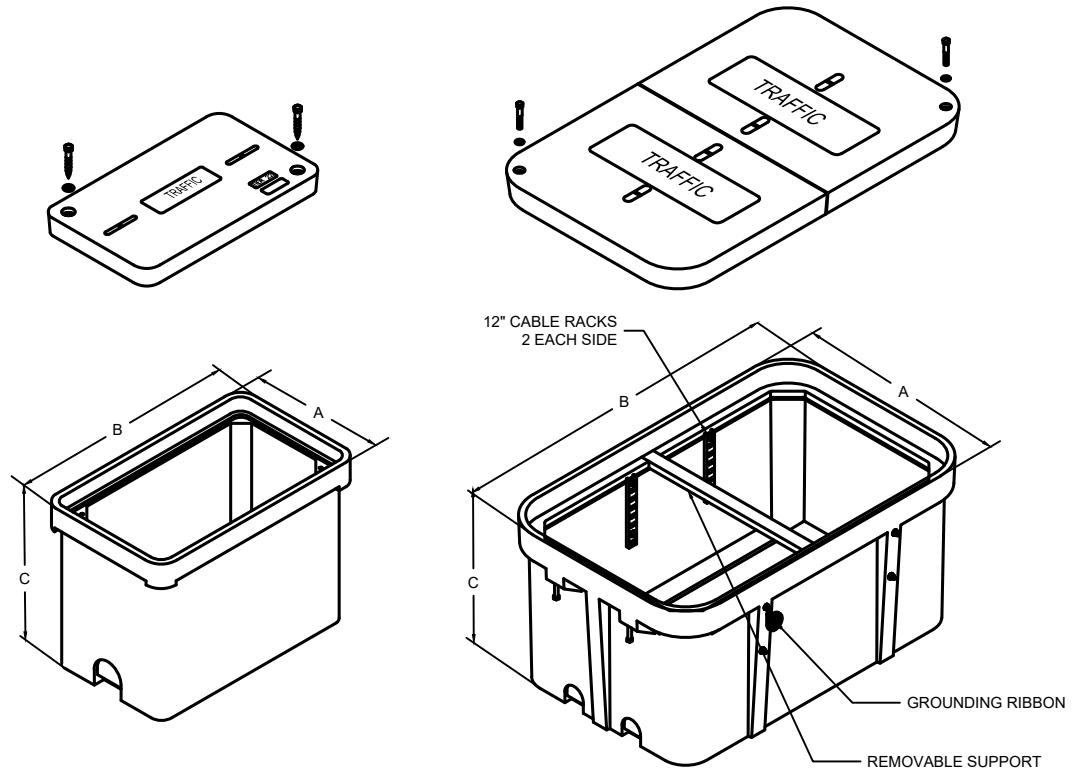
FOUNDATION LEGEND

- ① HEX NUT WITH WASHER
- ② HEX NUT WITH WASHER (LEVELING NUT)
- ③ 4" MIN. TO 6" MAX. NON-SHRINKABLE GROUT BETWEEN BASE PLATE AND TOP OF FOUNDATION
- ④ CONDUIT CONFIGURATION AND SIZES WILL VARY BASED ON INTENDED USE:
 PEDESTAL POLE - 2-2" CONDUITS
 TRAFFIC SIGNAL - 2-3" CONDUITS AND 2-2" CONDUITS
 STREET LIGHTS - 1-2" CONDUIT
 (24" MIN. DEPTH WITH 30" MIN. DEPTH UNDER ROADWAY)
- ⑤ INSTALL ANCHOR BOLTS (FURNISHED WITH POLE PER MANUFACTURER'S TEMPLATE PRINT (FURNISHED WITH ORDER). THE CONTRACTOR SHALL ESTABLISH THE TOP OF THE ANCHOR BOLT WITH RESPECT TO THE FINISHED GRADE.
- ⑥ MINIMUM OVERLAP OF 12"



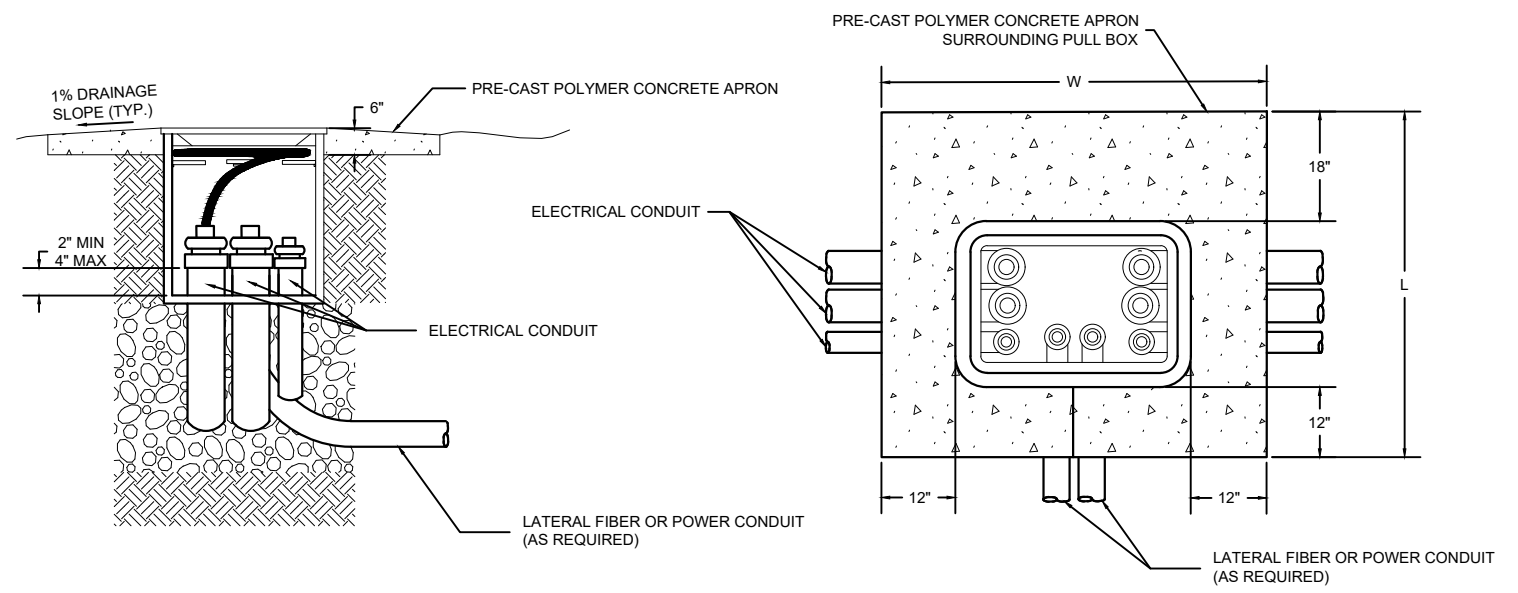
TYPICAL POLE FOUNDATION
(NOT TO SCALE)

REVISIONS			
NO.	DATE	DESCRIPTION	
	11/2024	ORIGINAL	
ARAPAHOE COUNTY, COLORADO DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT			
STANDARD SIGNAL DESIGN DETAILS			
POLE FOUNDATION DETAILS			
PROJECT NO.	DATE:	DESIGNED BY:	JOB NO.
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TYPE ONE, TWO, AND THREE PULL BOX

TYPE FOUR AND FIVE PULL BOX

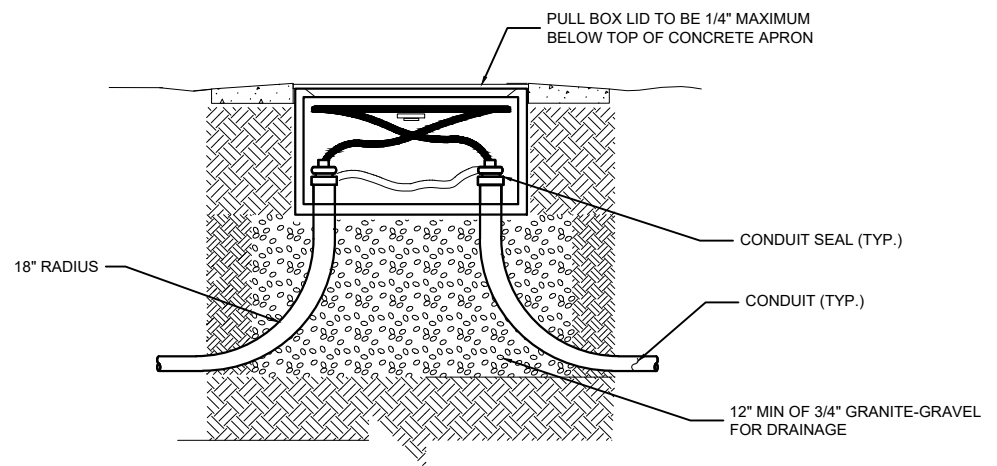


PRE-CAST PULL BOX DIMENSIONS (IN.)					
TYPE	DESCRIPTION	STANDARD USE	A	B	C
1	PULL BOX - (11"x18"x18")	TYPICAL FOR DETECTORS AND ELECTRICAL SERVICE	11	18	18
2	PULL BOX - (13"x24"x18")	WHEN APPROVED ONLY	13	24	18
3	PULL BOX - (17"x30"x18")	TYPICAL FOR SIGNAL POLES	17	30	18
4	PULL BOX - (24"x36"x24")	TYPICAL FOR SIGNAL CONTROLLER CABINET	24	36	24
5	PULL BOX - (30"x48"x24")	TYPICAL FOR ITS COMMUNICATIONS	30	48	24

PRE-CAST PULL BOX

PULL BOX TYPE	CONCRETE APRON DIMENSIONS (INCHES)	
	W	L
TYPE 1	42	41
TYPE 2	48	43
TYPE 3	54	47
TYPE 4	60	54
TYPE 5	72	60

APRON NOTES:
1. APRON DIMENSIONS MAY VARY BASED ON PULL BOX WALL THICKNESS.

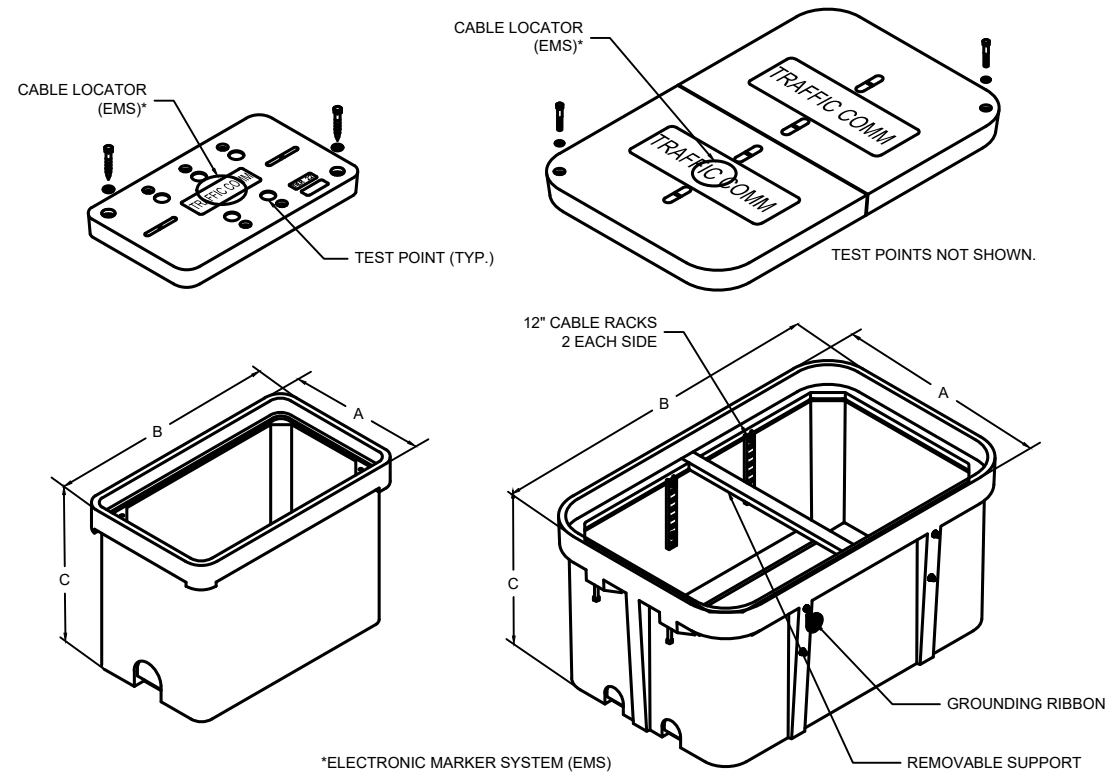


PULL BOX INSTALLATION

GENERAL NOTES

- CONDUITS DEPICTED ON THIS TYPICAL DETAIL ARE REPRESENTATIVE ONLY. NUMBER OF CONDUITS INSTALLED AND CONDUIT SIZE SHALL BE AS TABULATED AND SHOWN ON THE PLANS.
- ALL CONDUIT SHALL BE SEALED USING BRASS EMBEDDED DUCT SEAL AND SHALL BE INCLUDED IN THE COST OF ELECTRICAL CONDUIT PAY ITEM. SEALS SHALL BE INSTALLED IMMEDIATELY UPON CONDUIT INSTALLATION AT GRADE AT THE PROPOSED PULL BOX LOCATIONS TO PREVENT FILL MATERIAL FROM ENTERING THE CONDUIT.
- PULL TAPE SHALL BE INSTALLED IN EACH INDIVIDUAL CONDUIT AND BE INCLUDED IN THE COST OF ELECTRICAL CONDUIT PAY ITEM.
- TRACER WIRE SHALL BE INSTALLED IN EACH CONDUIT AND SHALL BE INCLUDED IN THE COST OF ELECTRICAL CONDUIT PAY ITEM.
- TOP OF CONDUIT SHALL BE LOCATED AT A DEPTH OF NOT LESS THAN 24 INCHES AND A DEPTH OF NOT LESS THAN 30 INCHES UNDER THE ROADWAY.
- ALL ELECTRICAL PULL BOXES SHALL HAVE THE WORD "TRAFFIC" CAST ON THE LID.
- STREET PULL BOX SHALL BE A WATER VALVE STEM TYPE PULL BOX MADE OF CAST IRON OR STEEL. THE PULL BOX SHALL HAVE THE CAPACITY OF ACCEPTING RISER RINGS FOR FUTURE OVERLAYS.
- STREET PULL BOXES SHALL HAVE 3/4 " TO 1" DIAMETER HOLE DRILLED OR TORCHED 3" FROM TOP OF PAVEMENT TO ACCEPT A 4" TO 6" LONG RUBBER TUBE (3/4 " GARDEN HOSE). THE NUMBER OF HOLES SHALL BE AS PER PLANS OR AS DIRECTED BY THE ENGINEER.
- STREET PULL BOX IS TO BE LOCATED IN AN AREA OF THE STREET NOT HEAVILY TRAVELED IF POSSIBLE AND PLACED A MINIMUM OF 12" FROM CONCRETE GUTTER PAN TO CENTER OF PULL BOX.
- 2' MINIMUM SLACK OF BOTH FEED AND LOOP WIRES IS TO BE PROVIDED SO THAT ALL TESTING AND SPLICING CAN BE DONE OUTSIDE OF THE PULL BOX.
- CONTRACTOR SHALL LABEL ALL CONDUCTORS.
- PULL BOXES SHALL HAVE A 12 INCH MINIMUM BY 6 INCH DEEP PRE-CAST POLYMER CONCRETE APRON, EXCEPT WHEN INSTALLED IN A SIDEWALK, SLOPED AWAY FROM THE PULL BOX. THE GAP BETWEEN THE APRON AND OUTER WALL SHALL BE A MAXIMUM OF 1/4 INCH. THE COST OF THE CONCRETE APRON SHALL BE PAID FOR AS PART OF THE PULL BOX ITEM.

REVISIONS			
NO.	DATE	DESCRIPTION	
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ARAPAHOE COUNTY, COLORADO DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT STANDARD SIGNAL DESIGN			
PULL BOX DETAILS - ELECTRICAL			
PROJECT NO.	DATE:	DESIGNED BY:	JOB NO.
PROJECT NAME:	SCALE:	DRAWN BY:	SHEET NO. 5 OF 10

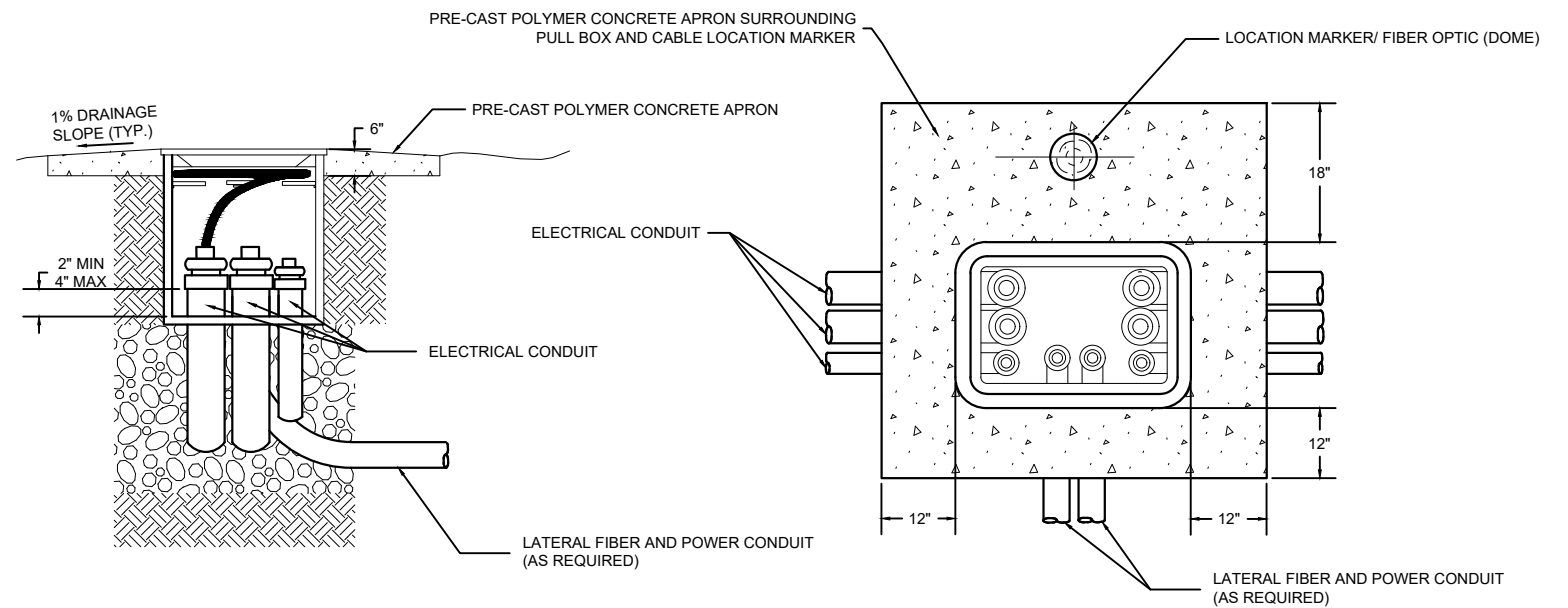


TYPE ONE, TWO, AND THREE PULL BOX

TYPE FOUR AND FIVE PULL BOX

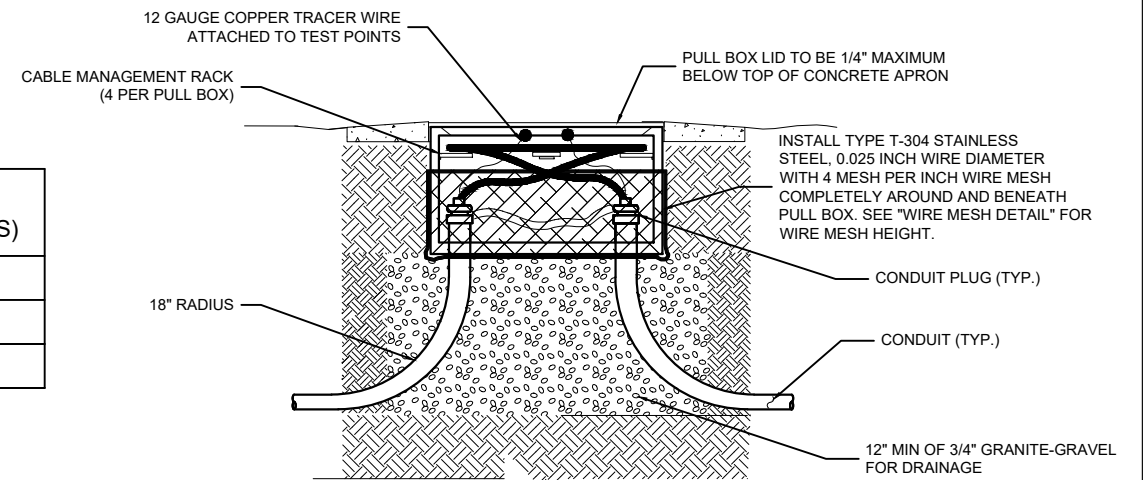
PRE-CAST PULL BOX DIMENSIONS (IN.)					
TYPE	DESCRIPTION	STANDARD USE	A	B	C
4	PULL BOX - (24"x36"x24")	INTERMEDIATE LOCATIONS	24	36	24
5	PULL BOX - (30"x48"x24")	SPLICE LOCATIONS	30	48	24

PRE-CAST PULL BOX



PULL BOX TYPE	CONCRETE APRON DIMENSIONS (INCHES)	
	W	L
TYPE 4	60	54
TYPE 5	72	60

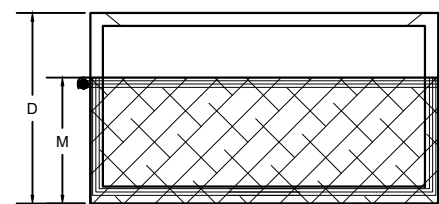
APRON NOTES:
1. APRON DIMENSIONS MAY VARY BASED ON PULL BOX WALL THICKNESS.



PULL BOX INSTALLATION

GENERAL NOTES

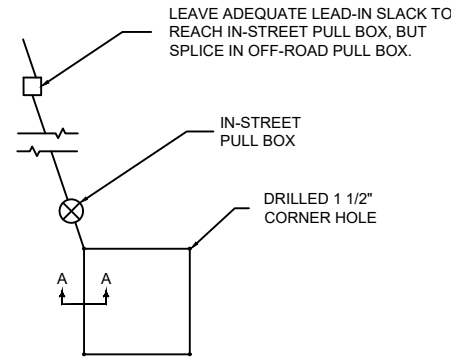
- CONDUITS DEPICTED ON THIS TYPICAL DETAIL ARE REPRESENTATIVE ONLY. NUMBER OF CONDUITS INSTALLED AND CONDUIT SIZE SHALL BE AS TABULATED AND SHOWN ON THE PLANS.
- CONDUIT PLUGS SHALL BE INSTALLED ON ALL CONDUITS, BOTH WITH AND WITHOUT WIRE OR CABLE AND SHALL BE INCLUDED IN THE COST OF ELECTRICAL CONDUIT PAY ITEM. PLUGS SHALL BE INSTALLED IMMEDIATELY UPON CONDUIT INSTALLATION AT GRADE AT THE PROPOSED PULL BOX LOCATIONS TO PREVENT FILL MATERIAL FROM ENTERING THE CONDUIT. CONDUIT PLUGS SHALL BE REMOVABLE AND EXPANDABLE AS TO CREATE A SNUG WATERTIGHT SEAL AROUND CABLES AND AGAINST CONDUIT WALLS.
- PULL TAPE SHALL BE INSTALLED IN EACH INDIVIDUAL CONDUIT AND BE INCLUDED IN THE COST OF ELECTRICAL CONDUIT PAY ITEM.
- TRACER WIRE SHALL BE INSTALLED IN EACH CONDUIT AND SHALL BE INCLUDED IN THE COST OF ELECTRICAL CONDUIT PAY ITEM.
- TOP OF CONDUIT SHALL BE LOCATED AT A DEPTH OF NOT LESS THAN 24 INCHES AND A DEPTH OF NOT LESS THAN 30 INCHES UNDER THE ROADWAY.
- ALL ITS PULL BOXES SHALL HAVE THE WORD "TRAFFIC COMM" CAST ON THE LID.
- CONTRACTOR SHALL LABEL ALL CONDUCTORS AND FIBER OPTIC CABLE.
- WIRE MESH IS REQUIRED ON ALL ITS PULL BOXES.
- PULL BOX LIDS SHALL BE FURNISHED WITH 3/8 (35) X 1/16 (2) DEEP TEST POINT AREAS WITH 2 - 3/8-7 LAG LONG STAINLESS STEEL HEX HEAD BOLTS, 2 - 3/8 (10) STAINLESS STEEL FLAT WASHERS, DIRECTIONAL LABELS, AND 1 - GROUND LABEL. THE MINIMUM NUMBER OF TEST POINT AREAS AND DIRECTIONAL LABELS SHALL EQUAL THE NUMBER OF CONDUIT BANKS ENTERING THE PULL BOX, UP TO A MAXIMUM OF 5 TEST POINTS. PULL BOXES WITH SPLIT LIDS SHALL HAVE TEST POINTS ON ONE SPLIT LID SECTION ONLY.
- PULL BOXES SHALL HAVE A 12 INCH MINIMUM BY 6 INCH DEEP PRE-CAST POLYMER CONCRETE APRON, EXCEPT WHEN INSTALLED IN A SIDEWALK, SLOPED AWAY FROM THE PULL BOX. THE GAP BETWEEN THE APRON AND OUTER WALL SHALL BE A MAXIMUM OF 1/4 INCH. THE COST OF THE CONCRETE APRON SHALL BE PAID FOR AS PART OF THE PULL BOX ITEM.



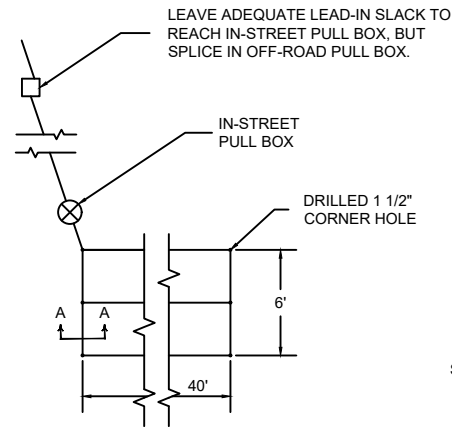
WIRE MESH DETAIL

PULL BOX DEPTH "D"	WIRE MESH HEIGHT "M" (FROM BOTTOM)
12"	9"
18"	12"
24"	18"
36"	18"

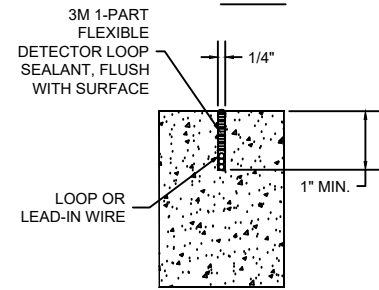
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NO.	DATE	DESCRIPTION	
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ARAPAHOE COUNTY, COLORADO DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT STANDARD SIGNAL DESIGN			
PULL BOX DETAILS - ITS			
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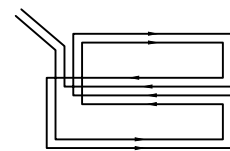
TYPICAL 6'X6' LOOP



TYPICAL 6'X40' QUADRAPOLE LOOP



SECTION A-A



QUADRAPOLE WIRING

SIZE OF LOOP	NO. OF TURNS
6'X6'	4
6'X8' TO 6'X20'	3
6'X22' TO 6'X40'+	2

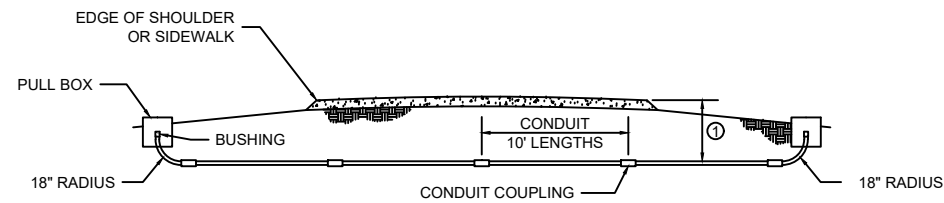
NO. OF TURNS MAY BE ADJUSTED BY ENGINEER IN FIELD. WIRING CONNECTIONS TO BE FIELD DETERMINED.

LOOP TURNS

GENERAL NOTES

1. IMMEDIATELY BEFORE LAYING THE LOOP WIRE, THOROUGHLY CLEAN AND DRY SAW CUT WITH HIGH PRESSURE COMPRESSED AIR.
2. LOOP WIRE IN ADJACENT LOOPS SHALL BE LAID UNIFORMLY IN EITHER A CLOCKWISE OR COUNTERCLOCKWISE DIRECTION AND THE LOOP TAGGED TO INDICATE THE DIRECTION.
3. USE A BLUNT, NON-METALLIC INSTRUMENT TO PUSH WIRE INTO SLOT.
4. LOOP WIRE SHALL BE CONTINUOUS (NO SPLICES) FROM THE PULL BOX. SPLICES IN PULL BOX SHALL BE WATERPROOFED WITH 3M SPLICE KIT, OR APPROVED EQUAL.
5. LOOP LEAD-IN WIRES FOR EACH LOOP SHALL BE TWISTED TOGETHER AT A MINIMUM OF 6 TWISTS PER FOOT BETWEEN THE STREET PULL BOX AND SIDE-OF-ROAD PULL BOX.
6. CONTINUITY TEST FOR EACH LOOP SHALL BE CONDUCTED 1) BEFORE ANY LOOP SEALER IS INSTALLED AND 2) AFTER LOOP SEALER IS INSTALLED AND LEAD-IN CABLE IS SPLICED AND TRAINED TO THE CONTROLLER. "RESISTANCE-TO-GROUND" AND "INDUCTANCE" SHALL BE MEASURED AND RECORDED FOR EACH LOOP.
7. CONTRACTOR SHALL CALL THE ARAPAHOE COUNTY BUILDING AND ZONING DEPARTMENT AT 720-874-6600 TO INSPECT ELECTRICAL WORK PRIOR TO BACKFILLING TRENCHES.
8. IF BORING TECHNIQUE IS USED, CONTRACTOR MUST VERIFY CONDUIT DEPTH WITH ARAPAHOE BUILDING AND ZONING DEPARTMENT - ELECTRICAL INSPECTIONS.

LOOP SAW CUT AND INSTALLATION

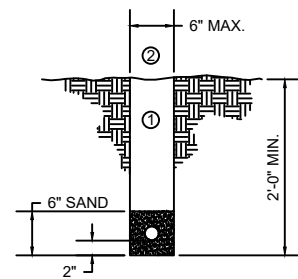


CONDUIT PLACEMENT UNDER PAVEMENT OR SIDEWALK

NOTES

- ① MINIMUM CONDUIT DEPTH: UNDER PAVEMENT 30" UNDER SIDEWALK 24"

ALL PVC CONDUIT SHALL BE SCHEDULE 80



UNDER GRASS / GROUND TRENCHING DETAIL

NOTES

- ① BACKFILL AND TAMP WITH SELECT BORROW TO MATCH COMPACTION OF SURROUNDING GROUND.
- ② RESEED OR RESOD SURFACE AT DIRECTION OF THE ENGINEER.

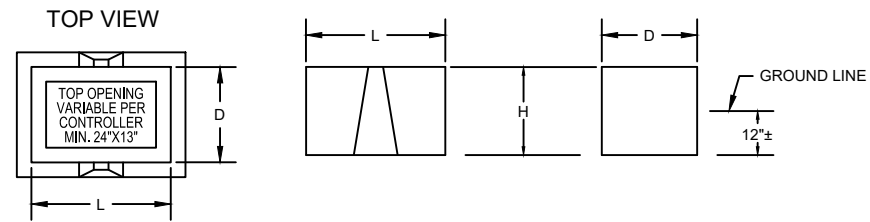
REVISIONS		
NO.	DATE	DESCRIPTION
	11/2024	ORIGINAL

ARAPAHOE COUNTY, COLORADO
DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

STANDARD SIGNAL DESIGN

LOOPS AND CONDUIT TRENCH DETAILS

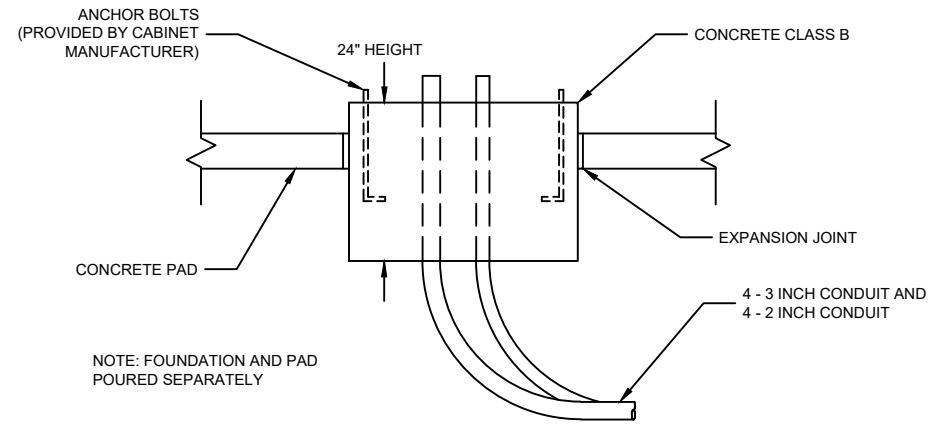
PROJECT NO.	DATE	DESIGNED BY:	JOB NO.
PROJECT NAME:	SCALE:	DRAWN BY:	SHEET NO.



FOUNDATION DIMENSIONS (MINIMUMS) SHALL BE AS FOLLOWS:

CABINET TYPE	L	D	H
P	44"	26"	24"

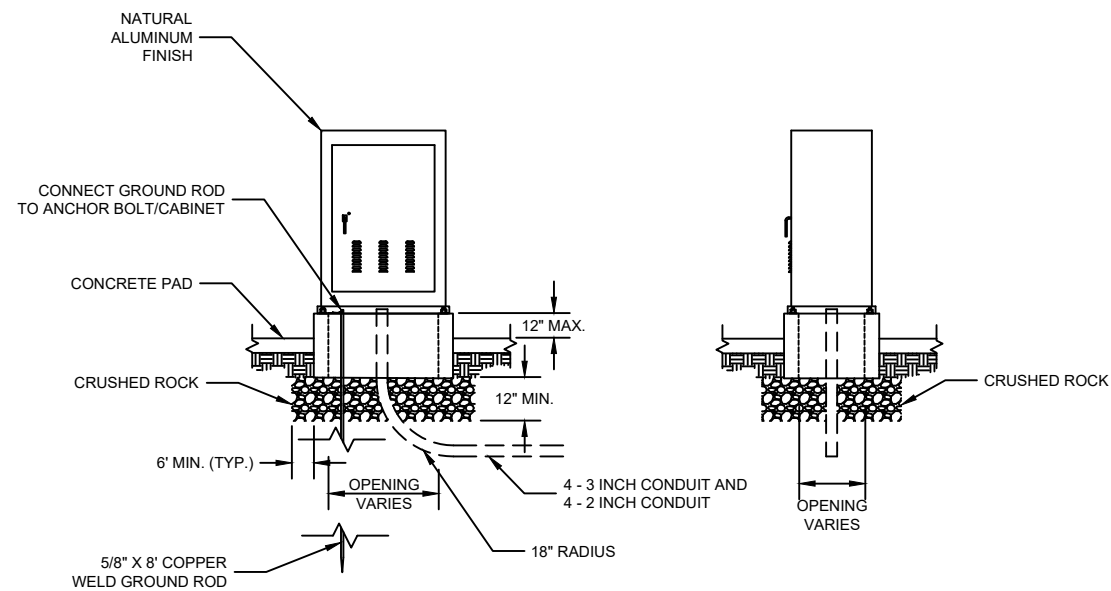
CONTROLLER CABINET FOUNDATION



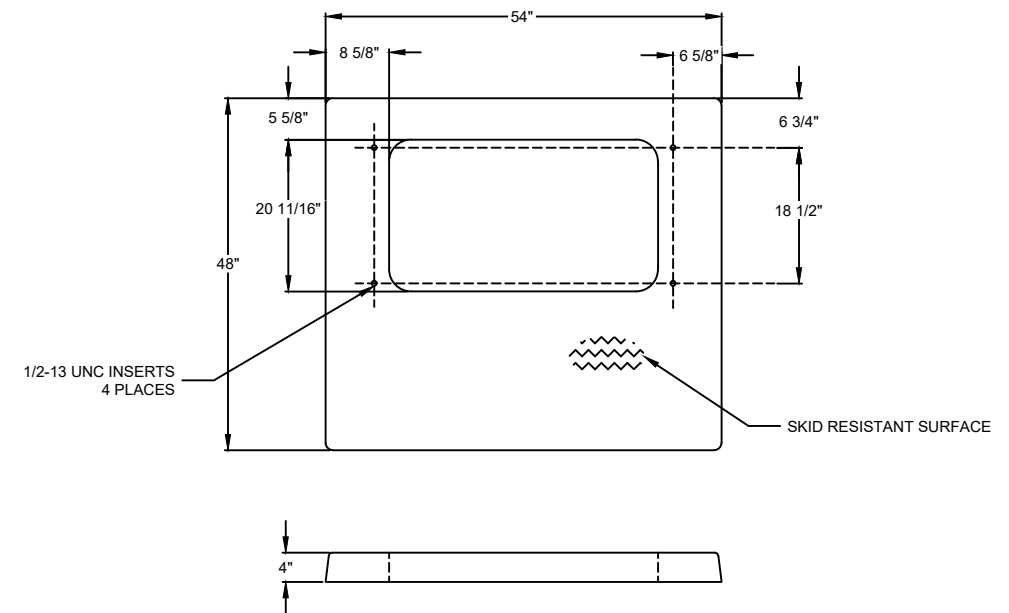
FOUNDATION CROSS SECTION

NOTES

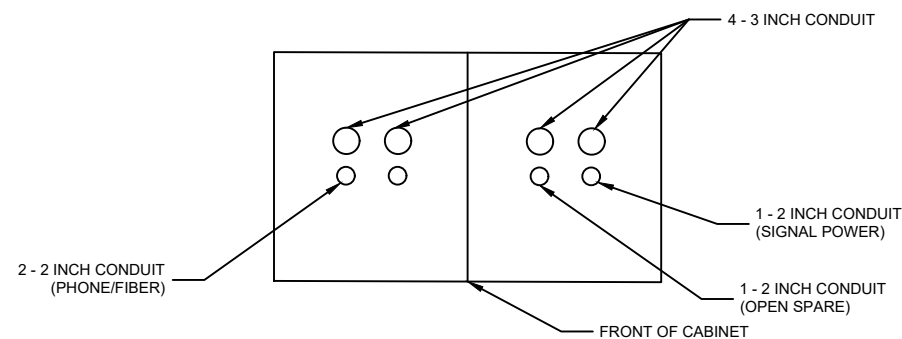
1. CONTROLLER CABINET SHALL BE POSITIONED WHERE THE DOOR OPENS TO ALLOW TECHNICIAN DIRECT VIEW OF THE INTERSECTION, UNLESS OTHERWISE APPROVED BY THE ENGINEER.
2. CONTROLLER CABINET DOOR SWING RADIUS SHALL NOT CONFLICT WITH ANY EXISTING OBJECTS.
3. CONTROLLER CABINET FOUNDATION SHALL BE PREFORMED TYPE, MANUFACTURED WITH FIRE RETARDANT RESIN AND A COMBINATION OF CHOPPED GLASS STRAYUP AND HAND LAYUP OF GLASS REINFORCEMENT. A 1/2" SHEET OF PLYWOOD SHALL BE EMBEDDED IN THE TOP SURFACE OF THE FOUNDATION. COLOR SHALL BE CEMENT GRAY.
4. CONCRETE PAD MUST BE FORM FITTED AROUND CONTROLLER CABINET FOUNDATION WITH GAPPING BETWEEN PAD AND FOUNDATION NOT TO EXCEED 1/4".



TYPICAL CONTROLLER CABINET FOUNDATION INSTALLATION

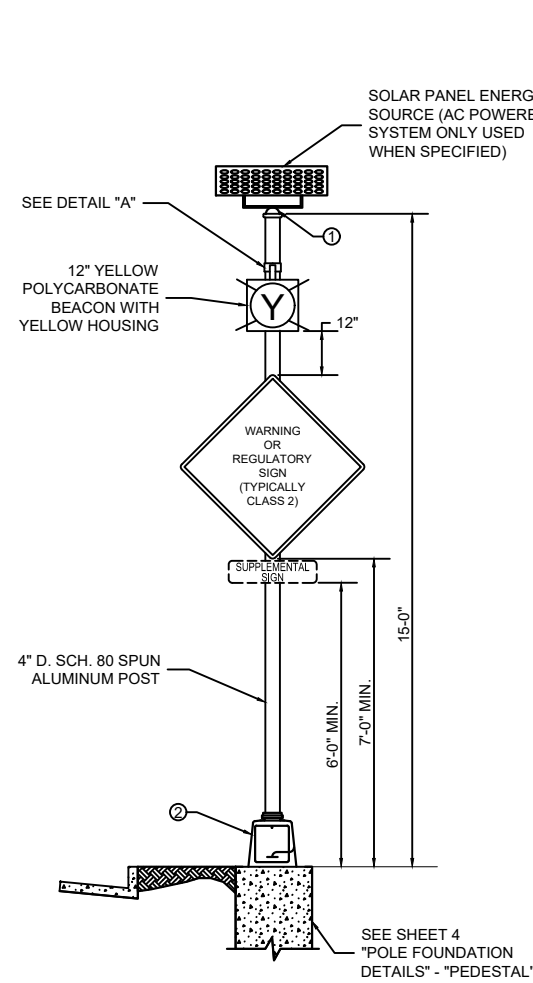


CONCRETE PAD - NEMA P CABINET

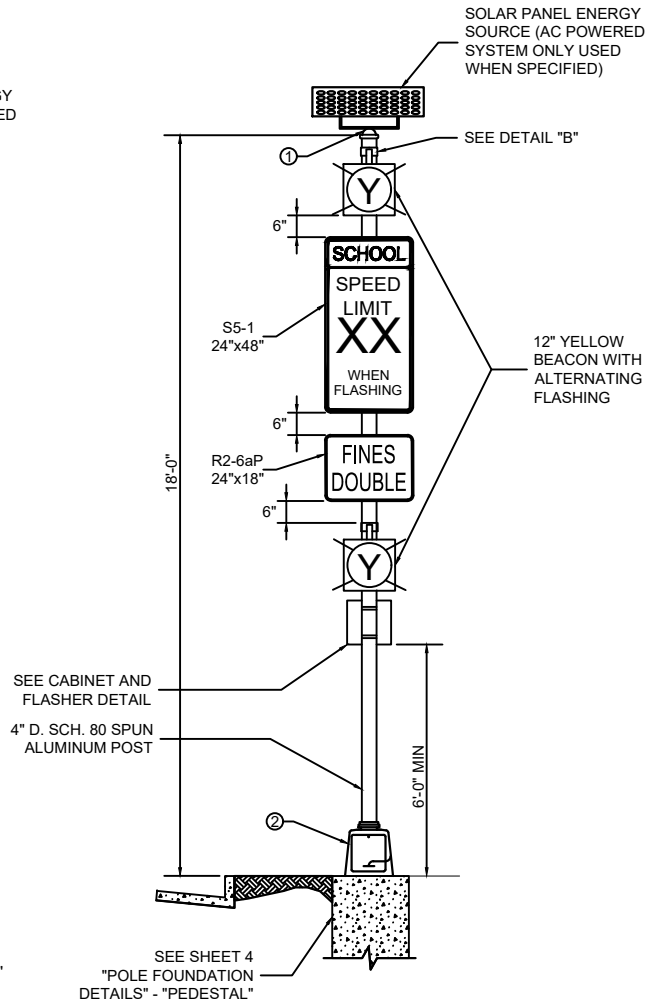
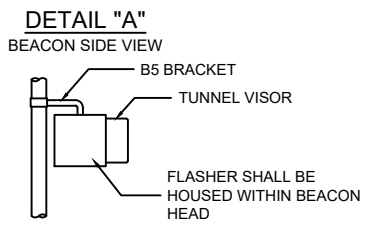


CONDUIT DETAIL CROSS SECTION

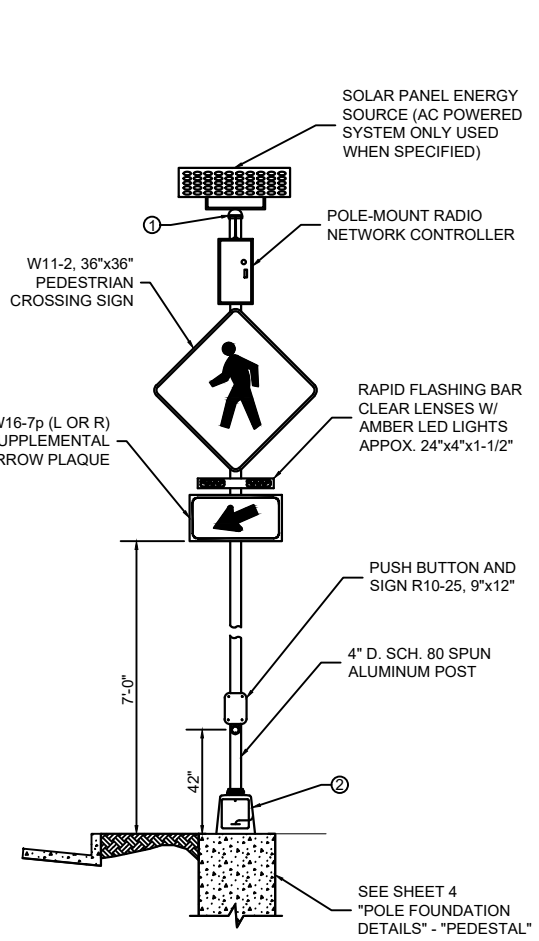
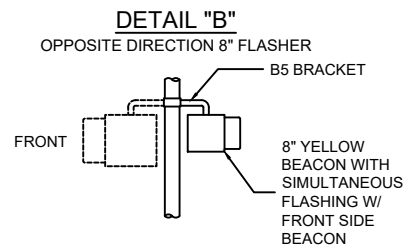
REVISIONS			
NO.	DATE	DESCRIPTION	
	11/2024	ORIGINAL	
ARAPAHOE COUNTY, COLORADO DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT STANDARD SIGNAL DESIGN TRAFFIC CABINET DETAILS			
PROJECT NO.	DATE:	DESIGNED BY:	JOB NO.
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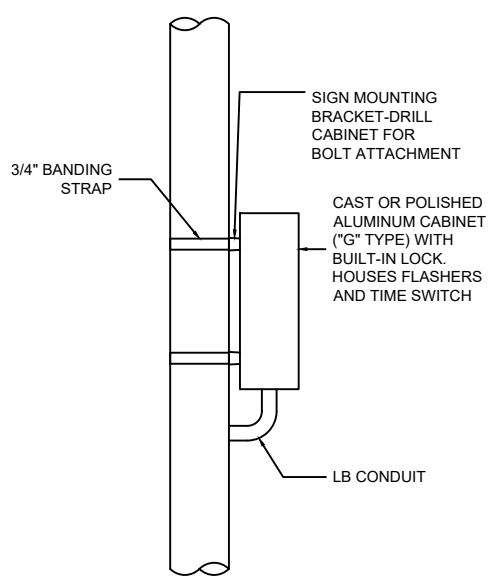
WARNING OR REGULATORY SIGN FLASHING BEACON ASSEMBLY



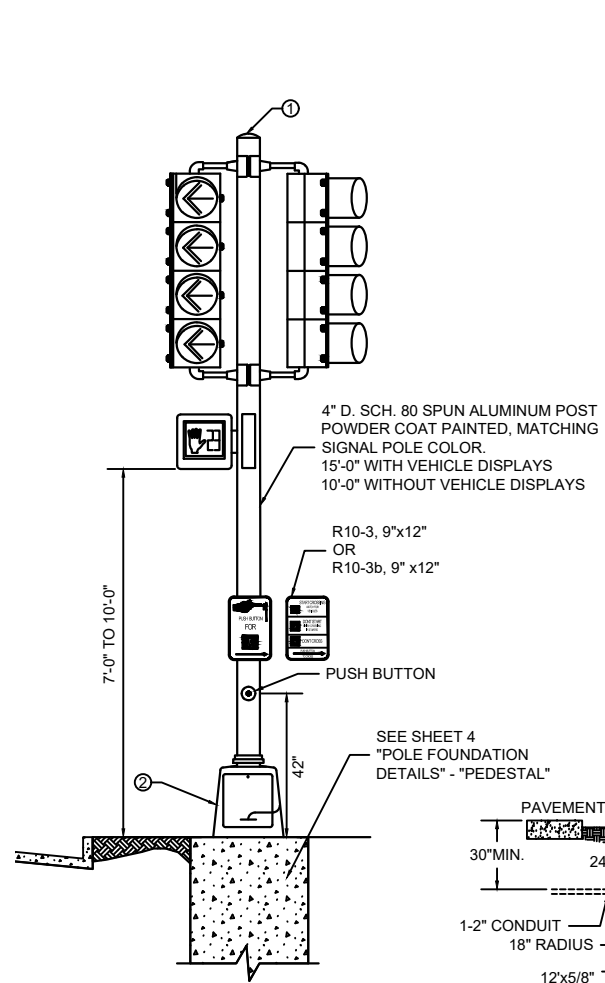
SCHOOL FLASHING BEACON ASSEMBLY



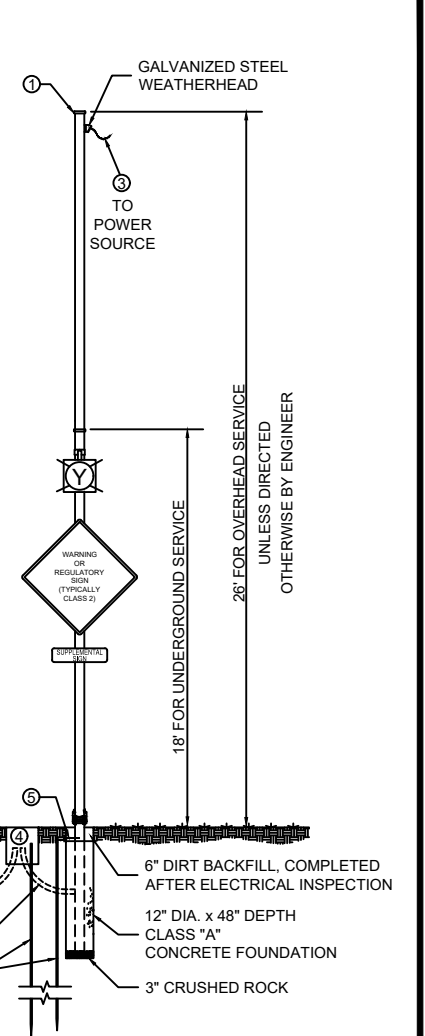
RECTANGULAR RAPID FLASHING BEACON (RRFB) ASSEMBLY



CABINET AND FLASHER DETAIL



TRAFFIC SIGNAL PEDESTAL POLE ASSEMBLY



AC POWERED FLASHING BEACON ASSEMBLY (ONLY IF SPECIFIED BY COUNTY)

- LEGEND**
- ① WATERTIGHT GALVANIZED STEEL POLE CAP
 - ② ALUMINUM SQUARE BASE ASSEMBLY WITH DOOR AND GROUNDING LUG WITH ALUMINUM COLLAR
 - ③ LEAVE 8' COILED WIRE FOR UTILITY COMPANY CONNECTION
 - ④ PROVIDE CONDUIT AND TYPE 1 PULL BOX FOR UNDERGROUND SERVICE ONLY
 - ⑤ BONDING STRAP IN BACKFILL FOR OVERHEAD SERVICE ONLY

FLASHING BEACONS
ALL FLASHING BEACONS SHALL BE POLYCARBONATE WITH TUNNEL VISORS AND YELLOW HOUSINGS

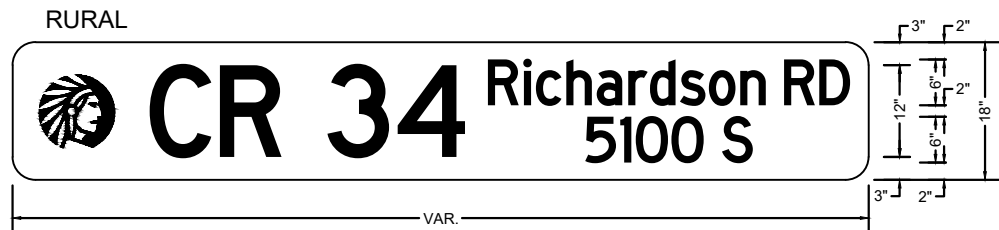
REVISIONS		
NO.	DATE	DESCRIPTION
	11/2024	ORIGINAL

ARAPAHOE COUNTY, COLORADO
DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT

STANDARD SIGNAL DESIGN

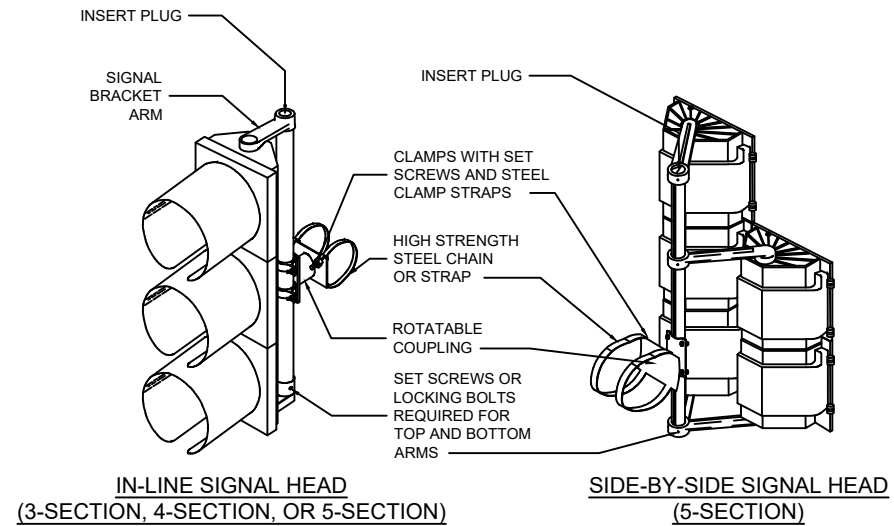
PEDESTAL POLE AND FLASHING BEACON ASSEMBLY DETAILS

PROJECT NO.	DATE:	DESIGNED BY:	JOB NO.
PROJECT NAME:	SCALE:	DRAWN BY:	SHEET NO. 9 OF 10

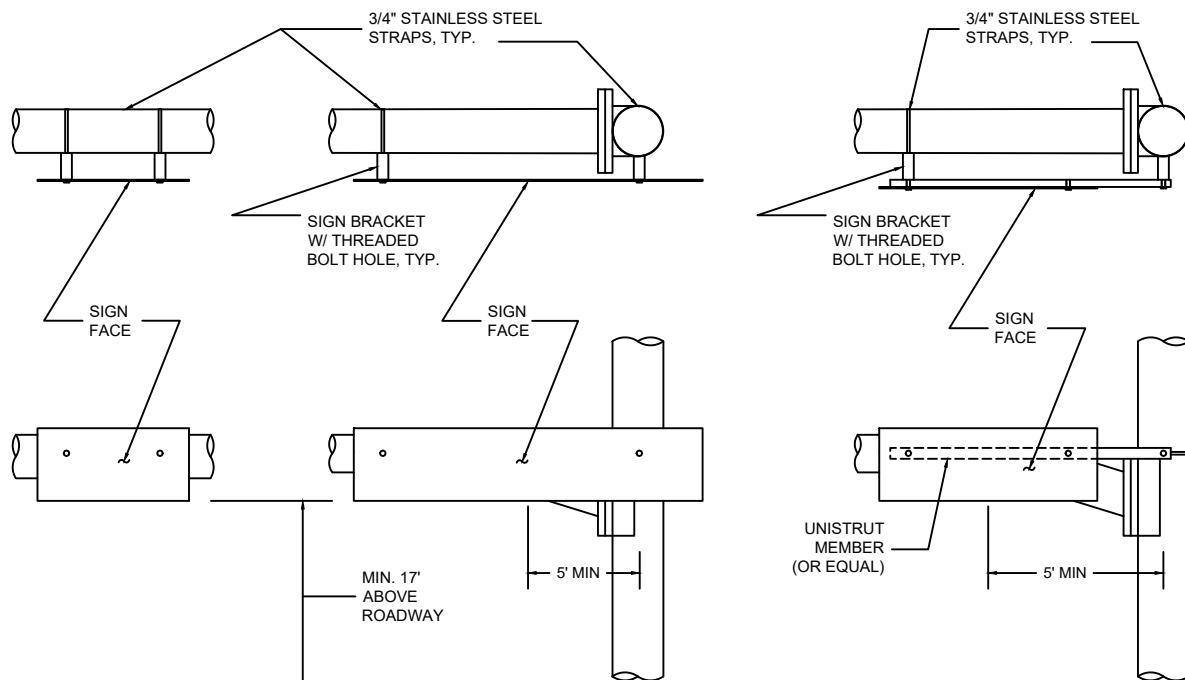


GREEN SIGN WITH WHITE LETTERS
WORD FONT D
INITIAL UPPERCASE LETTERS AT MINIMUM 12 INCHES HEIGHT
LOWERCASE LETTERS AT MINIMUM 9 INCHES HEIGHT

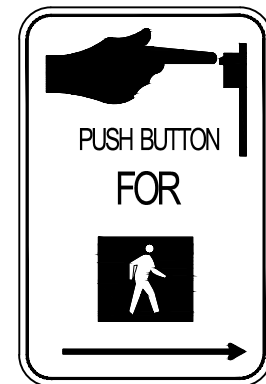
TYPICAL TRAFFIC SIGNAL STREET NAME SIGN LAYOUT



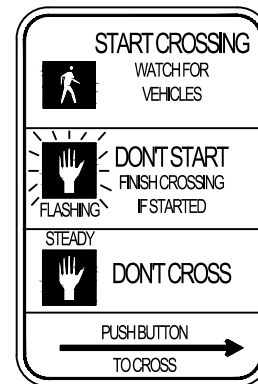
DETAIL OF MAST ARM MOUNTING FOR SIGNAL HEADS



MAST ARM SIGN MOUNTING DETAIL



R10-3 (L OR R)
"PUSH BUTTON FOR WALK SIGNAL" SIGN



R10-3b (L OR R)
"PUSH BUTTON FOR WALK SIGNAL" EDUCATIONAL SIGN

- NOTE:**
- 9" x 12" SIGN SHALL BE USED ON SIGNAL POLES.
 - 5" x 7-3/4" SIGNS SHALL BE USED ON PEDESTRIAN POLES AND PEDESTRIAN PUSH BUTTON POSTS.
 - SIGNS SHALL BE ALUMINUM UNLESS OTHERWISE APPROVED.

PEDESTRIAN PUSH BUTTON SIGNS

GENERAL NOTES

- SIGN FIXTURE AND PANELS SHALL WITHSTAND 100 MPH WIND LOADING, WITH STRUCTURAL REQUIREMENTS MEETING AASHTO "STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS," LATEST EDITION.

REVISIONS			
NO.	DATE	DESCRIPTION	
	11/2024	ORIGINAL	
ARAPAHOE COUNTY, COLORADO			
DEPARTMENT OF PUBLIC WORKS AND DEVELOPMENT			
STANDARD SIGNAL DESIGN			
MISCELLANEOUS DETAILS			
PROJECT NO.	DATE:	DESIGNED BY:	JOB NO.
PROJECT NAME:	SCALE:	DRAWN BY:	SHEET NO.
			10 OF 10

Revision of Section 613 Lighting

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.02 shall include the following:

(b) Light Standard

Material Data:

Component	ASTM Designation	Min. Yield (KSI)
Pole Shaft	A595 Gr. A	55
Arm Shaft	A595 Gr. A	55
Pole Base	A36	36
Galvanizing - Hardware	A153	-
Lum. Connection Bolt	A325	81
Lum. Arm Attachments	A36	36
Anchor Bolts	F1554	55

Finish:

Finish Coat - Triglycidyl Isocyanurate (TGIC) or Urethane Polyester Powder Finish Color - project defined towards conformance with adjacent light standards

Light poles shall be hot dipped galvanized inside and outside, according to ASTM A123 and factory painted with a rust inhibited epoxy primer (minimum dry film thickness of 1.0 mils) and coated with a triglycidyl isocyanurate (TGIC) or a urethane polyester powder (to a minimum dry film thickness of 2.0 mil). The powder type coating shall be electro-statically applied and cured in a gas fired convention oven by heating the steel substrate to a minimum of 350of and a maximum of 400of. All accessible interior surfaces shall be coated with a rust inhibited primer (minimum dry thickness of 1.0 mils).

Painting shall conform to CDOT Standard Specification Section 522 - Duplex Coating Systems.

All galvanized hardware, including anchor bolts, shall be fully galvanized. Hardware exhibiting rust prior to installation shall require factory refinishing or replacement prior to install.

Subsection 613.03 shall include the following:

Contractor to furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on Plans and/or listed below and all other work and miscellaneous items not specifically mentioned but reasonably inferred for a complete installation, including all accessories and appurtenances required for testing the system. It is the intent of the Plans and Specifications that all systems be complete and ready for operation.

Plans indicate general arrangement of electrical equipment and other work. Plans and Specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both. Data presented on the Plans are as accurate as planning can determine, but accuracy is not guaranteed, and field verification of all dimensions, locations,

voltages, etc. to suit field conditions is required. The Contractor shall review all Plans and adjust all work to conform to all conditions shown therein. Discrepancies between different plans or between Plans and Specifications or regulations and codes governing installation shall be brought to the attention of the Engineer prior to initiation of the work associated with this section.

Subsection 613.07 shall include the following:

The Contractor shall be responsible for repairing damage caused by boring, trenching, cutting, drilling, etc. or performance of any related work in this contract area. Contractor shall furnish and install all concrete sidewalk, pavement, landscape materials, etc. outside of the pavement, sidewalk, and other civil works included in the Plans to restore the construction site to pre-construction conditions as shown on the plan set.

Subsection 613.13 shall include the following:

Light Standard Steel (_ Foot) will include the light standard, mast arm, and all hardware necessary for a complete installation, and shall be measured by the actual number of light standards installed and accepted.

Luminaire (LED)(Lumens) will include the luminaire, housing, lens, Light Emitting Diode (LED) board, dimming driver, slip-fitting clamp or approved manufacturer mounting, all necessary internal wiring, 7-pin photoelectric control receptacle, photocells or shoring caps as applicable, and all hardware necessary for a complete installation, and shall be measured by the number of luminaires installed and accepted. Shoring caps shall be used where lighting control is via a Lighting Control Center (LCC) with centralized control.

Lighting Control Center shall include all equipment necessary for a complete installation and shall be measured by the number of lighting control centers installed and accepted.

Meter Power Pedestal shall include all equipment necessary for a complete installation and shall be measured by the number of combination lighting control centers with meter power pedestals installed and accepted.

Type _ Pull Box shall include all equipment necessary for a complete installation and shall be measured by the number of pull boxes installed and accepted.

All wiring necessary for the complete installation will be measured as a single lump sum.

Subsection 613.14 shall include the following:

The bill of lading shall be provided to Arapahoe County prior to final payment of the lighting.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Light Standard Metal (___ Foot)	Each
Light Standard Steel (___ Foot)	Each
Luminaire (LED) (___ Lumens)	Each
Lighting Control Center	Each
Meter Power Pedestal	Each
Type _ Pull Box	Each
Wiring	Lump Sum

END OF SECTION

Revision of Section 613 Pull Boxes - Electrical

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.02 shall include the following:

Pull boxes shall be verified by a 3rd Party Nationally Recognized Independent Testing Laboratory as meeting all test provisions of American National Standards Institute/Society of Cable Telecommunications Engineers (ANSI/SCTE) 77, 2013 Specification for Underground Enclosure Integrity, Tier 22 rating. Pull boxes shall be Underwriters Laboratories (UL) listed. Certification documents shall be submitted with material submittals.

Pull boxes shall be constructed of an aggregate material consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material shall have the following mechanical properties.

Compressive Strength	-	11,000psi
Tensile Strength	-	1,700 psi
Flexural Strength	-	7,500 psi

Pull box specifications shall consist of the following per the Plans or as directed by the Engineer:

- Type 1 Pull Box (11" x 18" x 18") shall be used for detectors and electrical service.
- Type 2 Pull Box (13" x 24" x 18") shall be used as directed by the Engineer.
- Type 3 Pull Box (17" x 30" x 18") shall be used at traffic signal poles.
- Type 4 Pull Box (24" x 36" x 24") shall be used at the signal controller cabinet.
- Type 5 Pull Box (30" x 48" x 24") shall be used as directed by the Engineer.
- Pull Box (Surface Mounted) sizes shall be project defined on a per project basis.

The use of multiple pull boxes in place of the larger one shall not be permitted. Other sizes may be approved by the Engineer.

At locations where electrical and fiber communications is to run through a single pull box, use the requirements of "Revision of Section 613 Pull Boxes - Traffic Communications" specification. Upsize pull box as needed to allow sufficient room in the pull box for fiber line slack.

Pull box lids shall have a non-skid surface with a minimum coefficient of friction of 0.5. Covers shall hold a minimum vertical test load of 15,000 pounds over a 10-inch x 10-inch surface with no physical damage or excess deflection. Pull boxes containing electrical conductors shall have the words "TRAFFIC" and tier level rating cast into the surface and be concrete gray color. Painting of the words shall not be accepted.

One-piece lids shall have a minimum of two lift slots per lid, while split lids shall have a minimum of one lift slot per lid.

Pull boxes installed on slopes 5:1 or less shall be installed with the grade of the slope. Pull boxes installed on slopes greater than 5:1 shall include a 2-foot leveled area surrounding the

apron.

Pull boxes shall have a 12 inch wide minimum by 6 inch deep pre-cast polymer concrete apron, except when installed in a sidewalk, sloped away from the pull box opening. The gap between the apron and outer wall shall be a maximum of 1/4 inch. The cost of the concrete apron shall be paid for as part of the pull box item.

The pre-cast polymer concrete apron shall be skid-resistant, non-metallic, non-conductive, and UV resistant, and shall include two lifting slots for placement in the field. The pre-cast polymer concrete apron shall be similar nominal dimensions of the concrete apron shown on the Plans. The gap between the pre-cast polymer concrete apron and outer wall of the pull box shall be a maximum of 1/4 inch.

A 5/8 inch by 8 foot long copper coated steel ground rod is required in electrical pull boxes.

Pull Box (Surface Mounted) shall be aluminum type with a hinged front door and have at least a National Electrical Manufacturers Association (NEMA) 3R rating. Pull Box (Surface Mounted) shall be Underwriters Laboratories (UL) listed. Certification documents shall be submitted with material submittals. The hinged door shall be provided with both a weather tight seal and an aluminum hasp. A keyed lock shall be provided. Surface mounted pull boxes shall be of the dimensions shown on the Plans.

Subsection 613.07 shall include the following:

Pull box locations shown on the Plans are approximate. The Contractor shall identify the exact location in the field, and the Contractor shall have the Engineer agree to the location prior to installation. It shall be the option of the Contractor, at his expense, to install additional pull boxes to facilitate their work as approved by the Engineer.

Pull boxes installed in concrete shall have a minimum of 6 inches of concrete around all sides of the pull box. Pull boxes adjacent to Light Standards or Traffic Signal Poles shall be placed along the side of foundations as shown on the Plans.

The cover of the pull box shall be installed level with the finish grade. When approved by the Engineer, pull boxes and covers located in sidewalks shall be installed level with the sidewalk.

A minimum of 12 inches deep of 3/4-inch granite-gravel shall be installed as a base for the pull box. The granite-gravel shall be free of dirt and debris and spread evenly to facilitate a level base for the pull box. The Contractor shall ensure that sufficient compacting is met prior to the installation of granite-gravel to alleviate future settling.

Pre-cast polymer concrete apron shall be 12 inch wide minimum by 6 inch thick and placed around the top of the pull box, level with the cover of the pull box and finish grade.

Pull Box (Surface Mounted) shall be mounted on or embedded into hard surfaces such as bridge decks, concrete barriers, retaining walls, or buildings, as shown on the Plans. Surface mounted pull boxes shall be attached using 3/8-inch epoxy anchors or other methods approved by the Engineer. Surface mounted pull boxes shall not be used for ground installations.

Pull tape and tracer wire shall be installed in all conduits per Standards and shall be routed through all pull boxes.

Subsection 613.13 shall include the following:

Pull boxes will be measured by the actual number that are installed per the Plans and accepted, and shall include base, lid, lift slots, support beam, excavation, backfill, concrete apron, and 3/4-inch granite-gravel and all work necessary for the final installation. Pull Boxes shall also include the removal and patching of pavement, sidewalks, curbs and gutters and their replacement in kind to match existing grade.

Subsection 613.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Type 1 Pull Box	Each
Type 2 Pull Box	Each
Type 3 Pull Box	Each
Type 4 Pull Box	Each
Type 5 Pull Box	Each
Pull Box (Surface Mounted)	Each

END OF SECTION

Revision of Section 613 Pull Boxes - Traffic Communications

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.02 shall include the following:

Pull boxes shall be constructed of an aggregate material consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material shall have the following mechanical properties.

Compressive Strength	-	11,000psi
Tensile Strength	-	1,700 psi
Flexural Strength	-	7,500 psi

Pull box specifications shall consist of the following per direction of the Engineer:

- Type 4 Pull Box (24" x 36" x 24") shall be used for ITS intermediate locations
- Type 5 Pull Box (30" x 48" x 24") shall be used for ITS splice locations.
- Pull Box (Surface Mounted) sizes shall be project defined on a per project basis.

The use of multiple pull boxes in place of the larger one shall not be permitted. Other sizes may be approved by the Engineer.

At locations where electrical and fiber communications is to run through a single pull box, use the requirements of "Revision of Section 613 Pull Boxes - Traffic Communications" specification. Upsize pull box as needed to allow sufficient room in the pull box for fiber line slack.

Each pull box shall have an Electrical Marker System (EMS) locator disk manufactured into the lid for communication line locating. The locator disk shall be compatible with an Arapahoe County cable locator and shall utilize the APWA uniform color code standard for visual reference if disk is observable on the exterior of the lid. The locator disk shall utilize the proper locate frequency for the pull box type.

Pull box lids shall have a non-skid surface with a minimum coefficient of friction of 0.5. Covers shall hold a minimum vertical test load of 15,000 pounds over a 10-inch x 10-inch surface with no physical damage or excess deflection. Pull boxes containing electrical conductors shall have the words "TRAFFIC COMM" and "EMS MARKER EMBEDDED IN COVER" and tier level rating cast into the surface and be concrete gray color. Painting of the words shall not be accepted.

One-piece lids shall have a minimum of two lift slots per lid, while split lids shall have a minimum of one lift slot per lid. Test point locations shall be integrated into the pull box lids to provide for attachment of test leads of various connector types for underground conduit tracing. The minimum number of test point locations shall equal the number of conduit banks entering the pull box, up to a maximum of five test points. Pull boxes with split lids shall have the test points on one split lid section only. Pull box lids shall be furnished with 3/8-inch x 1/16-inch deep recesses at locations adjoining each test point for the application of direction arrow symbols indicating the direction of underground conduit exiting the pull box. Recesses shall be thoroughly cleaned with alcohol prior to applying arrow symbols.

Wire mesh shall be installed in a manner to completely surround the box as shown on the Plans. The wire mesh shall meet the material standard ANSI/American Society of Testing and Materials (ANSI/ASTM) A555-79 and made of T-304 stainless steel, 0.025 inch wire diameter minimum and shall have a spacing of 4 mesh per inch.

Pull boxes installed on slopes 5:1 or less shall be installed with the grade of the slope. Pull boxes installed on slopes greater than 5:1 shall include a 2-foot leveled area surrounding the apron.

Pull boxes shall have a 12 inch wide minimum by 6 inch deep pre-cast polymer concrete apron, except when installed in a sidewalk, sloped away from the pull box opening. The gap between the apron and outer wall shall be a maximum of 1/4 inch. The cost of the concrete apron shall be paid for as part of the pull box item.

The pre-cast polymer concrete apron shall be skid-resistant, non-metallic, non-conductive, and UV resistant, and shall include two lifting slots for placement in the field. The pre-cast polymer concrete apron shall be similar nominal dimensions of the concrete apron shown on the Plans. The gap between the pre-cast polymer concrete apron and outer wall of the pull box shall be a maximum of ¼ inch.

Pull Box (Surface Mounted) shall be aluminum type with a hinged front door and have at least a National Electrical Manufacturers Association (NEMA) 3R rating. Pull Box (Surface Mounted) shall be Underwriters Laboratories (UL) listed. Certification documents shall be submitted with material submittals. The hinged door shall be provided with both a weather tight seal and an aluminum hasp. A keyed lock shall be provided. Surface mounted pull boxes shall be of the dimensions shown on the Plans.

Subsection 613.07 shall include the following:

Pull box locations shown on the Plans are approximate. The Contractor shall identify the exact location in the field, and the Contractor shall have the Engineer agree to the location prior to installation. Pull boxes for traffic communication conduit runs shall not be spaced more than 500 feet apart from each other unless approved by the Engineer. It shall be the option of the Contractor, at his expense, to install additional pull boxes to facilitate their work as approved by the Engineer.

Pull boxes installed in concrete shall have a minimum of 6 inches of concrete around all sides of the pull box.

The cover of the pull box shall be installed level with the finish grade. When approved by the Engineer, pull boxes and covers located in sidewalks shall be installed level with the sidewalk.

A minimum of 12 inches of ¾ inch granite-gravel shall be installed as a base for the pull box. The granite-gravel shall be free of dirt and debris and spread evenly to facilitate a level base for the pull box. The Contractor shall ensure that sufficient compacting is met prior to the installation of granite-gravel to alleviate future settling.

Wire mesh shall be installed to completely surround the box as shown on the Plans. The wire

mesh shall be gently cut to allow only the entrance of the conduit through at the bottom of the box. All openings cut in the wire mesh that are larger than the diameter of the conduit shall be covered with additional wire mesh in a manner to completely surround the pull box with wire mesh.

Tracer wire shall be attached to the trace test points on the underside of the pull box lid. Each trace wire shall be attached to an individual trace point; no two wires shall be attached to the same point. The Contractor shall coil an additional 6 feet of tracer wire inside the pull box to ensure that the tracer wire will not disconnect from test points when the lids are removed.

Pre-cast polymer concrete apron shall be 12 inch wide minimum by 6 inch thick and placed around the top of the pull box, level with the cover of the pull box and finish grade.

Pull Box (Surface Mounted) shall be mounted on or embedded into hard surfaces such as bridge decks, concrete barriers, retaining walls, or buildings, as shown on the Plans. Surface mounted pull boxes shall be attached using 3/8-inch epoxy anchors or other methods approved by the Engineer. Surface mounted pull boxes shall not be used for ground installations.

Pull tape and tracer wire shall be installed in all conduits per Standards and shall be routed through all pull boxes.

Subsection 613.13 shall include the following:

Pull Boxes will be measured by the actual number installed and accepted, and shall include base, lid, lift slots, support beam, integrated location disk, integrated test points, arrow symbols, excavation, backfill, concrete apron, wire mesh, ground rod, and 3/4-inch granite-gravel. Pull Boxes shall also include the removal and patching of pavement, sidewalks, curbs and gutters and their replacement in kind to match existing grade and shall include all work necessary for the final installation.

Subsection 613.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Type 4 Pull Box	Each
Type 5 Pull Box	Each
Pull Box (Surface Mounted)	Each

END OF SECTION

Revision of Section 614 Traffic Signals - General

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(a) General

Before the Pre-construction Conference, the County will provide the Contractor with a Checklist which the Contractor shall submit at the Pre-construction Conference, for approval, which includes a list of equipment and materials that will be installed. Supplemental data, including detailed scaled Plans and wiring diagrams of any non-standard or special equipment, and any proposed deviation from the approved Plans shall be submitted to the Engineer for approval. Each item shall be identified by the trade name, size, and catalog number. The Contractor shall not order materials or equipment until the Engineer has reviewed and approved the materials and equipment list. The Engineer's approval of the list shall not relieve the Contractor of responsibility for the proper functioning of the completed installation. Items furnished shall be new equipment and materials unless otherwise shown on the Plans and accepted by the Engineer.

Traffic control equipment installed in the controller cabinet shall be products from the same manufacturer, or fully compatible if equipment from more than one manufacturer is used. At existing traffic signal installations being rebuilt, all traffic control equipment furnished by the Contractor shall be compatible with the existing equipment that will remain.

The Contractor shall install all equipment to provide a complete installation including all ancillary wiring and connections to make certain that the equipment functions as a unified system in accordance with these specifications and manufacturer's instructions. The furnishing and installing of such non-listed items shall be considered incidental to the contract.

The Contractor shall supply and furnish all labor, tools, equipment, and incidentals necessary to complete the work.

Subsection 614.09 shall include the following:

Regulations and Codes.

All material and workmanship shall comply with the National Electrical Code (NEC); Rules for Overhead Electrical Line Construction of the Colorado Public Utilities Commission; standards of ASTM, ANSI, and local ordinances which may apply that is in effect on the date of advertisement for bids.

The Contractor shall have an IMSA Certified Traffic Signal Level II or Level III Technician on-site during the period of any splicing or termination of wiring for head and controller installation and shall provide the Engineer with a copy of the individual's certification prior to the start of work.

Schedule of Work and Working Conditions.

At the end of each working period, all excavations shall be barricaded or covered to provide safe pedestrian and vehicular passage.

At points where the Contractor's operations are adjacent to properties of traffic signal interconnect, railway, telephone, power companies, cable/data or any other utility to which damage might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection, thereof, shall have been made.

The Contractor shall cooperate with owners of all underground and overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication or rearrangement work be reduced to a minimum, and that services rendered by those parties not be unnecessarily interrupted.

In the event of interruption of water or utility services as a result of accidental breakage; being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with the authority in restoration of service. If water service is interrupted, repair work shall be continuous until the service is restored. Work shall not be undertaken around fire hydrants until approved by the local fire authority.

Inspection.

All material delivered to the site shall be subject to inspection—prior to or during installation—as deemed necessary by the Engineer. The Engineer may request samples of certain materials from the factory or warehouse for testing purposes prior to delivery on the site. Material which has been rejected by the Engineer shall not be delivered to the work site, and any material rejected at the work site shall be immediately removed from the site.

Any work within the public R.O.W. shall require 2 working days [48 hours] prior notice to the Engineer by the Contractor.

Contractor Supplied Documents.

Upon completion of the Work, the Contractor shall submit as-built Plans and additional data required by the Engineer to show in detail all construction changes. This shall include, but not be limited to wiring, cable, location, depth of conduit, and modifications to original cabinet wiring.

The Contractor shall submit one set of schematic wiring diagrams electronically to the Engineer for the traffic signal controller, the signal installation's light circuits and auxiliary equipment, including units and values of each component used in the cabinet. The diagrams shall show in detail circuits and components. Such components shown, thereon, shall be identified by name or number and in such a manner as to be readily interpreted.

All diagrams, plans, and drawings shall be prepared using graphic symbols shown in ANSI Y32.2, Graphic Symbols for Electrical and Electronic Diagrams.

One copy of the controller cabinet diagram and the intersection and phase diagram, as approved by the Engineer, shall be placed in a heavy-duty plastic envelope with side opening, and affixed to the cabinet door or placed inside the controller cabinet plan drawer prior to Final Acceptance of the project.

Maintaining Existing Traffic Signal Operations.

The Contractor shall furnish all materials, equipment, and labor needed to install and maintain temporary traffic signals as needed during progress of the work. All intersections presently signalized shall be kept in operation until the new signal equipment is properly installed and ready for operation. If in the opinion of the Engineer, temporary signal equipment is not constructible because the installation of new equipment is in the same location as existing equipment, the Contractor shall not proceed with any work which may cause the present equipment to become inoperative until all necessary replacement equipment is onsite.

Existing traffic signals shall remain operational until changing over and connecting new equipment. Signals shall be operational at the close of each day's work, over weekends, and during times when the Contractor is not working. When removal of a signal from operation is proposed, the Contractor shall notify the Engineer of the request in writing and shall provide enough time for Engineer review and obtaining the Engineer's approval at least 5 business days in advance.

The Contractor shall maintain the existing level of service for the traffic signal system from start of project through final acceptance, unless otherwise approved by the Engineer. Lane assignment changes during construction at existing or temporary traffic signals with video detection shall have the detection zones modified to reflect the lane assignments. If temporary signals are necessary to maintain the traffic signal system, the Contractor shall be responsible for furnishing materials, equipment, tools, and labor necessary to install and maintain the temporary signals. Temporary signals must be in the Plans or be approved by the Engineer prior to installation. The Contractor shall maintain any temporary signal installed. The Contractor shall furnish power for operation of a temporary signal.

Temporary span-wire traffic signals are not permitted unless shown on the Plans or approved in writing by the Engineer.

At intersections where power to the signals must be turned off, the Contractor shall request Uniformed Traffic Control. This request must be made at least 2 weeks prior to the time the officer and vehicle are needed.

The above does not apply to intersections which are completely closed to traffic due to construction.

Field Test of Equipment.

Documentation:

1. The Contractor shall submit a field method testing plan in a form acceptable to the Engineer, or;
2. The Contractor shall complete the Checklist supplied by the Engineer for review and approval.

Prior to completion of Work, the Contractor shall make the following tests on traffic signal circuits in the presence of the Engineer and the manufacturer's representative, if a new controller is used. The Contractor shall notify the Engineer 5 business days prior to conducting the tests:

1. Each circuit shall be tested for continuity.

2. Each circuit shall be tested for grounds.
3. Initial functional testing of a new traffic signal system shall be completed while the traffic signal heads are bagged. Heads shall be bagged with orange-colored covers.
4. Visors and signal heads shall be directed to provide maximum visibility.
5. Initial activation shall be between 9:00 a.m. and 2:00 p.m., unless otherwise specified or shown on the plans. Prior to activation, the equipment shown on the plans shall be installed and operable. This includes but is not an inclusive list: pedestrian signals; pedestrian push buttons; vehicle detectors; system communications; and emergency vehicle preemption. Any exceptions to this must be approved by the Owner.
6. Where the signal fails operational testing at the time of the signal turn-on, the signal shall be immediately deactivated with the signal returned to flash or signal heads re-bagged at the Engineer's discretion. Activation will require rescheduling.
7. The Contractor shall use the Engineer provided or approved controller timing plans to ensure proper operation of the traffic signal.
8. Flash and permanent activation shall have the Engineer present.
9. The signal shall be run on flash cycle for a minimum of 24 hours prior to turn-on. After flash operations, a functional test shall be made which demonstrates that every part of the system functions as specified including the Engineer provided or approved signal timing plans. The functional test for each traffic signal system shall consist of at least 5 days of continuous satisfactory operation. If unsatisfactory performance of the system develops, the conditions shall be corrected with the clock reset, and the test shall be repeated until 5 days of continuous, satisfactory operation is obtained.
10. Prior to the functional test, the Contractor shall make every effort to have resolved all operating difficulties and problems. Components of the system must be complete and in operational condition to the satisfaction of the Engineer prior to the functional tests being performed.

Functional tests shall start on any working day except Friday, the day preceding a legal holiday, or on a legal holiday. The Engineer reserves the right to require the test on any day of the calendar week.

Repair costs of any damage caused by public traffic and all other maintenance costs shall be the responsibility of the Contractor until Final Acceptance of the project by the Engineer.

Activation of Traffic Signal Equipment.

Activation of new or modified signal systems shall be made only after all traffic signal circuits have been thoroughly tested as specified and the Engineer concurs with the activation. Lapses in any component or system will necessitate a restart of the 5-day testing period.

Intersection Power.

The Contractor shall coordinate with the electric utility company so that orders may be issued for power connection to allow for adequate time for field testing prior to the specified signal turn-on date. The Contractor shall also coordinate with the electric utility company to ensure that each intersection is checked for and meets the appropriate power requirements for the traffic signal and other equipment.

Permits.

The Contractor shall obtain the appropriate traffic control, construction, ROW, and other permits from Arapahoe County, CDOT, or other jurisdictions as required.

Concrete Work, Asphalt Work, Aggregate Base Course.

All concrete work, asphalt work, and aggregate base course installation to be performed shall conform to the requirements of the latest edition of the CDOT Standard Specifications or as otherwise specified in the Specifications and Plans. Traffic signal pole foundation concrete shall be Class BZ with entrained air.

Subsection 614.13 shall include the following:

Excavation and backfill will not be paid for separately but shall be included with the item being installed.

Concrete and asphalt restoration work that is required due to pole foundation, traffic cabinet, pull box, or conduit installations will not be paid for separately but shall be included in the unit price for the item being installed.

END OF SECTION

Revision of Section 614 Traffic Signal Poles and Mast Arms

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(h) Traffic Signal Poles

Span wire poles, traffic signal poles, mast arms, pedestal poles, base plates, anchor bolts, and connecting hardware shall be of the general configuration shown on the Plans and shall be designed to meet the requirements outlined in the latest edition of "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals," published by AASHTO, for a wind velocity of 100 mph.

Mast arms and poles shall meet the requirements of the Arapahoe County Standard Signal Design details. Mast arms and poles shall match the overall appearance as illustrated and meet the performance requirements of the details and these specifications. Pole supplier submittals shall demonstrate conformity with this intent.

Signal poles and mast arms shall conform to the following specifications:

Material Data:

Component	ASTM Designation	Min. Yield (KSI)
Pole Shaft	A595 Gr. A	55
Arm Shaft	A595 Gr. A	55
Pole Base	A36	36
Galvanizing - Hardware	A153	-
Mast Arm Connection Bolt	A325	81
Mast Arm Attachments	A36	36
Lum. Connection Bolt	A325	81
Lum. Arm Attachments	A36	36
Anchor Bolts	F1554	55

Finish:

Finish Coat - Triglycidyl Isocyanurate (TGIC) or Urethane Polyester Powder

Finish Color - project defined towards conformance with adjacent signals

Traffic signal mast arm poles and mast arms shall be hot dipped galvanized inside and outside, according to ASTM A123 and factory painted with a rust inhibited epoxy primer (minimum dry film thickness of 1.0 mils) and coated with a triglycidyl isocyanurate (TGIC) or a urethane polyester powder (to a minimum dry film thickness of 2.0 mil). The powder type coating shall be electro-statically applied and cured in a gas fired convention oven by heating the steel substrate to a minimum of 350of and a maximum of 400of. All accessible interior surfaces shall be coated with a rust inhibited primer (minimum dry thickness of 1.0 mils).

Painting shall conform to CDOT Standard Specification Section 522 - Duplex Coating Systems.

All poles and appurtenances shall have a powder coat finish. Color shall be project defined

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toward conformance with adjacent signals. Span wire poles shall be finished with one coat of rust inhibited primer and one coat of a compatible topcoat suitable for long wearing outdoor use. Pole surfaces shall be white, clean and free of debris prior to finish application. Finish application shall be completed prior to the installation of signal/pedestrian heads, pedestrian push buttons or any other signed fixture.

Mast arms and poles shall be wrapped for shipping from the factory in heavy duty paper or plastic, to protect them from scratches and abrasions in transit. The mast arms and poles shall remain wrapped until the poles and mast arm is installed.

All galvanized hardware, including anchor bolts, shall be fully galvanized. Hardware exhibiting rust prior to installation shall require factory refinishing or replacement prior to install.

Neither chains nor cables will be used for unloading or installing poles.

Prior to the installation of poles and mast arms, Contractor shall wipe them clean. Following installation of poles, all unused drilled and torched holes made within the poles and mast arms shall be sealed using permanent epoxy seal, sanded flush with surface, color matched to pole finish color. Contractor shall use factory supplied paint to touch up nicks and abrasions. The paint manufacturer's application instructions shall be followed.

Mast arm poles shall be installed with the proper rake as recommended by the manufacturers of the poles to assure a substantially vertical set when the specified signal and lighting equipment is installed.

Plumbing the pole shall be accomplished by adjusting the nuts before the foundation is finished to final grade. Shims or other similar devices for plumbing or raking will be permitted only when approved by the Engineer.

Standard Poles.

Poles shall be straight, with a permissive variation not to exceed 1-inch measured at the midpoint of a 30-foot or longer pole, and not to exceed 3/4-inch measured at the midpoint of a pole shorter than 30 feet.

Standard poles with mast arms shall have a hand hole located opposite the mast arm connection.

The circumference of the poles and mast arms shall be circular. Angles along the circumference, or hexagonal, octagonal, square, or rectangular poles or mast arms shall not be permitted.

Signal Mast Arms.

The Contractor shall field verify with the Engineer all equipment prior to fabrication. Traffic signal mast arms will be furnished with end caps. The Contractor shall submit a method of modification statement to the Engineer for approval before any field modifications to mast arms.

Luminaire Mast Arms.

Luminaire mast arms will be of the single arching type and the length will be 15 feet.

Subsection 614.13 shall include the following:

Traffic signal poles shall include mast arms and installation of the pole, conduit connections, mitigation devices, replacement of surface materials in kind to match existing grade, anchor bolts, pole painting, and all necessary hardware as required and in conformance with the Plans, project specifications, and manufacturer specifications for a fully operational signal.

Concrete replacement within intersection islands created by foundation installation will not be paid separately but shall be included in the unit price for pole installation. Replacement of roadway, sidewalk, or native growth areas created by installation of poles and foundations will not be paid separately but shall be included in the unit price for the pole. Backfill material and seeding will not be paid separately but shall be included in the unit price for the pole.

The Contractor is responsible for legally disposing of all spoils generated from signal foundations in accordance with the Plans and Specifications or as directed by the Engineer or Engineer's representative.

Drilled caissons used as foundations for traffic signal poles will be measured and paid for per Section 503.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Traffic Signal - Light Pole Steel	Each
Traffic Signal - Light Pole Steel (1 -15 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -20 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -25 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -30 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -35 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -40 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -45 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -50 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -55 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -60 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -65 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (1 -75 Foot Mast Arm)	Each
Traffic Signal - Light Pole Steel (Special)	Each

END OF SECTION

Revision of Section 614 Pedestal Poles and Bases

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(h) Traffic Signal Poles

Pedestal Poles shall conform to the requirements of Arapahoe County's Standard Signal Design Plans, current version.

Pedestal poles shall be 4" Schedule 80 spun aluminum pipe unless otherwise approved by the Engineer.

Aluminum pipe poles and bases shall be powder coat painted.

Steel poles shall be ASTM A53 GRB and shall be hot dip galvanized according to ASTM A123 and factory painted with a rust inhibited epoxy primer (minimum dry film thickness of 1.0 mils) and coated with a triglycidyl isocyanurate (TGIC) or a urethane polyester powder (to a minimum dry film thickness of 2.0 mil). The powder type coating shall be electro-statically applied and cured in a gas fired convention oven by heating the steel substrate to a minimum of 350of and a maximum of 400of. All accessible interior surfaces shall be coated with a rust inhibited primer (minimum dry thickness of 1.0 mils).

Painting shall conform to CDOT Standard Specification Section 522 - Duplex Coating Systems.

All poles and appurtenances shall have a powder coat finish. Color shall be project defined toward conformance with adjacent signals. Finish application shall be completed prior to the installation of signal/pedestrian heads, pedestrian push buttons or any other signed fixture.

Pedestal poles shall have a frangible base mounted flush with sidewalk or island.

Subsection 614.13 shall include the following:

Pedestal poles shall include the pole and base, hardware including, but not limited to, handhole covers, pole caps, toe caps, anchor bolts, and nut covers and installation of the pole, conduit connections, replacement of surface materials in kind to match existing grade, and all necessary hardware as required. Pedestal poles will be measured by the actual number that are installed and accepted and shall include all work required to complete the item.

10-foot and 15-foot pedestal type signal poles shall be capable of supporting a signal head using a standard pole top mount.

Drilled caissons used as foundations for traffic signal pedestal poles will be measured and paid for per Section 503.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Traffic Signal Pedestal Pole - Aluminum	Each
Traffic Signal Pedestal Pole - Steel	Each

END OF SECTION

Revision of Section 614 Pedestrian Push Button Post Assembly

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(f) Pedestrian Push Buttons and (g) Accessible Pedestrian Signals

Pedestrian Push Button Post Assembly shall conform to the requirements of CDOT's Standard Plan No. S-614-45.

Pedestrian push button post shall be Schedule 40 Aluminum with a height of 5'-7" or as otherwise specified in the Plans or by the Engineer.

Aluminum posts and bases shall be powder coat painted.

Steel poles shall be ASTM A53 GRB and shall be hot dip galvanized according to ASTM A123 and factory painted with a rust inhibited epoxy primer (minimum dry film thickness of 1.0 mils) and coated with a triglycidyl isocyanurate (TGIC) or a urethane polyester powder (to a minimum dry film thickness of 2.0 mil). The powder type coating shall be electro-statically applied and cured in a gas fired convention oven by heating the steel substrate to a minimum of 350of and a maximum of 400of. All accessible interior surfaces shall be coated with a rust inhibited primer (minimum dry thickness of 1.0 mils).

Painting shall conform to CDOT Standard Specification Section 522 - Duplex Coating Systems.

All posts and appurtenances shall have a powder coat finish. Color shall be project defined toward conformance with adjacent signals. Finish application shall be completed prior to the installation of pedestrian push buttons or any other signal fixture.

Pedestrian push button extenders shall be used as needed per MUTCD and ADA accessibility requirements.

Subsection 614.13 shall include the following:

Pedestrian Push Button Post Assembly will be measured by the actual number that are installed and accepted and shall include post, base, foundation, and all electronic control equipment, mounting hardware, incidental materials, and internal wiring necessary to complete the item.

Push button assembly (integrated push button, informational sign, and housing) will be measured and paid for separately as Pedestrian Push Button or Accessible Pedestrian Signal, as specified in the Plans.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Pedestrian Push Button Post Assembly	Each

END OF SECTION

Revision of Section 614 Pedestrian Push Buttons

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(g) Accessible Pedestrian Signals

Accessible Pedestrian Signal (APS) shall be installed for all locations per the Public Right-of-Way Accessibility Guidelines (PROWAG), latest adopted version, unless otherwise authorized by the Engineer.

APS pedestrian push buttons shall be black Polara iNS2 or iDS2 2-Wire Push Button Station with iCCU-S2 or approved equal for new installations and shall be an audible and vibro-tactile pedestrian signal system. The system shall be direct push button contact type (iNS2) or touchless actuation type (iDS2). For retrofit installations, Polara iNS iNavigator 3-Wire Push Button Station may be used only with the Engineer's approval.

APS pedestrian push buttons shall consist of electronic control equipment, mounting hardware, informational sign, and push button with a raised, vibrating tactile arrow on the button as well as a variety of audible indications for differing pedestrian signal functions.

Materials for the APS integrated push button and sign shall conform to the following:

1. The latest version of the ADA Standards for Accessible Design, Chapter 3, Section 309 Operable Parts.
2. Current Arapahoe County adopted Manual of Uniform Traffic Control Devices (MUTCD), Chapter 4E-Pedestrian Control Features.
3. NEMA TS 2 Section 2.1 requirements for Temperature and Humidity, Transient Voltage Protection, and Mechanical Shock and Vibration.
4. IEC 61000-4-4; 4-5 Transient Suppression requirements.
5. FCC Title 47, Part 15, Class A, Electronic Noise requirements.
6. The APS push button enclosure shall meet the NEMA 250 - Type 4X enclosure requirement.

Extension Bracket Mount.

Pedestrian push button extension bracket mounts shall be installed when 2 push buttons are mounted on the same 4" diameter pole or when a retro-fit of existing installations does not meet the 10-inch horizontal reach ADA accessibility requirement. Extension bracket shall not be longer than 12 inches and may not extend more than 4 inches into the clear circulation pedestrian path unless otherwise approved by the Engineer.

Pedestrian Signing.

Pedestrian informational signs shall be aluminum unless otherwise approved by the Engineer. Sticker type informational signs shall only be used where sign frames are not installed. Sign size shall be 9" X 12" when installed on a signal pole. Sign size shall be 5" X 7 ¾" when installed on a pedestrian pole or pedestrian push button post. The standard pedestrian sign shall be MUTCD R10-3 or R10-3b with the correct directional arrow.

Subsection 614.13 shall include the following:

Accessible Pedestrian Signal will be measured by the actual number that are installed and accepted and shall include the integrated push button, informational sign, housing, and all electronic control equipment, mounting hardware incidental materials, and internal wiring necessary for the operation of the item.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Accessible Pedestrian Signal	Each

END OF SECTION

Revision of Section 614 Traffic Signal Faces

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(i) Traffic Signal Faces

Housing.

The traffic signal housing shall be for direct LED use or be a retrofit LED in a traffic signal housing built to the ITE Vehicle Traffic Control Signal Head (VTCSH) standards without modification to housing or need of special tools. The lens, lamp module, and gasket shall be weather tight and fit securely in the housing and shall be Gelcore, Dialight, or approved equal.

Mast Arm Mounts.

Signal head placement as shown on the Plans are representative only. Final placement shall be approved by the Engineer. All mast arm signal head mounts shall be Pelco Astro-Brac, Sky Bracket, or approved equal mounting hardware. Each head shall be mounted with a separate mount.

All pedestrian hybrid beacon (HAWK) mast arm and side of pole mounts shall be Sky Bracket HAWK Beacon Mount or approved equal.

Side of Pole and Top of Pole Mounts.

One-way side and top mounts shall be aluminum and shall be highway black in color. The upper and lower arm assemblies for one-way side of pole mounts shall use elbows and not "T" fittings. Two-way side of pole mounts for signal and pedestrian signal heads shall be aluminum and shall be highway black in color. Two-way side of pole signal head mounting assemblies shall use a "T" fitting in the center frame pipe. Elbows shall be used on the upper and lower arm assemblies at the signal head mounting locations.

(j) Backplates

All overhead vehicular signal heads mounted on mast arms shall have aluminum black backplates with a 2 inch wide 3M fluorescent yellow diamond grade retroreflective border.

Backplates shall be either all one piece or sectional. Sectional backplates shall be riveted together. No screws shall be allowed for putting backplates together.

Backplates shall be 5 inches in width unless otherwise approved by the Engineer and shall be louvered to allow airflow. No background light shall show between the backplates and the signal face or between sections of the signal head. Backplates shall be installed to the signal head using the appropriate screws and 1/4-inch zinc plated flat washers.

Subsection 614.09 shall include the following:

All signal faces installed prior to final activation of the system shall be masked with coverings designed for the purpose of masking signal heads which clearly indicate that the signal is not operational but allow for testing prior to activation. The covering shall be over the entire head and shall be securely fastened. No adhesive used to secure the head covering shall touch any

part of the head or mounting assembly. Signal heads and faces shall not be installed sooner than 5 days prior to activation, unless approved in writing by the Engineer.

All mast arm mounted heads shall be mounted at the location approved by the Engineer. No holes shall be placed into the mast arms until actual head location has been determined in the field by the Engineer.

Subsection 614.13 shall include the following:

Signal heads will be measured by the actual number that are installed and accepted and shall include all work necessary for the final installation and shall be operational.

Backplates will not be measured and paid for separately but shall be included in the Traffic Signal Face item.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Traffic Signal Face (12-12-12)	Each
Traffic Signal Face (12-12-12-12)	Each
Traffic Signal Face (12-12-12-12-12)	Each

END OF SECTION

Revision of Section 614 Pedestrian Signal Face (Countdown)

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(i) Traffic Signal Faces

All Pedestrian Signal Heads shall be polycarbonate 18-inch clamshell mounting type. Units shall be highway black in color. Units shall be 16-inch LED with a Hand/Man and Countdown display.

The countdown signal heads shall have the following characteristics:

1. Single, self-contained retrofit module for clamshell housing.
2. Two message overlay combining Portland Orange LED for the “Hand: and White LED for “Walking Man.”
3. Double digit display for countdown made of Red LEDs.
4. Timing is derived directly from the controller and no timing shall be programmed, or otherwise initiated.
5. Countdown numerals shall be illuminated continuously during countdown and not alternating.
6. Pedestrian signal head shall blank out countdown portion if the countdown is different than the controller.

Subsection 614.13 shall include the following:

Pedestrian Signal Heads will be measured by the actual number that are installed and accepted and shall include all work necessary for final installation.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Pedestrian Signal Face (16) (Countdown)	Each

END OF SECTION

Revision of Section 614 Traffic Signal Controller and Cabinet

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

(b) Traffic Signal Controllers - General

Traffic signal controller shall be an Econolite Cobalt 2100 G-Series, with EOS operating system factory installed or approved equivalent.

The Contractor shall be responsible for programming the controller and associated communications per the approved traffic signal timing work order included in the pay item and at no additional cost.

The controller and cabinet shall be 100% compatible with Arapahoe County's existing computerized signal system which utilizes Econolite (Econolite Centrac System). Econolite's latest model controller that is deemed compatible with current County signal equipment/system and that meets or exceeds current NEMA TS2-Type and NTCIP requirements shall be installed unless controller type is otherwise noted on the approved Plans.

An actuated controller shall be completely solid state, electronic device capable of selecting and timing traffic movements. It shall provide timing and load switch control of each major vehicular phase, including concurrent associated pedestrian movements. The controller shall conform to the latest NEMA specifications and shall provide for complete and full operation of 16 phases, 8 configurable concurrent groups in 4 timing rings.

The controller supplied shall be the manufacturer's latest, first line production model tested and delivered by a domestic manufacturer who is regularly engaged in the construction of such equipment. Each controller shall be supplied with a complete set of operational and service manuals, wiring schematics and parts layout up to a maximum of ten sets per order. Any controller for which these documents are not available is not a production model within the meaning of these specifications.

The controller shall have all electronic components easily accessible and arranged in functional groupings on the printed circuit boards. Printed circuit boards shall be designed to facilitate identification of components for maintenance purposes. Printed circuit design shall be of NEMA specification quality and designed so that components may be removed and replaced without permanent damage to the board or track.

(c) Controller Cabinets

Traffic signal cabinet shall be an Econolite P44 NEMA TS2 Type 1, 16 Channel or approved equal.

All controllers and auxiliary equipment shall be housed in a factory wired, weatherproof, metal cabinet. The cabinet shall have minimum dimensions of height - 55 inches, width - 44 inches, and depth - 26 inches. The cabinet shall be constructed of 0.125 minimum thickness aluminum having a natural finish with anti-graffiti coating. Cabinets shall be braced internally or by folded seams to provide sufficient rigidity to withstand normal handling and transport to the field location without deforming.

The main door shall have a self-locking, keyed, tumbler lock with two keys. Doors shall have neoprene gaskets of sufficient thickness to provide a rain tight and dust tight seal.

A police or auxiliary door shall be provided to provide access to a panel with labeled switches wired for: automatic (normal) to flashing operation; signal power on/off; and automatic (normal) to manual operation. A terminal to connect a hand control system which allows for manual operation shall be provided.

The cabinet shall be supplied with a full complement of Power Supply, Channel Detector Cards (if applicable), Bus Interface Unit (BIU), Flash Transfer Relays, and Load Switches. Where not used resulting from intersection configuration, unused components shall be delivered to the County as spares.

Cabinets shall have the following items included in addition to the items specified for each cabinet.

1. Cabinet assembly shall be fully wired and capable of receiving the specified controller and support equipment.
2. Cabinet shall be natural aluminum finish with one set of anchor bolts in accordance with FHWA-IP-78-16 specifications.
3. Conflict monitor, Econolite MMU2-16LEIP
4. Rack Detector Assembly, shelf mount, 16 channel plus 4 channels EVP.
5. Telemetry, see Revision of Section 614 Telemetry (Master) as applicable.
6. Wired for Opticom pre-emption equipment
7. Internal lighting
8. Cabinet shall also include the following:

Quantity	Item
2	Corbin locks
1	Slide-out shelf/drawer storage unit
1	Slot for two-circuit flasher
6	Flash transfer relays
1	Power Supply
3	Bus Interface Unit (BIU)
16	Load Switches
1	Two-circuit Flasher

Assembly wiring.

All cabinet wiring shall be neatly arranged and laced or enclosed in plastic tubing. Wiring shall be continuous from its point of origin to its termination point. Butt type connections/splices are not acceptable. No harness or wire shall be attached to any shelf rack or other point where it may be damaged by movement of shelves or doors.

Terminal Facilities.

Terminal facilities (load bays) shall be firmly attached in a position not less than 6 inches from the bottom of the cabinet so as to provide easy access and maximum convenience to the user.

Side mounted auxiliary panels should be firmly installed with the forward edge not more than 4 inches from the door sill and not less than 6 inches from the bottom of the cabinet in all

cabinets.

The load bay and its associated equipment, harness, switches, etc., shall be grouped on removable panels. Each panel or group of receptacles and connecting cables shall be arranged to permit so that work can be performed on panel backs or cables.

The load bay shall be protected by a main circuit breaker. A surge arrester with a suitable radio interference filter shall be supplied. The arrester shall be a three-electrode type with the following ratings:

- Impulse breakdown - less than 1,000 volts in less than .1 microseconds at 10 KV per micro-second.
- Standby current - less than 1 milliampere
- Striking voltage - greater than 212 VDC
- Energy capability - capable of withstanding pulses of peak current each of which will rise in 8 microseconds and fall in 20 micro-seconds to one-half the peak voltage at 3 minute intervals.

Field terminals shall be screw type, capable of accommodating at least three number No. 12 AWG wires. All terminals in the load bay shall be permanently identified by engraving, silk screening or contrasting plastic labels. Terminal blocks shall be the barrier type and no live parts shall extend above the barrier.

A convenience outlet with a ground fault interrupter fused at 15 amps shall be provided. It should be located in a position which is convenient and safe for service personnel.

All AC power busses, switch or relay lugs and/or similar activity connection points which extend more than 1-1/2 inches from the panel are to be protected by insulation for safety. The locations of these items shall provide reasonable protection for service personnel.

Flash transfer relays shall be as manufactured by Midtex Model 136-62 T 3A1, 120 VAC, DPDT, 30 amp with Jones Plug base and dust cover or approved equal.

Flasher.

The cabinet shall be equipped for flashing operation of signal lights with a 2-circuit solid state flasher in accordance with the latest NEMA specifications (15 amps per circuit). Flashing operation shall be set for flashing yellow on all main street approaches and red on all other approaches unless otherwise specified by the engineer. Pedestrian and turn signals shall be extinguished during flashing operation. The flashing mechanism shall remain in operation during shutdown or removal of controller.

Load Switches.

The cabinet shall be equipped with solid state load switching assemblies in accordance with the latest NEMA specification. Each load switch shall be equipped with a 3 input LED indicator. Load switches shall contain 3 separate cube type solid state relays, which use a solid state switch which is capable of operations at 240 VAC and 25 amps when properly heat sinked but derated to 10 amps when used in load pack assembly.

Conflict Monitor.

The cabinet shall have provision for conflict prevention in accordance with the latest NEMA specification. Conflict prevention shall be provided by a conflicting display monitor unit that monitors all green, yellow and walk displays and detects absence of reds to cause flashing operation and stop timing if conflicting indications are detected. Removal of the monitor from the cabinet shall cause flashing operation.

Ethernet patch cords, Cat5E/Cat6, shall be of length suitably long to be connected between the communications equipment (i.e. fiber optic ethernet switch) and conflict monitor. Appropriate strain relief shall be applied to the patch cords in the traffic signal cabinet at an adequate number of points as to protect the cords from snagging and catching during equipment installation and removal and during standard maintenance operations.

Emergency Vehicle Preemption.

The cabinet shall be equipped and wired with an Opticom card rack mount for 3M Model M752, M754 or approved equal. All equipment shall be capable of accommodating a minimum of two modules with capability of four-channel operation. The cabinet shall be equipped with the number of phase selectors required for full operation.

Communications.

Cabinet shall be equipped and wired for Ethernet with Ruggedcom switch, CDMA modem, or other as specified.

Uninterrupted Power Source.

All traffic signal controller cabinets shall include an Uninterrupted Power Supply (UPS).

Subsection 614.10 shall include the following:

Signal cabinet locations shown on the Plans are approximate. The Contractor shall coordinate with the Traffic Engineer or Engineer's Representative on location and orientation of the cabinet prior to installation.

The ground polymer concrete signal cabinet base shall be installed level and as shown on the approved Plans or as directed by the Traffic Engineer or Engineer's Representative.

The seam between the base and the cabinet shall be caulked both inside and outside the controller base to prevent water seepage. The cabinet shall be set flush on the cabinet base.

Traffic cabinet doors shall not swing towards traffic unless approved by the Traffic Engineer or Engineer's Representative.

Subsection 614.13 shall include the following:

The Contractor shall assemble the traffic signal controller, cabinet, and other auxiliary hardware in accordance with the Arapahoe County criteria.

All traffic signal timing (controller programming) shall be bench tested with a minimum of 72-hours burn time to verify successful operation prior to installation. The Contractor shall coordinate all testing and installation procedures with the Arapahoe County Traffic

Operations staff. The Contractor shall contact Arapahoe County Traffic Operations at (720) 874-6500 for all testing and installation requirements.

Traffic Signal Controller Cabinet will be measured by the actual number that are installed, made operational and accepted. Traffic Signal Controller Cabinet shall include the controller, the cabinet, and all auxiliary equipment required on the Plans and shall include all labor, materials, wiring and wiring re-connection (including Utility electrical energy power feed) required to provide and install a complete system and successful operation of the item.

Traffic signal cabinet base and foundation, as required, will not be measured and paid for separately but will be included in the Traffic Signal Controller Cabinet item.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Traffic Signal Controller Cabinet	Each

END OF SECTION

Revision of Section 614 Traffic Signal, Lighting, and Communication Conduit

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

Conduit runs shown on the approved Plans are tentative as to routing and may be changed, as directed by the Engineer, to avoid underground obstructions. Any change in location from those shown on the approved Plans shall require the prior approval of the Engineer and shall be accurately recorded on Project as-built Plans.

(l) Traffic Signal Electrical Conductors and Control Cables

All conductors shall be run in conduit except when run in metal poles. Conduits shall be Polyvinyl Chloride rigid plastic (PVC), High-Density Polyethylene (HDPE), or galvanized rigid steel (GRC) type conforming to the Plans and Specifications. Rigid PVC conduit and HDPE conduit shall only be used for underground installations; conduit used above ground shall be galvanized rigid steel.

Existing underground conduit that is incorporated into a new system shall be cleaned with a mandrel and compressed air.

Rigid Conduit (PVC).

Rigid PVC conduit shall be Schedule 80, Type 2 and shall be manufactured of high-impact PVC and shall conform to industry and Commercial Standards No. CS-207-60. Each length of PVC conduit and the various PVC fittings (expansion joints, coupling, adapter, etc.) shall bear the label of Underwriter's Laboratories, Inc., or be approved by the Engineer. The conduit shall be of the size or sizes shown on the approved Plans or as indicated in these specifications.

Rigid PVC conduit ends shall be squared and trimmed after cutting to remove rough edges. All connections shall be made using E-Loc couplings or approved equal.

High-Density Polyethylene (HDPE) Conduit.

HDPE conduit shall be used for bored installation and shall conform to NEMA requirements. When HDPE conduit is used, transition to PVC conduit using E-Loc fittings is required for entrance into pull boxes.

Galvanized Rigid Conduit - Steel (GRC).

Steel conduit and fittings shall be rigid galvanized steel and shall be uniformly and adequately zinc-coated by the hot-dipped process conforming to ASTM Designation A153. Joints shall be set up tight with squared ends. Fastenings shall be secured and of a type appropriate in design and dimensions for the particular applications. Couplings, connectors, and fittings shall be approved types specifically designed and manufactured for the purpose. Fittings shall be installed to provide a good electrical ground throughout the conduit system. The interior as well as the exterior of a 6-inch sample cut from a center of a standard length of conduit when tested in accordance with the applicable portion of ASTM Designation A239 shall not show a fixed deposit of copper after four one-minute immersions in the standard copper sulfate solution. The interior of the rigid conduit shall have a continuous coating of lacquer or enamel. Each length shall bear the label of Underwriter's Laboratories, Inc., and shall conform

to appropriate articles of the Code. The Contractor shall provide catalog information for review by the Engineer prior to purchase and installation of GRC.

The end of metallic conduit shall be threaded and well-reamed to remove burrs and rough edges. Field cuts shall be made true and square so that the ends will butt or come together for the full circumference, thereof. Slip joints or running thread will not be permitted for coupling conduit. When a standard coupling cannot be used, weatherproofed threaded three-piece union shall be used. All three-piece unions must be threaded; non-threaded couplings shall not be accepted.

The threads on all conduits shall be well painted with a high-quality rust-preventive paint before couplings are made up. All couplings shall be tightened until the ends of the conduits are brought together so that an adequate electrical connection will be made throughout the entire length of the conduit run. Conduit stubs, caps, and exposed threads, as well as any point along the surface of the conduit that has been injured in handling or installation, shall be painted with high quality asphalt bituminous or other paint suitable for the purpose or replaced as directed by the Engineer or Engineer's Representative.

Subsection 614.09 shall include the following:

General Requirements.

Underground utility information shown on the Plans is for information only. The Contractor shall field locate and verify utility information before starting installation of underground conduit runs and traffic signal pole foundations.

The Contractor shall cooperate with any other Contractor under contract with the Engineer and with utility companies providing services to the project area while installing underground conduit runs.

Electrical conduit shall be installed in accordance with the applicable requirements described in the latest revision of the Colorado Department of Transportation Utility Manual, as amended.

All buried wiring shall be placed in a conduit. It will be the option of the Contractor, at their own expense, to use larger size conduit if desired. Where larger size conduit is used, it shall be for the entire length of the run from outlet to pull box or from pull box to pull box. No reducing coupling will be permitted in any conduit run. The Engineer must approve increased sizes prior to installation.

Conduits shall be installed under existing pavement through use of directional boring operations. Conduits under pavement may be installed through use of open trench operations only where approved by the Engineer.

Conduit installation shall include the installation of marking tape laid in the backfilled trench at a depth not more than 8 inches or less than 4 inches below finished grade. Heavy gauge polyethylene film (0.004 inch tape, with legend "Caution Buried Electric Line Below"), shall be used. Where tape length ends and conduit run continues, lapping of not less than 6 inches will be provided. No glue or adhesive will be allowed to join separate tape sections.

Conduit runs shown on the Plans are tentative as to routing and may be changed as directed by the Engineer to avoid underground obstructions. In the event of any change from the location shown on the Plans, accurate records shall be incorporated into the as-built Plans, and all necessary details and as-built Plans submitted to the Engineer before final payment is made.

Installation Methods.

Conduit sizes and locations shall be as shown on the Plans. Post installation, conduits shall be immediately plugged or capped per project specifications pending wiring installation. A T-Post, 2"x4", 4"x4" or other applicable marker shall be installed at the conduit ends when directed by the Engineer or Engineer's Representative. Plan set as-builts shall show these conduit ends with survey data or field measurement triangulations including approximate depth.

Existing empty underground conduit to be incorporated into a new system shall be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air and capped until put into service. The Contractor shall search for such conduit in the general vicinity shown on the Plans and shall notify the Engineer in advance as to when this operation will take place. The Engineer may, at their option, be present to monitor the activity. The cost of such activity shall be incidental to the project. If such conduit has been rendered inoperative prior to the signal installation, the Contractor shall notify the Engineer and payment for new conduit shall be made as per the unit costs provided in the bid or negotiated per field conditions.

Conduit size shall be consistent for the entire length of the run from outlet to outlet, and no reducing couplings shall be allowed. Conduits terminating in poles, cabinets, or pedestal bases shall extend above the foundation a maximum of 4 inches and a minimum of 2 inches vertically and slope toward pole hand holes or transformer base openings. Conduit entering pull boxes shall terminate a minimum of 2 inches and a maximum of 4 inches above the crushed rock. See Arapahoe County Standard Signal Design Plans for details.

Conduit ends shall be accomplished by a 90 degree elbow with a minimum radius of 48 degrees. Where two or more conduits meet, all 90 degree elbows shall be brought together in the center of the pull box or cabinet foundation. Conduit shall only enter through the bottom of a pull box. Galvanized rigid conduit terminations within pull boxes shall be fitted with an end coupling as well as insulating bushings to prevent chafing the wire.

Conduits required to be terminated, stubbed, and plugged shall be as shown on the Plans and as directed by the Engineer. Capping may be permitted as a temporary solution pending intersection wiring. After wiring, traffic signal conduits shall be sealed using brass embedded duct seal with ITS conduits requiring use of reusable conduit duct plugs per the appropriate standards. Reusable split conduit duct plugs shall be used where cable is present. Unused split conduit ports shall be filled per manufacture's specifications. Manufactured Conduit plugs shall be expandable, sized for the conduit to create a watertight seal.

Ends of unused metal type conduit shall be threaded and shall be capped with standard pipe caps until conductors are in place. When caps are removed, the threaded ends shall be provided with conduit bushings. Ends of unused non-metallic type conduit shall be plugged with a removal conduit plug and ends of conduit populated with wire shall be plugged with brass wool embedded duct seal to prevent water infiltration and rodent infestation of the

conduit.

Conduit installed outside of the traveled portion of the roadway and out of future roadway areas shall be laid as follows: maximum depth of 30 inches and a minimum depth of 24 inches. Conduit installed under the traveled portion of the roadway and under future roadway areas shall be laid at a minimum depth of 36 inches. Conduits under railroad tracks shall not be less than 42 inches below the bottom of the tie or less than the depth below the bottom tie as specified by railroad code.

An 1/8-inch pull tape shall be installed in all new conduit and all existing conduit where a cable is added, or an existing cable is replaced. At least 2 feet of pull tape shall be doubled back into the conduit at each termination.

All conduits, including conduits from the home run pull box to the controller cabinet, shall include pull tape and 14-gauge copper stranded tracer wire inside the conduit for future locating of conduits. A minimum of 2 feet of slack tracer wire shall be left in each pull box and in the controller cabinet. For new installations adhering to these Specifications, tracer wires in communications conduits shall be connected to the pull box lid test points. Where existing communications pull boxes don't have embedded test points, tracer wires shall be spliced in all intermediate pull box locations to present a continuous end-to-end locate link.

Excavation and Backfilling.

The excavations required for the installation of conduit shall be performed in such a manner as to avoid unnecessary damage to streets, sidewalks, landscaping, and other improvements. Trenches shall not be excavated wider than necessary for the installation of the electrical appurtenances. Concrete removal limits shall be to the nearest pavement, sidewalk or curb and gutter control joint. Trenching occurring in any other pavement shall be neatly sawcut and existing asphalt to be removed in a manner that does not damage surrounding pavements. Excavation shall not be performed until immediately before installation of conduits. The material from the excavation shall be placed in a position not to cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

Trenches outside the traveled portion of the roadway shall be backfilled with granular material as approved by the Engineer, in 6-inch lifts and each lift compacted. Off-street trenches in native soil areas shall be backfilled with native soil and shall be compacted and shaped to match the surrounding surface. Surface materials in native soil areas disturbed by excavation and backfilling operations shall be replaced in kind equal to or exceeding original conditions. This shall include replacement of sod in lawn areas or reseeding in native soil areas at no additional cost to the project as directed by the Engineer.

Trenches within islands, under sidewalks, in parking lots or other trenches in paved areas outside the traveled portion of the roadway shall be backfilled with Class 6 granular aggregate base course material as approved by the Engineer. The backfill shall be in 6-inch lifts and each lift compacted up to a point within 3 inches of existing grade.

Trenches within or across the roadway, bike paths, trails and sidewalks shall be backfilled with Engineer-approved structural backfill within 3 inches of existing grade, except on concrete surfaces which shall be removed to the nearest control joint and replaced in kind to match existing pavement thickness, grade, and finish. The top 9 inches minimum of all

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trenches in asphalt roadways or asphalt off-roadway areas shall be filled to match existing surrounding pavement thickness, grade, and surfacing materials with hot asphalt mix and the top 2 inches being Grading SX. The asphalt removal shall extend 6 inches past the asphalt patch on all sides and be a minimum of 24 inches wide. All roadways shall be repaired within 48 hours of cutting the surface.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time, unless otherwise permitted by the Engineer. A minimum of one lane of traffic in each direction shall be kept open for each direction, unless otherwise permitted by the Engineer.

Excavations at intersections being reconstructed or improved shall be performed and backfilled before other improvements are completed so as to not require the repair or replacement of newly installed sidewalks, curbs and gutters, pavement, or landscaping.

Prior to backfilling, the Engineer shall have the opportunity to inspect the trench, conduit, and tape placement.

Potholing is required to confirm depth of existing conduits before boring. Epoxy of core back in place is required for cement and asphalt potholes, and patching of concrete is required for sidewalk potholes.

Subsection 614.13 shall include the following:

Conduit shall be measured by linear foot and measured horizontally from centerline of pull box to centerline of pull box or centerline of pull box to centerline of controller cabinet. Elbow, vertical, and slack quantities shall be incidental to the horizontal dimension.

Subsection 614.14 shall include the following:

The cost for conduit installations will include costs for all necessary items including but not limited to boring, backfill, saw cutting, patching, jacking, drilling pits, removal of pavement, sidewalk, gutters and curbs, and their replacement in kind to match existing grade and other incidentals necessary to complete the conduit installation in place for acceptance.

Concrete replacement within roadway or intersection islands created by installation of conduit will not be paid for separately but shall be included in the unit price for conduit.

Replacement of roadway, sidewalk, landscaped areas, or native growth areas created by installation of conduit or potholes will not be paid for separately but shall be included in the unit price for conduit.

The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment shall be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
1 Inch Electrical Conduit	Linear Foot
1-1/2 Inch Electrical Conduit	Linear Foot
2 Inch Electrical Conduit	Linear Foot
2-1/2 Inch Electrical Conduit	Linear Foot
3 Inch Electrical Conduit	Linear Foot
3-1/2 Inch Electrical Conduit	Linear Foot
4 Inch Electrical Conduit	Linear Foot
5 Inch Electrical Conduit	Linear Foot
6 Inch Electrical Conduit	Linear Foot

END OF SECTION

Revision of Section 614 Intersection Detection System (Camera)

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This Specification sets forth the minimum requirements for a system that monitors vehicles on a roadway via processing of video images and provides detector outputs to a traffic controller.

Subsection 614.08 shall include the following:

Intersection Detection System.

Where specified on the Plans, video detection shall be installed. The intersection detection systems shall be Econolite Autoscope Vision system or approved equal, and shall include network interface ports for remote monitoring and management.

The equipment shall be 100% compatible with the hardware and software used by Arapahoe County. Determination of compatibility is within the sole discretion of Arapahoe County. The equipment must be compatible with the existing Arapahoe County ATMS, Econolite Centracs System.

Equipment shall be as noted or approved equivalent. Arapahoe County Traffic Ops reserves the right to modify equipment as new technology is evaluated.

Functional Capabilities.

The intersection detection system shall be able to detect the following:

- Stop bar through and left turn
- Bicycles
- Pedestrians
- Pedestrian cross walks
- Advanced detection up to 600 feet
- Left turn advance
- Departure

Environmental.

The intersection detection equipment shall be able to withstand -29°F to 140°F and relative humidity of 0 to 95%, non-condensing.

Installation Requirements.

The Contractor shall be responsible for furnishing and installing of all hardware required for successful operation of the intersection detection system, including but not limited to, additional cable and wiring which may not be specifically called out in the above list, additional mounting hardware not called out, and all ancillary work required to install the system in accordance with the NEC and all local ordinances which apply.

Ethernet patch cords, Cat5E/Cat6, shall be of length suitably long to be connected between the communications equipment (i.e. fiber optic ethernet switch) and Intersection Detection System. Appropriate strain relief shall be applied to the patch cords in the traffic signal cabinet at an adequate number of points as to protect the cords from snagging and catching during equipment installation and removal and during standard maintenance operations.

All installation shall be in accordance with the manufacturer's recommendations.

Subsection 614.13 shall include the following:

Intersection Detection System (Camera) shall be measured and paid by the number of intersections at which the system is installed. The item shall include all equipment, labor, materials, and ancillary hardware required to provide a fully functional system to the satisfaction of the Engineer.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Intersection Detection System (Camera)	Each

END OF SECTION

Revision of Section 614 Emergency Vehicle Pre-emption Detection

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of the installation of emergency vehicle pre-emption detection at signalized intersections. This work shall be done per these specifications and in conformity with the details shown on the Plans.

Subsection 614.08 shall include the following:

Emergency Vehicle Pre-emption Detection. The Contractor shall contact the Traffic Engineer to verify the type of emergency vehicle pre-emption detection unit to install.

Emergency detection units shall be the following:

- a) 722 detection where opposing lanes (N/S, E/W) have signalized left turns.
- b) 721 detection where opposing lanes (N/S, E/W) have no signalized left turns.
- c) 711 detection where there is no opposing lanes.
- d) Phase Selector cards shall be 762 Phase Selectors.

Subsection 614.10 shall include the following:

Emergency vehicle pre-emption detection shall be installed per the manufacturer's recommendations.

Subsection 614.13 shall include the following:

Emergency vehicle pre-emption detection will be measured by the actual number of detector head units installed, made operational, and accepted and shall include all equipment and wiring necessary for operation.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Fire Preemption Unit	Each

END OF SECTION

Revision of Section 614 Uninterrupted Power Supply (UPS)

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of installation of the uninterrupted power supply for the traffic signal. The work shall be done per these specifications. Equipment shall be as noted or approved equivalent. Arapahoe County Traffic Ops reserves the right to modify equipment as new technology is evaluated.

Subsection 614.08 shall include the following:

Uninterrupted Power Supply (UPS). The Uninterrupted Power Supply (UPS) shall be a Marathon Power Ruggedized Vault UPS system or approved equivalent. Specific model shall be based on signal design for electrical loads and intended runtime.

UPS system shall include the following:

- a) SNMP networking
- b) Standard bypass switch
- c) 3-battery configuration
- d) Ethernet patch cable

The Contractor shall contact the Traffic Engineer to determine the specific model based on designed electrical loads and intended run time of 2 hours and going to Flash after 2 hours to conserve power.

Subsection 614.10 shall include the following:

UPS and cabinet compatible battery shelf shall be installed per the manufacturer's recommendations.

Ethernet patch cords, Cat5E/Cat6, shall be installed of length suitably long to be connected between the communications equipment (i.e. fiber optic ethernet switch) and UPS. Appropriate strain relief shall be applied to the patch cords in the traffic signal cabinet at an adequate number of points as to protect the cords from snagging and catching during equipment installation and removal and during standard maintenance operations.

Subsection 614.13 shall include the following:

UPS shall be measured per unit installed, made operational, and accepted and shall include all equipment and wiring necessary for operation. Operation shall include installation of SNMP network adapters and Cat5E cables as necessary to facilitate network communications.

The County may elect to either have the Contractor program the communications, providing the required details, or may opt to program the communications using in-house personnel. Where programming is identified as the Contractor's responsibility, programming shall be at

no additional cost.

Subsection 614.14 shall include the following:

Payment will be made under:

Pay Item

Uninterrupted Power Supply

Pay Unit

Each

END OF SECTION

Revision of Section 614 Telemetry (Master)

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of termination of fiber optic cable at each traffic signal controller cabinet (“traffic signal cabinet”) location(s) as identified in the planned or contracted scope of work. This work also includes furnishing and installing all necessary fiber optic cable and telemetry equipment including, but not limited to, fiber splice closures, termination panels, termination bulkheads, bulkhead plates, and patch cords.

Subsection 614.08 shall include the following:

Fiber Optic Cable Laterals

Fiber Optic Cable Laterals shall be installed at each traffic signal controller cabinet (“traffic signal cabinet”) and other location(s) as identified in the project plans, contracted scope of work, or as otherwise directed by the project engineer. Fiber Optic Cable Laterals to traffic signal cabinets shall be 12 fibers count of the same manufacturer and model as the fiber backbone and shall be fusion spliced to the fiber backbone. Fusion splices of fiber optic cable laterals shall be protected and stored within Fiber Optic Splice Closures per “Revision of Section 614 Fiber Optic Splice Closure.”

Fiber Cable Routing inside Traffic Signal Cabinet.

Fiber cable shall be neatly run within the controller cabinet adjacent to cabinet mounting channels, securely attached at a minimum of three locations with a minimum of two locations attached to the cabinet mounting channels, with adequate strain relief conforming to manufacturer specifications. Twenty-five (25) feet of fiber cable slack shall be left inside each traffic signal cabinet.

Fiber Optic Patch at the Termination inside Traffic Signal Cabinet.

Fiber optic cable shall be terminated within the traffic signal cabinet within a Fiber Optic Termination Panel per Revision of Section 614 Fiber Optic Termination Panel, securely fastened to the left side wall of the traffic signal cabinet using cabinet channel clips or DIN rail mounts. Shelf mounting, use of Velcro, adhesive based or other methods for mounting of the termination panel shall require Engineer approval.

Fiber optic patch cord cables, Single-Mode (SM), shall be of length suitably long to be connected between the Fiber Optic Termination Panel and the communications equipment (i.e. fiber optic ethernet switch). Patch cord couplings, Straight Tip Connector (ST) or Lucent Connector (LC), shall be compatible with termination points. Appropriate strain relief shall be applied to the patch cords in the traffic signal cabinet at an adequate number of points as to protect the cords from snagging and catching during equipment installation and removal and during standard maintenance operations. Handhole/comm box locations, backbone connection locations, splice diagrams and Ethernet Switch port designations shall be provided by the Engineer.

Subsection 614.13 shall include the following:

Telemetry (Master) includes all required materials, hardware and labor required to interconnect the fiber optic lateral cable from the backbone to and inside the Traffic Signal Cabinet as shown in the planned or contracted scope of work:

- a) All required termination materials and ancillary hardware and labor required to accomplish the cabinet termination.
- b) All required fiber optic lateral cable.
- c) All required optical splice enclosures.
- d) All required optical splice trays.
- e) All other labor and material necessary to complete the item.

All labor and materials necessary to complete this item shall be considered included in the unit price and will not be paid separately. Verify all materials and hardware with the Engineer.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Telemetry (Master)	Lump Sum

END OF SECTION

Revision of Section 614 Fiber Optic Cable (Single Mode)

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

Fiber Optic Cable (Single Mode) consists of furnishing and installing backbone and lateral single mode fiber optic cables as indicated on the Plans.

Subsection 614.10 shall include the following:

Where specified on the Plans, interconnect wire connecting traffic signal controller cabinets shall be fiber optic type. Fiber optic cable runs consist of a main cable, which runs the length of the project, and connects to the individual local controller cabinets and is explained in detail in this specification.

Fiber optic cable shall be loose tube, powder dry block, non-armored outdoor cable. Lateral interconnect cable shall consist of 12 single mode fibers, or as defined in the Plans. Backbone interconnect cable shall consist of 96 single mode fibers, or as defined in the Plans.

Fiber optic cable for installation in conduit shall meet the applicable portions of I.M.S.A. Specification 60-2 or approved equal. A 16 ga (min) stranded trace wire and mule tape shall be installed in conduit with fiber. Fiber markers as specified in this section shall be installed along the duration of the conduit/fiber run at minimum 500-foot intervals or at acceptable intervals as indicated on approved Plans.

General.

- a) The fiber optic cable shall meet all requirements stated in the specification. The cable shall be an accepted product of the United States Department of Agriculture Rural Electrification Administration (REA) as meeting requirements of 7CFR1755.900.
- b) The cable shall be new, unused and of current design and manufacture.
- c) If terminated a - termination panel (universal mount panel adapter "ST" type) is required in the controller cabinet. See Revision of 614 Fiber Optic Termination Panel.
- d) Connectors shall be "ST" single mode type.

Fiber Characteristics.

- a) All fibers in the cable must be usable fibers and meet this specification.
- b) All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements of this specification.
- c) Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.
- d) The single-mode fiber utilized in the cable specified herein shall conform to the following specifications:
 - a. Typical Core Diameter: 8.3 μm .
 - b. Cladding Diameter: 125.0 \pm 1.0 μm .
 - c. Core-to-Cladding Offset: \pm 0.8 μm .
 - d. Cladding Non-Circularity: 1.0%. Defined as: $[1 - (\text{min. Cladding dia.} / \text{max. Cladding dia.})] \times 100$.

- e. Coating diameter: $245 \pm 10 \mu\text{m}$.
- f. Colored Fiber Diameter: nominal $250 \mu\text{m}$.
- g. Attenuation Uniformity - No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.
- h. Attenuation at the Water Peak - The attenuation at $1383 \pm 3 \text{ nm}$ shall not exceed 2.1 dB/km.
- i. Cutoff Wavelength - The cabled fiber cutoff wavelength shall be $\leq 1250 \text{ nm}$.
- j. Mode-field Diameter (Petermann II) -
 $9.30 \pm 0.50 \mu\text{m}$ at 1310 nm
 $\pm 1.00 \mu\text{m}$ at 1550 nm
- k. Zero Dispersion Wavelength (λ_0)- $1301.5 \text{ nm} \leq (\lambda_0) \leq 1321.5 \text{ nm}$.
- l. Zero Dispersion Slope (S0)- $\leq 0.092 \text{ ps}/(\text{nm}^2.\text{km})$.
- m. The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer.
- n. The coating shall be mechanically strippable without damaging the fiber.

Fiber Specification Parameters.

- a) All fibers in the cable shall meet the following requirements:
 - a. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable and Other Passive Fiber Optic Components", (single- mode only), the average change in attenuation at extreme operational temperatures (-40°C to $+70^\circ\text{C}$) shall not exceed 0.05 dB/km at 1550 nm. The magnitude of the maximum attenuation change of each individual fiber shall not be greater than 0.15 dB/km at 1550 nm.
 - b. Required Fiber Grade - Maximum Individual Fiber Attenuation
 - c. The maximum dispersion for single mode optical fibers shall be $\leq 3.3 \text{ ps}/(\text{nm}.\text{km})$ for 1285 nm through 1330 nm and shall be $\leq 18 \text{ ps}/(\text{nm km})$ at 1550 nm.
- b) Specifications for Outdoor Cables
 - a. Optical fibers shall be placed inside a loose buffer tube.
 - b. Each buffer tube shall contain up to 12 fibers.
 - c. The fibers shall not adhere to the inside of the buffer tube. Each fiber shall be distinguishable from others by means of color coding or numbers Buffer tubes containing fibers shall also be per applicable/standard color chart.
 - d. Colors shall meet EIA/TIA-598, "Color coding of Fiber Optic Cables".
 - e. In buffer tubes containing multiple fibers, the colors or numbers shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.
 - f. Buffer tubes shall be of a dual-layer construction with the inner layer made of polycarbonate and the outer layer made of polyester.
 - g. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
 - h. The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.
 - i. Each buffer tube shall be of powder, dry block construction.
 - j. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "SZ", stranding process.
 - k. The cable core interstices shall be consistent with above powder, dry block construction.
 - l. Binders shall be applied with sufficient tension to secure the buffer tubes to the

- central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.
- m. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
 - n. Tensile strength shall be provided by high tensile strength aramid yarns, fiberglass yarns, or both.
 - o. The high tensile strength aramid yarns and/or fiberglass yarns shall be helically stranded evenly around the cable core.
 - p. All-dielectric cables (with no armoring) shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.
 - q. The jacket or sheath shall be free of holes, splits and blisters.
 - r. The cable jacket shall contain no metal elements and shall be of a consistent thickness.
 - s. Cable jackets shall be marked with sequential meter or foot markings, year of manufacture and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within -0/+1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm.
 - t. The maximum pulling tension shall be 2700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.
 - u. The shipping, storage and operating temperature range of the cable shall be -40oC to +70oC. The installation temperature range of the cable shall be -30oC to +70oC.

General Cable Performance Specifications.

- a) The unaged cable shall withstand water penetration when tested with a one-meter static head or equivalent continuous pressure applied at one end of a one-meter length of filled cable for 24 hours. No water shall leak through the open cable end. When a one-meter static head or equivalent continuous pressure is applied at one end of a one meter length of aged cable for one hour, no water shall leak through the open cable end. Testing shall be done in accordance with FOTP-82, "Fluid Penetration Test for Filled Fiber Optic Cable".
- b) When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable", Method A; the cable shall exhibit no flow (drip or leak) of filling or flooding compound at 80oC. If material flow is detected, the weight of any compound that drips from the sample shall be less than 0.05 grams (0.002 ounce).
- c) The cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) for non-armored cables applied uniformly over the length of the compression plate. The cable shall be tested in accordance with FOTP-41 "Compressive Loading Resistance of Fiber Optic Cables", except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (single-mode). The average increase in attenuation for

the fibers shall be ≤ 0.02 dB at 1300 nm (multimode). The repeatability of the measurement system is typically ± 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.

- d) When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test", the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute, with a sheave diameter not greater than 20 times the cable diameter. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (single-mode). The repeatability of the measurement system is typically ± 0.05 dB or less. The cable jacket shall exhibit no cracking or splitting when observed under 5X magnification.
- e) When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies", the cable shall withstand 25 impact cycles. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (single-mode). The repeatability of the measurement system is typically ± 0.05 dB or less. The average increase in attenuation for fibers shall be ≤ 0.04 dB at 1300 nm (multimode). The cable jacket shall not exhibit evidence of cracking or splitting at the completion of the test.
- f) When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test", using maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N (608 lbf) applied for one hour (using "Test Condition II" of the procedure). In addition, the cable sample, while subjected to a minimum load of 2660 N (600 lbf), shall be able to withstand a twist of 360 degrees in a length of less than 3 meters. The magnitude of the attenuation change shall be within the repeatability of the measurement system of 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm. The repeatability of the measurement system is typically ± 0.05 dB or less. The average increase in attenuation for fibers shall be ≤ 0.40 dB at 1300 nm (multimode). The cable shall not experience a measurable increase in attenuation when subjected to the rated residual tensile load, 890 N (200 lbf).
- g) When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test", a length of cable no greater than 2 meters will withstand 10 cycles of mechanical twisting. The magnitude of the attenuation change will be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers will not experience an attenuation change greater than 0.1 dB at 1550 nm. The repeatability of the measurement system is typically ± 0.05 dB or less. The average increase in attenuation for fibers shall be ≤ 0.40 dB at 1300 nm (multimode). The cable jacket will exhibit no cracking or splitting when observed under 5X magnification after completion of the test.
- h) When tested in accordance with the proposed FOTP-181, "Lighting Damage Susceptibility Test for Fiber Optic Cables with Metallic Components", the cable shall withstand a simulated lighting strike with a peak value of the current pulse ≥ 105 kA. The test current used shall be damped oscillatory with a maximum time-to-peak value of 15 μ s (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time of half-value of the waveform envelope (t_2) shall be from 40 - 70 μ s. In addition to the analysis criterion set forth in FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e., core tube) and strength members must be intact after removal of the cable specimens from the test box.

Quality Assurance Provisions.

- a) All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 ksi.
- b) All optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.

Packaging.

- a) The complete cable shall be packaged for shipment on non- returnable wooden reels.
- b) Top and bottom ends of the cable shall be available for testing.
- c) Both ends of the cable shall be sealed to prevent the ingress of moisture.
- d) Each reel shall have a weatherproof reel tag attached identifying the reel and cable.
- e) Each cable shall be accompanied by a cable data sheet that contains significant information on the cable.

Miscellaneous.

- a) The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.
- b) Fiber optic cable shall be tested as indicated below.

Where cable ends are stored in pull boxes, cable ends shall be sealed to protect against damage resulting from water wicking. Sealing shall require use of a rubberized end cap heat shrink sealed over the cable ends.

Subsection 614.13 shall include the following:

Fiber Optic Cable shall be measured by the linear foot for both backbone and lateral cable and shall include all labor and materials required to install, splice and terminate the cable to make a complete and operational system and shall include the following items:

- a) All splice closures and all associated materials.
- b) All splicing at designated locations shown in the Plans or as directed by the Engineer.
- c) Identification labels for both backbone and lateral fiber cables in each pull box, manhole and field equipment cabinet.
- d) As Built Documentation.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Fiber Optic Cable (Single Mode) (12 Fiber)	Linear Foot
Fiber Optic Cable (Single Mode) (96 Fiber)	Linear Foot

END OF SECTION

Revision of Section 614 Fiber Optic Cable Installation

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

Fiber Optic Cable Installation consists of installing backbone and lateral single mode fiber optic cables as indicated on the Plans.

Subsection 614.08 shall include the following:

Fiber optic cable shall be installed in continuous runs except where cable type changes or where maximum pull lengths govern. The manufacturer's recommended limits for cable lengths shall not be exceeded. Cable ends shall be stored in controller cabinets or pull boxes immediately adjacent to cabinets or as directed by the Engineer. Only active (lit) fibers need to be spliced in cabinets. All other (dark) fibers shall be sealed in a manner recommended by the manufacturer.

Under no conditions shall the single-mode fibers be cut or spliced at intermediate points without express written direction from the Engineer.

Prior to installation of interconnect cable, the Contractor shall submit an interconnect schematic diagram to the Engineer for approval. The diagram shall clearly indicate cable routing, splice points and fiber connections including identifying the color-coded fibers and buffer tubes. Installation of the cable will not be permitted until the schematic diagram has been approved by the Engineer.

The same color-coded pairs of fibers shall be used throughout the entire project. At the terminal point the jackets shall be stripped and the ends taped.

For fiber optic cables, each fiber shall be checked with an optical time-domain reflectometer (OTDR) and full traces documenting fiber performance shall be provided to the Engineer within 30 days. All optical fibers shall be within the manufacturer's recommended tolerances. In addition, any other acceptance testing recommended by the manufacturer shall be provided. Data is to be supplied to the Engineer prior to completion of the project.

The Contractor shall leave a minimum of 50 feet of extra fiber in each pull box and 25 feet within the controller cabinet or as directed by the Engineer.

Fiber Optic Cable Markers.

When the Engineer has approved distances between ITS pull box spacing exceeding 500 feet, vertical utility markers shall be installed at the minimum 500-foot intervals or at locations as approved by Engineer. Markers shall consist of flexible composite material with a minimum width of 4", minimum height of 62" and marking code color of orange. Acceptable fiber marker product is Carsonite product specification number CUM-375 "Curve-Flex" Utility Marker or other approved equal.

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Subsection 614.13 shall include the following:

Fiber Optic Cable Installation will not be measured and paid for separately but shall be included in the work for Fiber Optic Cable (Single Mode).

END OF SECTION

Revision of Section 614 Fiber Optic Splice Closure

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

Fiber Optic Splice Closure includes installing fiber optic splice closures and performing splicing of both fiber optic backbone and fiber optic lateral cables at locations shown on the Plans.

Subsection 614.8 shall include the following:

Fiber optic splice closure shall be used to enclose fiber splices of both fiber optic backbone and fiber optic lateral cables at locations shown on the Plans. The splice closures shall be suitable for underground installations.

The fiber optic splice closures shall be furnished by the Contractor.

The splice closures shall be stand-alone, dome type and shall meet the following minimum requirements:

- a) The closures shall seal, anchor and protect fiber optic cable splices.
- b) The closures shall have a minimum of six total cable entries.
- c) The closures shall be suitable for underground applications and shall be watertight and airtight.
- d) The closures splice trays shall have a hinged design with an upright locking mechanism for all splice trays to provide ease of access for future maintenance to raise and lower trays.
- e) The closures shall have a gel compression ring type sealing design. A gluing or sealant design for sealing of the closure shall not be accepted.

The closures shall be sized to provide a capacity equal to the total number of strands for all cables entering the closure. All fiber optic cables shall be secured and sealed at the closure entrances to prevent the ingress of water per the manufacture's recommendations. All remaining access holes not utilized shall be plugged to prevent water from entering the closure.

Subsection 614.10 shall include the following:

All splices shall be performed using the fusion splicing method. The fusion splicer shall be calibrated and certified at least once within the previous year from this project. All certification documentation shall be presented to the Engineer prior to start of fiber splicing.

The Contractor shall cut and splice only those fiber strands shown to be spliced on the fiber splice plan sheets. All unused buffer tubes and fiber strands shall remain uncut. After the fiber cable and proposed buffer tube is prepped for splicing, all fiber strands in the buffer tube shall be cleaned of all homogeneous gel. All uncut fiber strands shall be coiled in the tray. Remaining buffer tubes shall be neatly coiled, secured and stored in the storage area within the closure under the splice trays per the manufacturer's recommendations. Buffer tubes proposed for splicing shall be wrapped and secured to the splice tray with ties per the

manufacturer's recommendations.

Bare fiber strands shall not be taped to the splice tray.

If the closure requires re-entry, it shall be conducted per the manufacturer's recommendation for re-entry and resealing. The Contractor shall use caution to prevent damage to the fiber strands, splices, or buffer tubes existing inside. When sealing the closure for a second time, the Contractor shall follow all re-reentry requirements of the manufacturer.

The Contractor shall ensure that the fiber optic splice enclosures and associated fiber cable coils fit adequately within the manhole or pull box splice locations specified on the Plans.

The optical fibers shall be fusion spliced and shall meet the following minimum requirements:

- a) Splice loss <0.15 Db
- b) Reflection <50 dB
- c) Completed splice shall be stable from -40° F to +185° F (-40°C to +85°C)

The Contractor shall label each individual splice and buffer tube in all splice trays per the Project Detail Sheet included in the Plans.

The Contractor shall inform the Engineer two (2) days before and the morning of proposed splicing locations for that day. While the splicing procedures are occurring and within four (4) hours prior to sealing the closure and installation in the pull box, the Contractor shall again contact the Engineer for inspection.

In the event that the Engineer cannot be on site, a minimum of eight (8) digital pictures shall be taken at varying angles of the interior of the splice closure showing all completed work as stated in this specification and shown on the Project Detail Sheet. These pictures shall include exposed fiber stands, (both spliced and uncut) in all splice trays, fiber tray labeling and remaining buffer tubes showing appropriate coiling. One picture shall also include the complete re-assembly of all interior parts prior to final sealing. Once the closure and fiber coils are installed in the pull box or manhole, two pictures shall be taken showing the final installation of both the closure and the coiled fiber cable attached to the fiber management hardware.

All pictures shall be organized per location and shall be submitted to the Engineer along with all final testing result documentation.

Subsection 614.13 shall include the following:

Fiber Optic Splice Closure and all associated materials will not be measured or paid for separately but will be considered subsidiary to the Fiber Optic Cable (Single Mode) pay item.

END OF SECTION

Revision of Section 614 Test Fiber Optic Cable

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

Test Fiber Optic Cable shall include Optical Time Domain Reflectometer (OTDR) tests and Optical Power Meter tests of all installed fiber and modified existing fiber on the Project. Tests are required for all active, inactive, terminated, and unterminated fibers on the Project.

Subsection 614.08 shall include the following:

When fiber optic cable is installed, the fiber optic cable test shall consist of the testing of both multimode and single mode fiber optic cable. The testing procedures involve an optical time-domain reflectometer (OTDR) test and an Optical Power Meter Test.

The guidelines for fiber optic cable testing include:

1. Test jumpers and patch cords must be of the same fiber core size and connector type as the cable system: Single mode fiber 8.3/125 μm
2. The light source and OTDR must operate with the range of 1310 ± 10 nm and 1550 ± 20 nm for single mode testing in accordance with ANSI/EIA/TIA-526-7.
3. The power meter and the light source must be set to the same wavelength during testing.
4. The OTDR and power meter must be calibrated and traceable to the National Institute of Standards and Technology (NIST). Calibration certificates shall be supplied to the Engineer prior to any testing.
5. All system connectors, adapters and jumpers must be cleaned as per manufacturer's instructions before measurements are taken.

Subsection 614.10 shall include the following:

Fiber Optic Cable Testing Equipment. The following is required to perform fiber optic cable tests:

- a) OTDR
- b) Test reel, if necessary
- c) Light source at the appropriate wavelength
- d) Optical Power Measurement Equipment
- e) Test Jumpers as specified below

Single mode Fiber Testing.

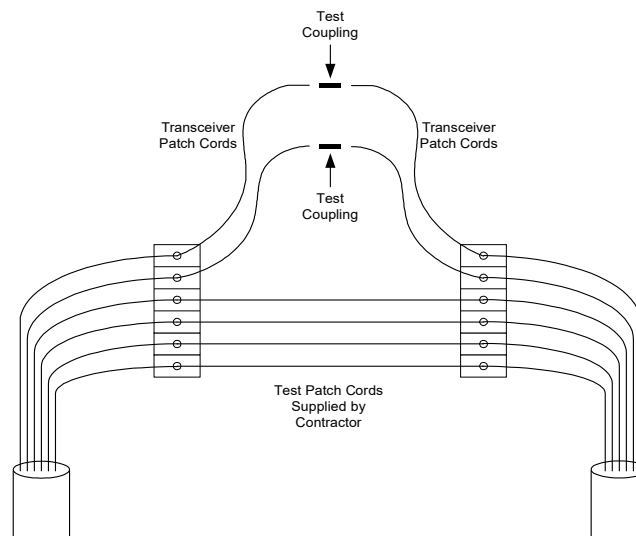
CPR Test Jumper-1 and Test Jumper-2 shall be 1-5 meters long with connectors compatible with the light source and power meter and have the same fiber construction as the link segment being tested.

Optical Fiber Cable Testing with OTDR. The Contractor shall perform an OTDR test of all fibers in all tubes on the reel, prior to installation of the fiber. The test results shall be supplied to the Engineer prior to installation of the cable.

If the fiber is specified as “Install Only”, the Contractor shall test the fiber on the reel and provide the test results to the Engineer prior to accepting the cable. After installation, if there are unused portions of cable remaining on the reel, the Engineer may request the Contractor or other qualified technician to perform a reel test. The Contractor shall provide the Engineer the test results prior to delivering the cable to the Engineer. Any cable damaged while in the Contractor’s possession shall be replaced at the Contractor’s expense.

Segmented end to end testing shall not be less than 1 mile. Patches for testing shall not exceed five.

If the Plans require installation of a fiber optic patch panel, the Contractor shall supply patch cords to patch all terminated fibers through the panel for all fiber testing. If patch cords are specified in the Plans for final equipment installation, these patch cords shall be connected using a test coupling for the end-to-end test.



OTDR readings will be used to ensure proper installation and to troubleshoot faults. OTDR signature traces will be used for documentation and maintenance. An OTDR provides an indirect estimate of the loss of the cable plant; generally, more accurate or reliable values will be obtained by using an Optical Power Meter. For fibers that are identified in the Plans to be left unterminated, an OTDR shall be used to test end-to-end attenuation.

Loss numbers for the installed link shall be calculated by taking the sum of the bi- directional measurements and dividing that sum by two.

The Contractor shall use an OTDR that is capable of storing traces electronically and shall save each final trace.

To ensure the traces identify the end points of the fiber under test and the fiber designation, the Contractor shall use a test reel, if required, to eliminate the “dead zone” at the start of the trace so that the start of the fiber under test can be identified on the trace. Indicate the length of the test reel for all test results.

If the fiber designation is not indicated on the trace itself, the Contractor shall provide a cross-reference table between the stored trace file name and the fiber designation.

In compliance with EIA/TIA-455-61 "Measurement of Fiber or Cable Attenuation Using an OTDR" the Contractor shall record the following information during the test procedure:

1. Names of personnel conducting the test.
2. Type of test equipment used (manufacturer, model, serial number, calibration date).
3. Date test is being performed.
4. Optical source wavelength and spectral width.
5. Fiber identification.
6. Start and end point locations.
7. Launch conditions.
8. Method of calculation for the attenuation or attenuation coefficient.
9. Acceptable link attenuation.

Optic Fiber Cable Testing with Optical Power Meter. The Contractor shall conduct an Optical Power Meter Test for each fiber installed.

Single mode segments shall be tested in one direction at both the 1310 nm and 1550 nm wavelength.

In compliance with TIA/EIA-526-14A "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant" and TIA/EIA-526-7 "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant," the following information shall be recorded during the test procedure:

1. Names of personnel conducting the test.
2. Type of test equipment used (manufacturer, model, serial number, calibration date).
3. Date test is being performed.
4. Optical source wavelength, spectral width, and for multimode, the coupled power ratio (CPR).
5. Fiber identification.
6. Start and end point locations.
7. Test direction.
8. Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
9. Measured attenuation of the link segment.
10. Acceptable link attenuation.

The minor attenuation differences due to test direction are on par with the accuracy and repeatability of the test method. Lateral segments within a building are limited to 90 meters. Therefore, attenuation differences caused by wavelength are insignificant, and as a result, single wavelength testing is sufficient.

Acceptable Attenuation Values. Acceptable attenuation values shall be calculated for each fiber tested. These values represent the maximum acceptable test values.

Single mode Fiber. The general attenuation equation for any single mode link segment is as

follows:

Acceptable Link Attn. = Cable Attn. + Connector Attn. + Splice Attn.

8.3 μm Single-mode Attenuation Coefficients:

Cable Attn.=Cable Length (km) x (0.34 dB/km@1310 nm or 0.25 dB/km@1550 nm)

Connection Attn. (ST or SC connectors)=(No. of Connections x 0.39 dB)+0.42 dB.

Connection Attn. (LC connectors)=(No. of Connections x 0.14 dB)+0.24 dB.

Splice Attn. (Mechanical or Fusion)=Splices x 0.30 dB.

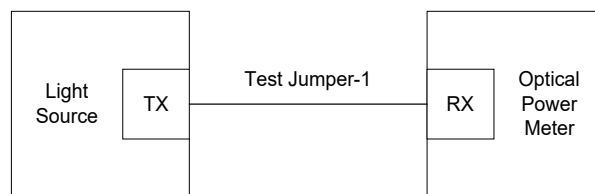
Test Procedures.

All fiber testing shall be performed on all fibers in the completed end-to-end system.

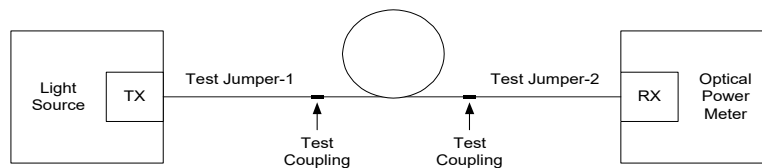
Single mode Fiber.

The single mode Optical Power Meter fiber test shall be conducted as follows:

1. Clean the test jumper connectors and the test coupling per manufacturer’s instructions.
2. Follow the test equipment manufacturer’s initial adjustment instructions.
3. Connect Test Jumper-1 between the light source and the power meter. Avoid placing bends in the jumper that are less than 4 inches in diameter



4. If the power meter has a Relative Power Measurement Mode, select it. If it does not, reduce the Reference Power Measurement (Pref). If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
5. Disconnect Test Jumper-1 from the power meter. Do not disconnect the test jumper from the light source.
6. Attach Test Jumper-1 to one end of the cable plant to be measured and Test Jumper-2 to the other end.



7. Record the Power Measurement (Psum). If the power meter is in Relative Power Measurement Mode, the meter reading represents the true value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:
 - a. If Psum and Pref are in the same logarithmic units (dBm, dBu, etc.):
CPR (dB) = Psum - Pref
 - b. If Psum and Pref are in watts:
CPR (dB)= 10 x log10 [Osum/Pref]

Test Acceptance.

The Contractor shall demonstrate that each Optical Time Domain Reflectometer (OTDR) test results in acceptable attenuation values for each of the individual attenuation coefficients. Acceptable attenuation coefficients shall not be exceeded for any test unit (Cable Attn, Connection Attn, or Splice Attn).

The Contractor shall demonstrate that each Optical Power Test results in acceptable attenuation values. Acceptable attenuation values shall not exceed the "Acceptable Link Attn."

The Contractor, solely at the Contractor's cost, shall remake any fusion splices that have test results exceeding acceptable attenuation values. Acceptable attenuation values shall not exceed "Splice Attn."

The Contractor, solely at the Contractor's cost, shall bring any connectors exceeding acceptable attenuation values into value. Attenuation values shall not exceed the "Connection Attn". Hand polishing of connectors to bring into value shall not be permitted.

The Contractor, solely at the Contractor's cost, shall retest any fiber links that have been re-spliced or re-connectorized. Retesting shall include both OTDR and Power Meter Testing as appropriate.

The Contractor, solely at the Contractor's cost, shall bring any link, or link coefficient value, not meeting the requirements of this specification into compliance.

Submittals.

The Contractor shall submit test results documentation to the Engineer.

Optical Fiber Cable Testing with OTDR - **"reel test" before installation**, After each reel test, the Contractor shall submit an electronic copy of the OTDR trace for every fiber on the reel.

Optical Fiber Cable testing with OTDR and Power Meter - **After installation**, the Contractor shall submit an electronic copy of the OTDR trace, and Optical Power Meter result on every fiber installed.

The Contractor shall submit all test results in electronic format.

The Contractor shall submit one copy of the complete contract Plans, including additional Plans issued as part of any change orders, with any deviations clearly marked in color. Deviations to be noted and shall include but not be limited to the following:

- Fiber Splice location Fiber Splice configuration Termination layout

Testing After Repair. Repairs to fiber optic cable shall be tested according to the requirements determined by the County and could include fiber pigtail fusion splicing.

Subsection 614.13 shall include the following:

Test Fiber Optic Cable shall include on reel testing of all fiber strands, continuity testing, and complete end-to-end OTDR tests and power meter tests on the “dark” unused fiber, including labor, materials, and document submission necessary to complete the work.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Test Fiber Optic Cable	Lump Sum

END OF SECTION

Revision of Section 614 Fiber Optic Termination Panel

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of furnishing and installing fiber optic termination panels in communication cabinets for single mode fiber optic cables.

Subsection 614.08 shall include the following:

All termination panels shall be manufactured using aluminum and shall be finished with powder coat. The termination panels shall accommodate lateral fiber optic cables as shown on the Plans.

All termination panels shall have a labeling scheme that complies with details as shown on the Plans.

All termination panels shall be 12-port wall mount patch panels for support of lateral fiber count entering the cabinet. All termination panels shall be compatible with the fiber optic cable being terminated.

12-port termination panels for lateral fiber optic cables shall be provided to accommodate 12 adaptor ports. The panels shall be provided with two 6-port adaptor panels with ST type adaptors. The panel shall be provided with covers for the remaining adaptor port slots. The termination panel shall have a slide out interior to allow easy access to the interior of the termination panel for future maintenance.

Terminations within the panel shall use 12-Fiber factory pre-terminated pigtailed with ST Ultra Physical Contact (UPC) connectors. Pigtailed shall be a minimum length of 12" post termination. Pigtailed shall be fusion spliced to the fiber lateral. Splice connections shall be organized and secured using fiber optic splice holders securely mounted within the panel.

During installation, where any strand of a pigtail is shortened below 12", the entire pigtail shall be replaced. Hand-Polishing of UPC connectors shall not be permitted.

Fiber lateral entering the panel shall be secured at a minimum of one point within the panel using a minimum two wire ties. Connection of the fiber lateral to the panel shall count as 1 of the 3 required fiber connection points.

The panel shall be sized to accommodate the entry of the lateral fiber optic cable, fiber fan out, and bulkheads with the access door closed. The fiber optic patch panel shall be suitable for wall mounting. Each fiber optic patch panel shall include a fiber adapter panel, adapters, fiber pig tails, strain relief, grommet tape, zip ties, cable management hardware for fiber strands and fan out kit buffer tubes, and wall mounting bracket. Terminations within the patch panel shall be polished with an ultra physical contact (UPC) finish.

Adaptor panels in all termination panels shall be metal. Plastic adaptor panels will not be

accepted.

Termination panels shall be securely fastened to the left side wall of the traffic signal cabinet using cabinet channel clips or DIN rail mounts. Shelf mounting, use of Velcro, adhesive based or other methods for mounting of the termination panel shall require Engineer approval.

Subsection 614.13 shall include the following:

Fiber Optic Termination Panels will be measured by the actual number of fiber optic termination panels installed and accepted and shall include all bulkheads, field terminations, covers for empty bulkhead entries, labeling panels and all materials, hardware, labor, and equipment necessary to complete the work.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Fiber Optic Termination Panel (12 Fiber)	Each

END OF SECTION

Revision of Section 614 Network Switch

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of the installation of Network Switch in the controller cabinets. The Contractor shall furnish and install the switch within the Traffic Signal Cabinet as an integral part of the Traffic Signal Controller and Cabinet Assembly.

Subsection 614.08 shall include the following:

At signal locations where fiber backbone communications extend in only two directions and at which no wireless communications are in use (network pass-through locations), Network Switch shall be Siemens RUGGEDCOM RS900G or approved equal. Wireless locations utilizing CDMA connectivity shall also use the RS900G switch.

At locations where fiber backbone extends in more than two directions or where wireless communications utilizing broadband radio are in use (network branch locations), Network Switch shall be Siemens RUGGEDCOM RST916C or approved equal.

Fiber optic small form-factor pluggable (SFP) modules shall be supplied with each switch, supplied by the switch manufacturer to ensure compatibility, supporting fiber communications as defined in the project. SFP modules shall be LC type single-mode (SM) 1 Gbps long haul SFP supporting nominal transmission distances as defined in the plans. Nominal transmission distances shall meet or exceed 1.5x the distance to the next network series switch using 10km, 25km, 70km, or other transmission distances as defined or approved by the Engineer.

Where SFP switch ports are unused, port covers shall be installed.

Network switches shall be DIN rail mountable and shall be DIN rail mounted unless otherwise approved by the Engineer.

Subsection 614.10 shall include the following:

All hardware shall be installed in accordance with manufacturer's recommendations.

The County may elect to either have the Contractor program the communications, providing the required details, or may opt to program the communications using in-house personnel. Where programming is identified as the Contractor's responsibility, programming shall be at no additional cost.

The Contractor shall deliver the network switch with SFP modules to the County for configuration and programming by the County prior to installation by the Contractor. Delivery and pickup of equipment to the County shall be at no additional cost to the pay item.

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Subsection 614.13 shall include the following:

Network Switch and all associated materials will not be measured or paid for separately but will be considered subsidiary to the Traffic Signal Controller Cabinet pay item.

Fiber optic small form-factor pluggable (SFP) module and all associated materials will not be measured or paid for separately but will be considered subsidiary to the Traffic Signal Controller Cabinet pay item.

END OF SECTION

Revision of Section 614 Closed Circuit Television (CCTV) Camera

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of the installation of a closed circuit television (CCTV) camera at the traffic signal. The work shall be done per these specifications. Equipment shall be as noted or approved equivalent. Arapahoe County Traffic Operations Manager reserves the right to modify equipment as new technology is evaluated.

Subsection 614.08 shall include the following:

CCTV camera shall be AXIS Communications Q6075-E PTZ network camera or approved equivalent and shall include camera, housing, POE injector, and all cabling and incidentals required to constitute a complete CCTV camera system.

Subsection 614.10 shall include the following:

CCTV camera shall be installed per the manufacturer's recommendations.

The County may elect to either have the Contractor program the communications, providing the required details, or may opt to program the communications using in-house personnel. Where programming is identified as the Contractor's responsibility, programming shall be at no additional cost.

The Contractor shall deliver the CCTV camera to the County for configuration and programming by the county prior to installation by the Contractor. Delivery and pickup of equipment to the county shall be at no additional cost to the pay item.

Subsection 614.13 shall include the following:

CCTV camera shall be measured per unit installed, made operational and accepted and shall include all equipment and wiring necessary for operation.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Closed Circuit Television Camera (Traffic Surveillance)	Each

END OF SECTION

Revision of Section 614 Flashing Beacon Assembly

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of the installation of school zone flashing beacon assemblies and warning/regulatory sign flashing beacon assemblies. The work shall be done per these specifications and Arapahoe County Standard Signal Design detail sheets.

Subsection 614.06 Flashing Beacon shall include the following:

Pedestal pole shall be Pelco Pedestal Pole, 4” - 8 NPT Sch 80, Spun Alum, natural aluminum finish (item number PB-5102-16-PNC).

Pedestal base shall be Pelco Square Base Assembly, Alum -12K Capacity w/ Alum Door, with 3 set screws, natural aluminum finish (item number PB-5334-3S-PNC).

The base shall include a Pelco Pole & Base Collar Assembly, Alum Square Base, natural aluminum finish (item number PB-5325-PNC).

School Zone Flashing Beacon Assembly.

Components of the flashing beacon assembly shall be Carmanah item number R829-G Cabinet-Based School Zone Flashing Beacon. The Contractor shall coordinate with a Carmanah representative to conduct a site assessment to determine the solar panel size required.

System Specifications:

Component	Specification
Power System	Solar
Solar Mount	3.5”- 4.5” Diameter Round Top of Pole Mount
Beacon Head	Yellow, UV-resistant polycarbonate signal heads
Beacon Mounting	Triple Beacon - Alternating, Flashing
Beacon Module	Two (2) front-mounted 12” LED modules and one (1) back-mounted 8” LED module, yellow
Energy Storage	12 V battery system, 110Ah
Cabinet	Lockable, hinged door with #2 lock
Cabinet finish	Raw aluminum
School Beacon Back Plate Assembly	900-11-01 Solar Flat
Door Switch	900-038-01 Flat Bracket
Beacon flasher timer switch	Applied Information, item number AI 500-070

Beacon flasher time switch, Applied Information, item number AI 500-070, shall include the following:

Glance License	One-Time Subscription per Device
Glance Configuration	Configuration Fee per Device
Beacon (C&S) 10 Y	Connectivity & Support (C&S) Plan 10 Year

Warning/Regulatory Sign Flashing Beacon Assembly

Components of the flashing beacon assembly shall have the following specifications:

System Specifications:

Component	Specification
Power System	Solar
Solar Mount	Top of Pole Mount
Beacon Head	Yellow, UV-resistant polycarbonate signal head
Beacon Module	One (1) front-mounted 12" LED module, yellow

Subsection 614.09 shall include the following:

Flashing beacon assembly shall be installed per the manufacturer's recommendations.

Mounting Hardware:

Location	Mounting Hardware
Beacon bracket to pole	BAND-IT strap
Sign to pole	BAND-IT bracket and strap
Cabinet to pole	Manufacturer U-bolts or optional BAND-IT strap

The foundation for the flashing beacon assembly shall be constructed per CDOT Specifications Section 503 - Drilled Shaft.

Subsection 614.13 shall include the following:

School Zone Flashing Beacon Assembly shall be measured as a complete unit in place and accepted and shall include the pole, pedestal base, base collar, sign panels, solar power system, battery, beacons, cabinet, mounting hardware, and all equipment and wiring necessary for operation.

Warning/Regulatory Flashing Beacon Assembly shall be measured as a complete unit in place and accepted and shall include the pole, pedestal base, base collar, sign panels, solar power system, battery, beacon, cabinet, mounting hardware, and all equipment and wiring necessary for operation.

The foundation for the pole shall be measured and paid for separately per CDOT Standard Specifications Section 503 - Drilled Shaft.

Subsection 614.14 shall include the following:

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Flashing Beacon	Each

END OF SECTION

Revision of Section 614 Rectangular Rapid Flashing Beacon (RRFB) Assembly

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of the installation of rectangular rapid flashing beacon (RRFB) assemblies. The work shall be done per these specifications and Arapahoe Country Standard Signal Design detail sheets.

Subsection 614.08 shall include the following:

Rectangular Rapid Flashing Beacon (RRFB) Assembly.

Rectangular Rapid Flashing Beacon shall be manufactured by Carmanah.

Pedestal pole shall be Pelco Pedestal Pole, 4" - 8 NPT Sch 80, Spun Alum, 16' in length, natural aluminum finish (item number PB-5102-16-PNC).

Pedestal base shall be Pelco Square Base Assembly, Alum -12K Capacity w/ Alum Door, with 3 set screws, natural aluminum finish (item number PB-5334-3S-PNC).

The base shall include a Pelco Pole & Base Collar Assembly, Alum Square Base, natural aluminum finish (item number PB-5325-PNC).

Solar Engine.

The solar engine shall be constructed from aluminum and shall be no greater than 13.6 inches L X 4.0 inches D X 13.8 inches H. When mounted the overall height from the top of the pole to the top of the solar engine shall be no greater than 14.6 inches. The solar panel shall be integrated to the solar engine.

All batteries and electronics shall be mounted in the solar engine, with no external control cabinet or battery cabinet required. A hinged lid shall provide access to the interior of the engine. The solar engine shall be vented to provide cooling of the battery and electronic system.

The solar engine shall be supplied with a fixed tilt angle and shall be able to be oriented south with no additional hardware.

The solar engine shall house an on-board user interface that provides on-site configuration adjustment, system status and fault notification, and system activation information.

The solar engine shall include one 10-watt solar panel no larger than the footprint of the solar engine enclosure and shall have a hinged top to provide access to the on-board user interface and batteries.

Access into the solar engine and replacement of batteries shall not require tools. The solar engine shall house 7 Ah valve-regulated lead-acid batteries. Batteries shall be readily available from multiple suppliers and non-proprietary. Solar panel and battery system shall be 12-volt

DC.

Light Bar.

The light bar housing shall be constructed from aluminum and shall have the approximate dimensions: 24 inches L X 1.5 inches D X 4.5 inches H.

Each light bar shall have two light modules of approximately 7 inches wide by approximately 3 inches high. Each light bar shall include a side-emitting pedestrian confirmation light on each end.

The light bar shall be mounted to the pole using a separate bracket assembly to facilitate mounting two light bars back-to-back and to allow the light bar to pivot. The light bar shall be able to pivot by approximately 40 degrees in order to aim the light bar independent of the wire hole location on the pole.

The light bar bracket shall be constructed from 3/16 inch galvanized steel and shall have both banding and bolting mounting options and shall be able to be mounted to all specified pole types.

The light bar assembly shall open for access to the wiring connections for the LED modules. LED modules shall be rated to MIL-STD-810F, Method 506.4 for ingress.

The flash duration shall be adjustable in-the-field from 10 to 60 seconds in one second increments.

The system shall provide configurable nighttime intensity settings.

The system shall be capable of enabling ambient brightness auto-adjustment. This feature allows the system to provide optimal output brightness in relation to ambient light levels while always maintaining adherence to SAE J595 Class I specifications.

Flash duration and other in-the-field adjustable settings shall be automatically broadcast to all units in the system, except channel selection which shall be configured on each unit.

Operational Requirements.

The intensity of the yellow indicators directly perpendicular to the lens shall be a minimum of 1,800 Candela at full sun daylight conditions. The intensity shall be able to adjust to ambient light conditions, however during daylight operation the intensity shall meet the minimum specifications of the Society of Automotive Engineers (SAE) standard J595 Class I.

The color of the yellow indicators shall meet the specifications of SAE standard J578 (Color Specification).

The solar engine shall have the capacity to activate other solar engines by wireless communications within 500 feet. The solar engine shall have unique channels that can be configured on-site to avoid activation of nearby systems.

The system shall use a dedicated light sensor to detect night and day states and apply any optionally-enabled intensity adjustments.

The system shall be actuated by pedestrian push buttons that shall have an LED indicator with audible tone with Piezo control and shall be ADA compliant and MUTCD compliant for momentary operation.

All RRFBs in the system shall initiate activation simultaneously after 150mS of activation.

If an additional actuation occurs while the system is activated, the flash duration shall reset.

If the RRFB has ceased operation, any subsequent actuation shall activate the RRFB without delay regardless of how the RRFB ceased operation.

Subsection 614.10 shall include the following:

The solar engine and light bar assemblies shall be furnished with mounting hardware for mounting to standard 4-inch Diameter Round Pole.

The foundation for the flashing beacon assembly shall be constructed per CDOT Standard Specifications Section 503 - Drilled Shaft.

Subsection 614.13 shall include the following:

Rectangular Rapid Flashing Beacon Assembly shall be measured as a unit complete in place and accepted and shall include the pole, pedestal base, base collar, sign panels, solar panel, light bars, push button, battery, mounting hardware, and all equipment and wiring necessary for operation.

The foundation for the pole shall be measured and paid for separately per CDOT Standard Specifications Section 503 - Drilled Shaft.

Subsection 614.14 shall include the following:

The accepted quantities will be paid for at the contract unit price for the pay item listed below.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Rectangular Rapid Flashing Beacon	Each

END OF SECTION

APPENDIX H - PAVEMENT MARKING STANDARD DETAILS

PAVEMENT MARKING STANDARD DETAILS

SHEET NO. CONTENTS

1	GENERAL PAVEMENT MARKING NOTES
2	TYPICAL INTERSECTION LAYOUT
3	STOP BAR AND CROSSWALK DETAILS
4	TURN LANE DETAILS
5	BIKE LANE DETAILS
6	WORDS AND SYMBOLS DETAILS
7	UNCONTROLLED CROSSING DETAILS



ARAPAHOE COUNTY

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GENERAL PAVEMENT MARKING NOTES

1. PAVEMENT MARKINGS SHALL FOLLOW THE REQUIREMENTS SET FORTH IN THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), LATEST EDITION ADOPTED BY ARAPAHOE COUNTY. ADDITIONAL PAVEMENT MARKING REQUIREMENTS MAY BE REQUIRED PER ARAPAHOE COUNTY COMPREHENSIVE SAFETY PLAN.
2. CENTER LINES
 - a. DOUBLE SOLID, YELLOW, 4-INCH-WIDE. LINES SPACED 4 INCHES APART (NO PASSING ZONES - TWO DIRECTIONS)
 - b. SINGLE BROKEN, YELLOW, 4-INCH-WIDE, 10-FOOT-LONG SEGMENTS WITH 30-FOOT GAPS (2 LANE ROADWAYS ONLY)
 - c. SINGLE BROKEN, YELLOW, 4-INCH-WIDE, 10-FOOT-LONG SEGMENTS WITH 30-FOOT GAPS AND SINGLE SOLID, YELLOW, 4-INCH-WIDE. LINES SPACED 4 INCHES APART (NO PASSING ZONES - ONE WAY AND MEDIAN TWO-WAY-LEFT-TURN LANES)
3. LANE LINES
 - a. BROKEN, WHITE, 4-INCH-WIDE, 10-FOOT SEGMENTS WITH 30-FOOT GAPS.
 - b. SOLID, WHITE, 4-INCH WIDE. A SOLID LINE MAY BE USED TO DISCOURAGE LANE CHANGING, WHILE TWO PARALLEL SOLID WHITE LINES WITH 4" SPACE ARE REQUIRED TO PROHIBIT LANE CHANGING.
4. EDGE LINES
 - a. SOLID YELLOW, 4-INCH-WIDE. YELLOW EDGE LINES SHALL BE USED ONLY FOR LEFT EDGE, IN THE DIRECTION OF TRAVEL.
 - b. SOLID WHITE, 4-INCH-WIDE. WHITE EDGE LINES SHALL BE USED FOR RIGHT EDGE, IN THE DIRECTION OF TRAVEL.
 - c. EDGE LINES SHALL NOT BE CONTINUED THROUGH INTERSECTIONS AND SHALL NOT BE BROKEN FOR DRIVEWAYS OR ALLEYS, UNLESS DEFINED BY THE COUNTY ENGINEER.
 - d. EDGE LINES ARE NOT REQUIRED ADJACENT TO RAISED MEDIANS OR CURB AND GUTTER.
5. DOTTED LINES

BROKEN, WHITE, 2-FOOT-LONG SEGMENTS WITH 6-FOOT GAPS. LINE WIDTH SHALL MATCH THAT OF THE SOLID LINE IT IS EXTENDING.

TO PROVIDE GUIDANCE OR WARNING OF A DOWNSTREAM CHANGE IN LANE FUNCTION. ALSO SHALL BE USED DELINEATE THE EXTENSION OF A LANE LINE THROUGH AN INTERSECTION.
6. LANE DROP LINES

BROKEN, WHITE, 8-INCH-WIDE, 3-FOOT-LONG SEGMENTS WITH 9-FOOT GAPS.

FOR A THROUGH LANE THAT BECOMES A MANDATORY EXIT OR TURN LANE.
7. AUXILIARY LINES

BROKEN, WHITE, 8-INCH-WIDE, 3-FOOT-LONG SEGMENTS WITH 9-FOOT GAPS.
8. CHANNELIZING LINES

SOLID, WHITE, 8-INCH-WIDE.

FOR DECELERATION LANES, PAVEMENT WIDTH TRANSITIONS, LEFT/RIGHT TURN SLOTS, AND CHANNELIZING ISLANDS.
9. CROSS-HATCH LINES

SOLID, 8-INCH-WIDE, 45 DEGREE DIAGONALS SLANTING AWAY FROM TRAFFIC IN ADJACENT TRAVEL LANES, SPACED AT 20 TO 100 FOOT INTERVALS.

CROSS-HATCH SHALL BEGIN WHERE NEUTRAL AREA IS 6 FEET OR WIDER.

YELLOW SHALL BE USED FOR PAINTED MEDIANS OR PAVEMENT WIDTH TRANSITIONS ONLY.

WHITE SHALL BE USED FOR SHOULDER MARKINGS.

10. CHEVRON MARKINGS

SOLID, WHITE, 8-INCH-WIDE, 45 DEGREE DIAGONALS WITH POINT OF EACH CHEVRON FACING TOWARDS APPROACHING TRAFFIC, SPACED TYPICAL 50 FOOT INTERVALS WITH A MINIMUM OF 20 FOOT INTERVALS.

PAVED AREAS LESS THAN 150 FEET OF LENGTH: 25 FOOT INTERVAL

PAVED AREA OVER 400 FEET OF LENGTH: 100 FOOT INTERVALS.
11. BIKE LANE LINES
 - a. SOLID, WHITE, 6-INCH-WIDE.
 - b. BROKEN, WHITE, 2-FOOT-LONG SEGMENTS WITH 6-FOOT-GAPS, MATCHING WIDTH OF LINE IT IS EXTENDING.
 - c. BUFFERED BIKE LANES AND PROTECTED BIKE LANES: DOUBLE SOLID, WHITE, 6-INCH-WIDE. BUFFER LESS THAN 2 FEET: BLANK BUFFER SPACE. BUFFER 2 FEET TO 4 FEET: SOLID, WHITE, 8 INCH 45 DEGREE CROSS-HATCH ON 20 FOOT INTERVALS, SLANTING AWAY FROM TRAFFIC IN THE ADJACENT VEHICLE TRAVEL LANE. BUFFER GREATER THAN 4 FEET: SOLID, WHITE, 8 INCH CHEVRONS ON 20 FOOT INTERVALS.
12. PARKING LINES

SOLID, WHITE, 3-INCH-WIDE. DIAGONAL OR PARALLEL.
13. STOP BARS

SOLID, WHITE, 24-INCH-WIDE. EXTEND PARALLEL TO INTERSECTED ROADWAY ACROSS ALL APPROACH LANES OR AS INDICATED AT LOCATIONS ON THE PLANS.

LOCATE AT THE DESIRED STOPPING POINT, SHALL NOT BE LESS THAN 4 FEET OR MORE THAN 30 FEET, FROM THE NEAREST EDGE OF CROSSWALK LINE/BAR OR FROM START OF PAVEMENT/CURB RADIUS.
14. YIELD LINES

SOLID, WHITE TRIANGLES.

THE INDIVIDUAL TRIANGLES COMPRISING YIELD LINES SHALL HAVE THE FOLLOWING DIMENSIONS:

 - a. SHARED USE PATHS OR BY-PASS LANES - 12 INCH BASE, 18 INCH HEIGHT, SPACE BETWEEN EACH TRIANGLE SHALL BE 6 INCHES.
 - b. VEHICLE TRAVEL LANES - 24 INCH BASE, 36 INCH HEIGHT, SPACE BETWEEN EACH TRIANGLE SHALL BE 12 INCHES.

TRIANGLES SHALL BE PERPENDICULAR TO APPROACH LANE LINES.
15. CROSSWALK LINES

LONGITUDINAL BAR TYPE - SOLID, WHITE, 18 TO 24 INCHES WIDE AND 8 TO 10 FEET LONG, AS DETAILED IN THE PLANS OR AS DIRECTED BY THE ENGINEER.
16. WORD, ARROW, AND SYMBOL MARKINGS

ALL LETTERS, ARROWS, AND SYMBOLS SHALL BE IN CONFORMANCE WITH THE FEDERAL HIGHWAY ADMINISTRATION'S "STANDARD HIGHWAY SIGNS AND MARKINGS," CURRENT EDITION ADOPTED BY ARAPAHOE COUNTY.
17. TRANSITION LINES

SOLID, YELLOW, 8-INCH-WIDE.

THESE LINES SHALL BE PLACED WHERE ADDITIONAL EMPHASIS OR VISIBILITY IS DESIRABLE AT PAVEMENT WIDTH TRANSITIONS.
18. SPEED MEASURING MARKING

SOLID, WHITE, 24 INCHES WIDE.

EXTEND 4 FEET FROM OUTSIDE OF EDGE LINES ON SHOULDERS.
19. ALL SPACING IS DETERMINED CENTER OF LINE TO CENTER OF LINE EXCEPT FOR DOUBLE LINES WHERE IT IS MIDPOINT BETWEEN THE TWO LINES UNLESS OTHERWISE STATED.

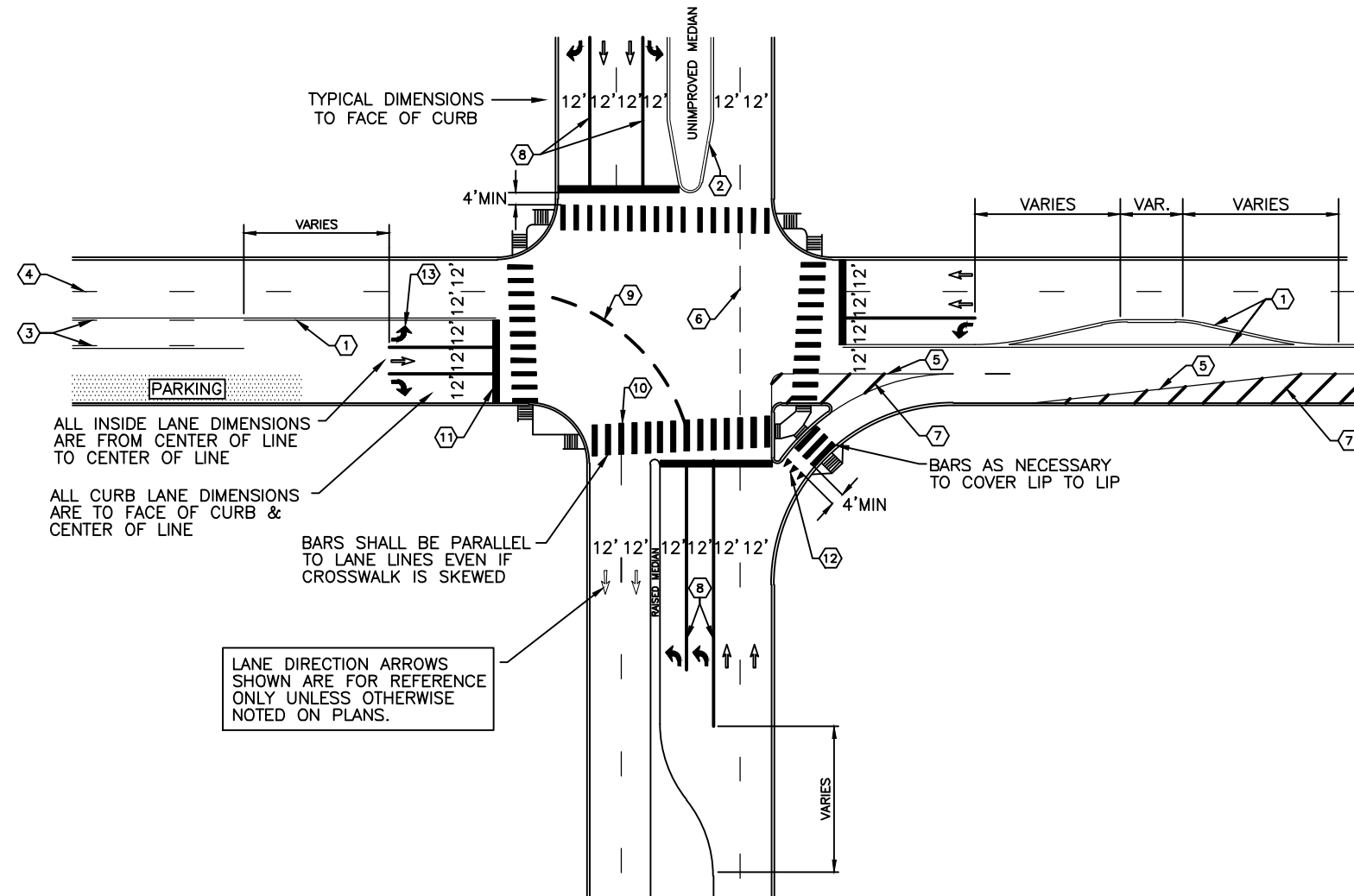
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PAVEMENT MARKING LEGEND

- ① 4" DOUBLE YELLOW CENTERLINE WITH 4" SEPARATION
- ② 4" SOLID YELLOW TWO WAY LEFT EDGE LINE
- ③ 4" SOLID YELLOW WITH 4" SKIP YELLOW, 10' LINE WITH 30' GAP, AND 4" SEPARATION
- ④ 4" SKIP WHITE LANE LINE, 10' LINE WITH 30' GAP
- ⑤ 4" SOLID WHITE RIGHT EDGE LINE
- ⑥ 4" DOTTED WHITE LINE THRU INTERSECTION, 2' LINE WITH 6' GAP
- ⑦ 8" SOLID WHITE 45° DIAGONAL CROSSHATCH
- ⑧ 8" SOLID WHITE CHANNELIZING LANE LINE
- ⑨ 8" DOTTED WHITE LINE THRU INTERSECTION, 2' LINE WITH 6' GAP
- ⑩ WHITE CROSSWALK BAR (SEE NOTE D)
- ⑪ 24" WHITE STOP BAR (SEE NOTE D)
- ⑫ WHITE YIELD MARKINGS (SEE NOTE D)
- ⑬ PAVEMENT MARKING TURN ARROW

PAVEMENT MARKING NOTES

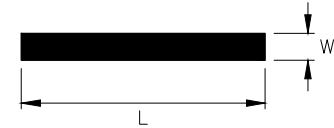
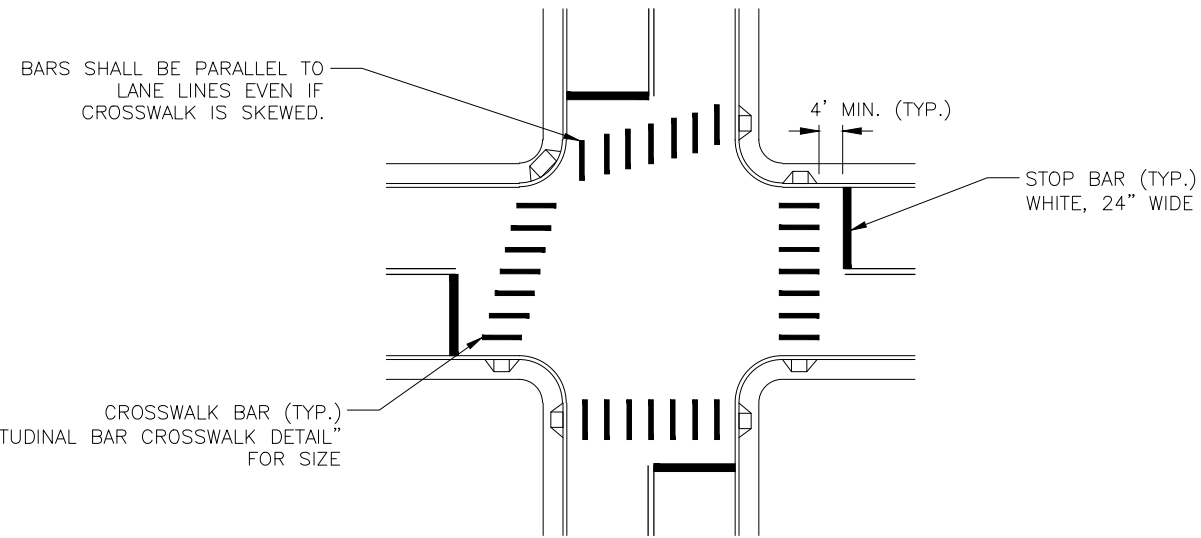
- A. INLAID REFLECTORIZED PREFORMED THERMOPLASTIC (MIN. 90 MIL THICKNESS) FULL WIDTH WITHOUT SEAMS SHALL BE USED FOR THE FOLLOWING UNLESS OTHERWISE APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT:
 WHITE CROSSWALK BARS
 WHITE STOP BARS
 PAVEMENT MARKING TURN ARROWS
- B. CONCRETE ROADWAY SURFACE:
 INLAID PREFORMED PLASTIC TAPE (CONTRAST) PAVEMENT MARKING MATERIAL SHALL BE USED FOR THE FOLLOWING UNLESS OTHERWISE APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT:
 4" SKIP WHITE LANE LINE, 10' LINE WITH 30' GAP
 8" DOTTED WHITE OR YELLOW LINE THRU INTERSECTION, 2' LINE WITH 4' GAP
- C. MODIFIED EPOXY PAVEMENT MARKING MATERIAL SHALL BE USED FOR ALL OTHER APPLICATIONS FOR CONCRETE AND ASPHALT ROADWAY SURFACES UNLESS OTHERWISE APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT.
- D. SPACING SHALL BE A MINIMUM OF 4 FEET BETWEEN BACK OF CROSSWALK BAR AND FRONT OF STOP BAR AND A MINIMUM OF 4 FEET BETWEEN BACK OF CROSSWALK BAR AND FRONT OF YIELD MARKING TRIANGLES UNLESS OTHERWISE APPROVED BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT.
- E. PARKING LANE WIDTH SHALL BE 7 FEET TO 9 FEET AS SPECIFIED BY THE DESIGNER.
- F. THE CONTRACTOR SHALL BE REQUIRED TO REMOVE ALL TEMPORARY AND DETOUR MARKINGS AS NECESSARY. THIS WORK WILL NOT BE TABULATED, MEASURED, OR PAID FOR SEPARATELY, BUT SHALL BE INCLUDED IN THE OVERALL COST OF THE FINAL PAVEMENT MARKINGS.
- G. ALL OTHER PROVISIONS OF "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION", COLORADO DEPARTMENT OF TRANSPORTATION, CURRENT EDITION, SHALL APPLY.
- H. ALL REMOVALS SHALL BE BY SANDBLASTING OR WATER BLASTING METHODS. THE PAVEMENT MARKINGS SHALL BE REMOVED TO THE EXTENT THAT THEY SHALL NOT BE VISIBLE UNDER DAY OR NIGHT CONDITIONS.



INTERSECTION PAVEMENT MARKINGS SHALL BE PLACED PER APPROVED PROJECT PLANS

TYPICAL PAVEMENT MARKING EXAMPLES

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STREET CLASSIFICATION	W	L
LOCAL	18"	8'
MINOR COLLECTOR	18"	8'
MAJOR COLLECTOR	24"	10'
ARTERIAL	24"	10'
MIDBLOCK	24"	10'

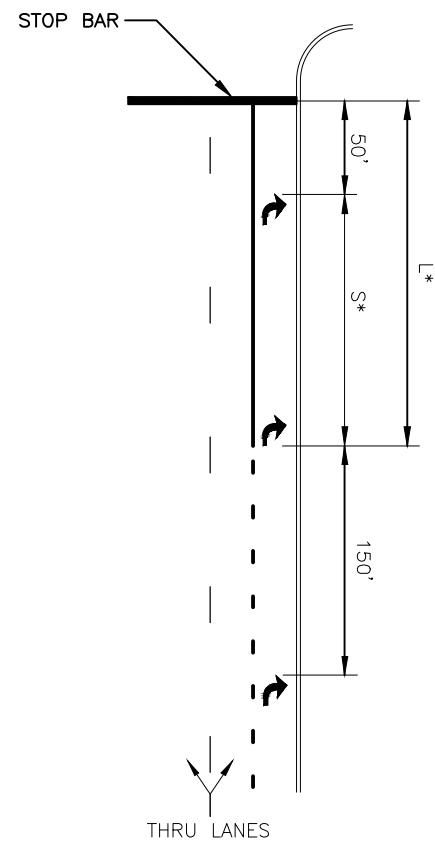
LONGITUDINAL BAR CROSSWALK DETAIL

LOCATION OF STOP BARS AND CROSSWALKS AT INTERSECTIONS ON APPROVED PROJECT PLANS
TYPICAL LONGITUDINAL BAR CROSSWALK MARKINGS

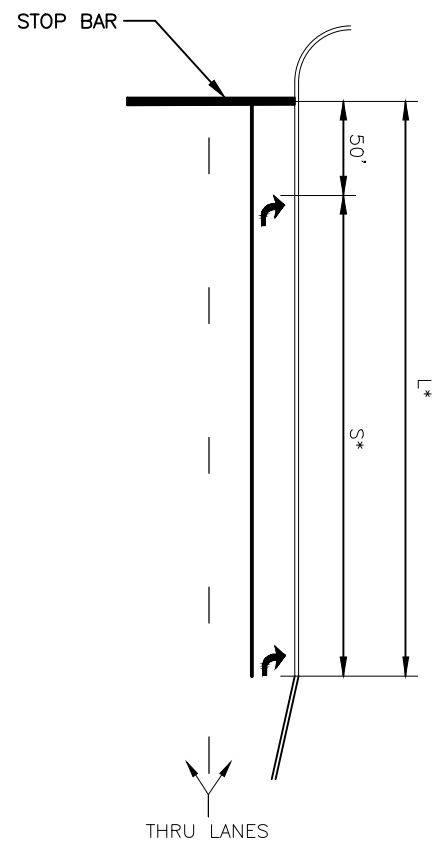
LONGITUDINAL BAR CROSSWALK LAYOUT NOTES

- CROSSWALKS SHALL BE CENTERED ON CURB RAMPS.
- CROSSWALK BARS SHALL BE ANGLED SUCH THAT THEY ARE PARALLEL TO THE TRAVEL PATH OF APPROACHING TRAFFIC.
- CROSSWALK BARS SHALL BE SPACED TO BE CENTERED ON LANE LINES AND IN THE CENTER OF EACH LANE TO AVOID WHEEL PATHS. SPACING SHALL NOT EXCEED 2.5 TIMES CENTER TO CENTER WIDTH OF CROSSWALK BAR.
- ALL CROSSWALK BARS IN EACH CROSSWALK SHALL BE SAME WIDTH.
- CROSSWALKS SHALL NOT EXTEND PAST THE CURB LINE OF ADJACENT ROADWAY.

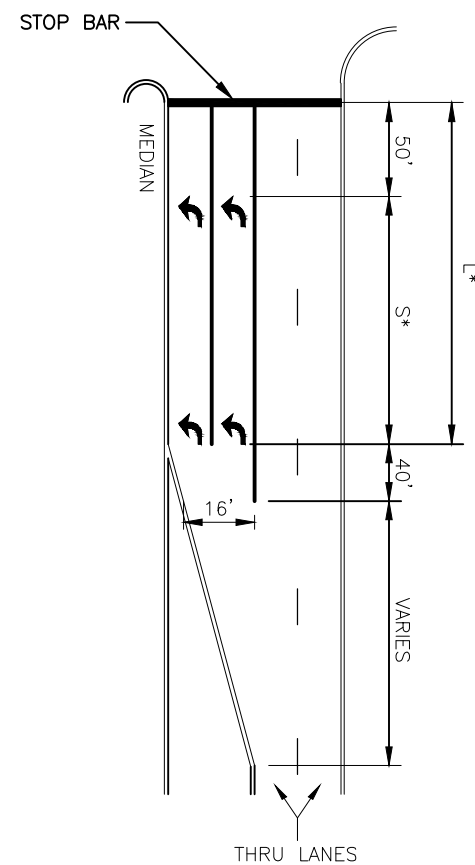
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LANE DROP



POCKET TURN LANE



DOUBLE TURN LANE

NOTES

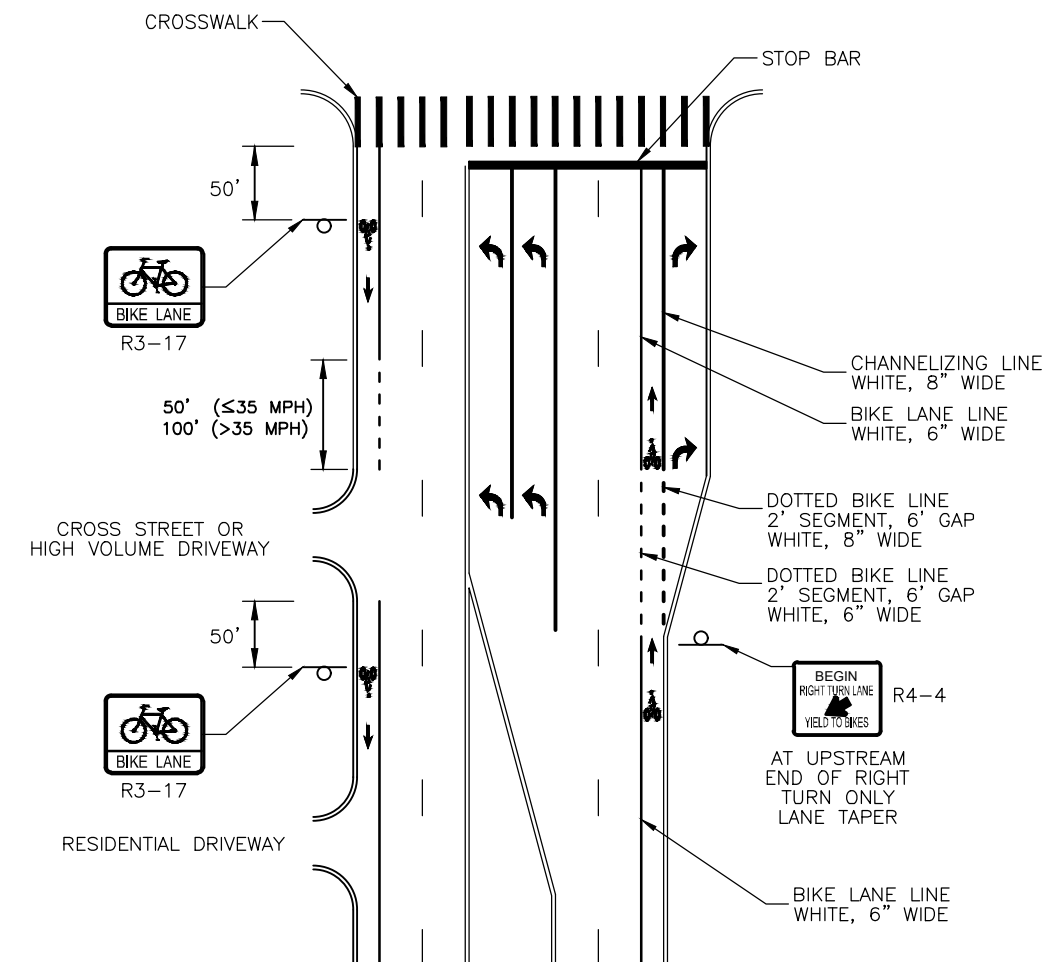
1. THE SPACING IN THE TABLE APPLIES TO LEFT AND RIGHT TURN LANES.
2. WHEN ONE (1) ARROW IS USED, IT SHALL BE PLACED AT THE BEGINNING OF THE FULL WIDTH TURN LANE. OTHERWISE, USE THE TABLE BELOW FOR ARROW PLACEMENT.

LENGTH (L)	NO. OF MARKINGS PER LANE	SPACING (S)
L < 250'	1	NA
250' - 500'	2	EVENLY SPACED BETWEEN 150' - 350'
L > 500'	3+	

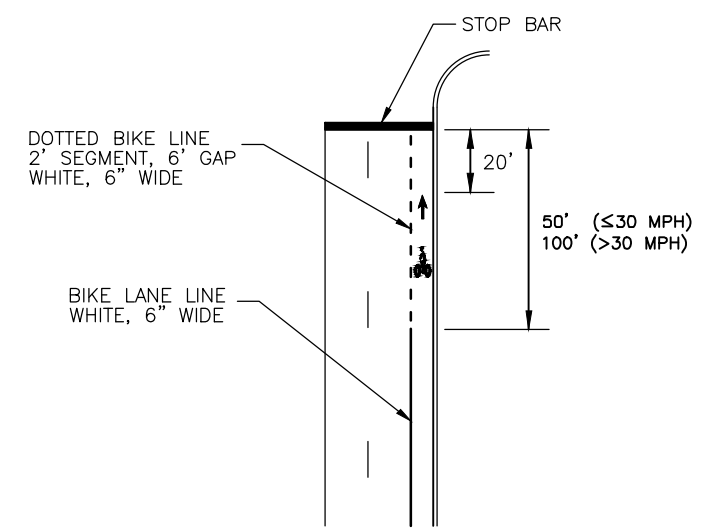
* L (LENGTH) AND S (SPACING) PROVIDED IN THE TABLE ABOVE WILL HELP DETERMINE THE NUMBER OF ARROWS NEEDED PER LANE.

3. SEE MUTCD LATEST EDITION FOR REQUIRED ADVANCED SIGNAGE THAT MAY BE REQUIRED.

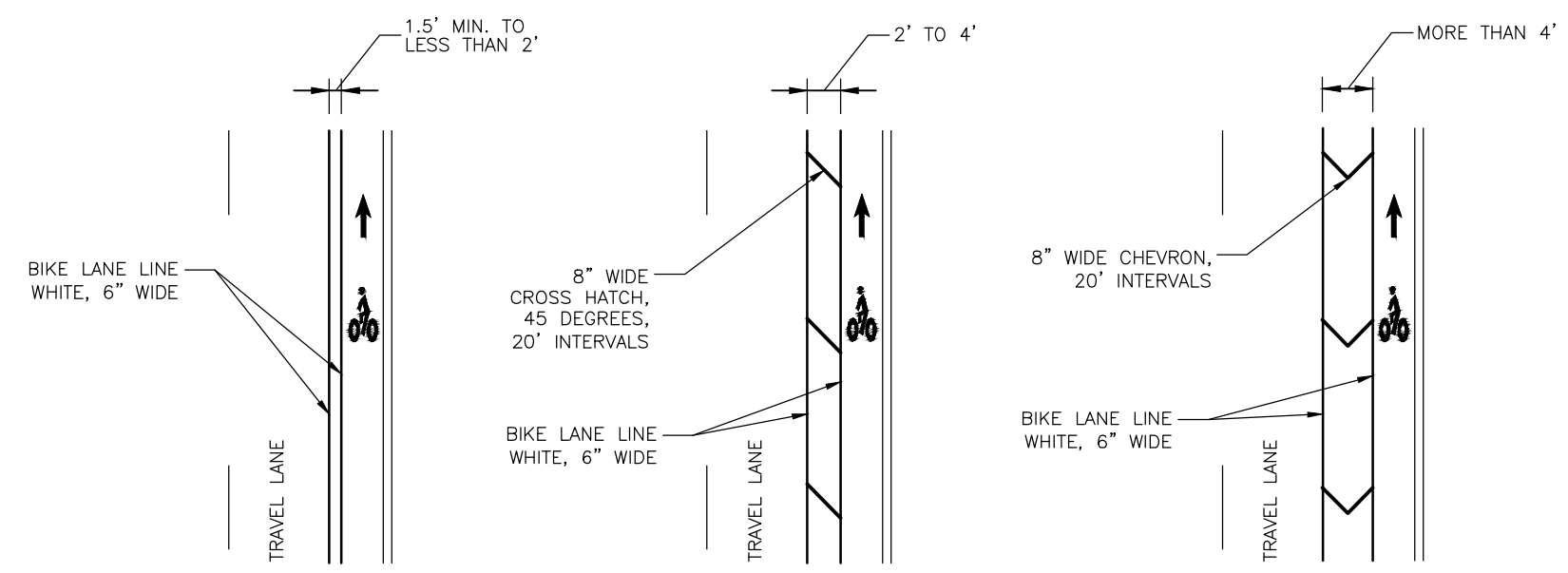
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TYPICAL BIKE LANE PAVEMENT MARKING



APPROACH BIKE LANE (NO RIGHT TURN POCKET) PAVEMENT MARKING

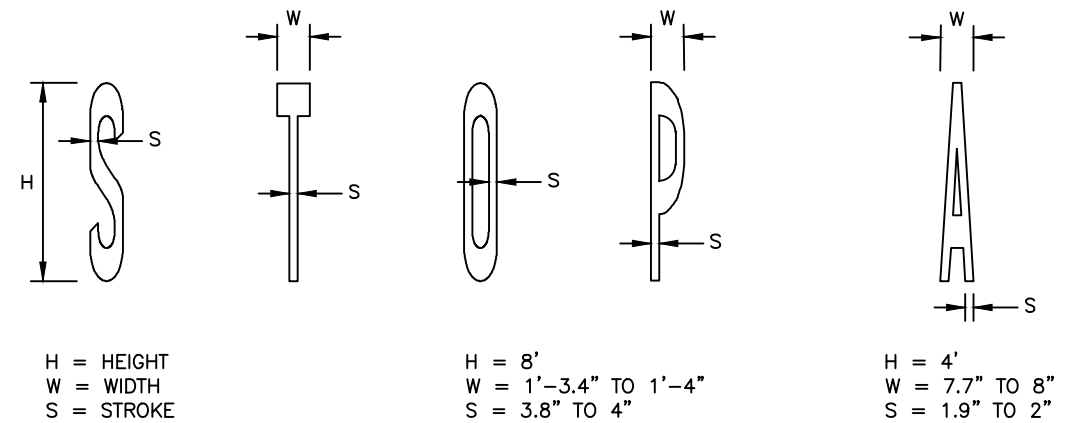
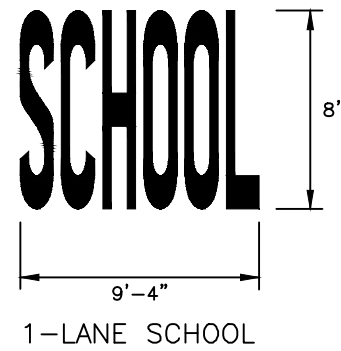
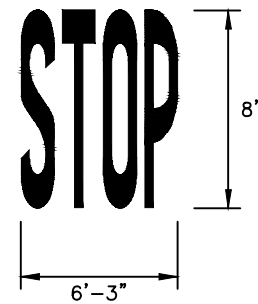
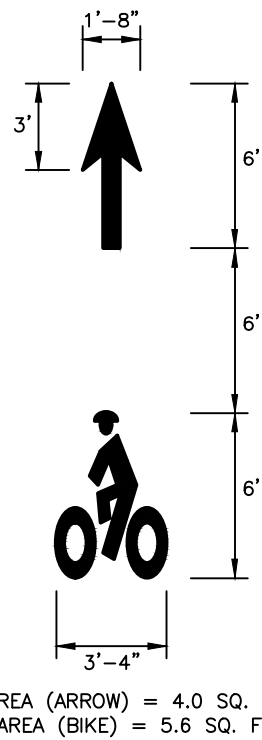
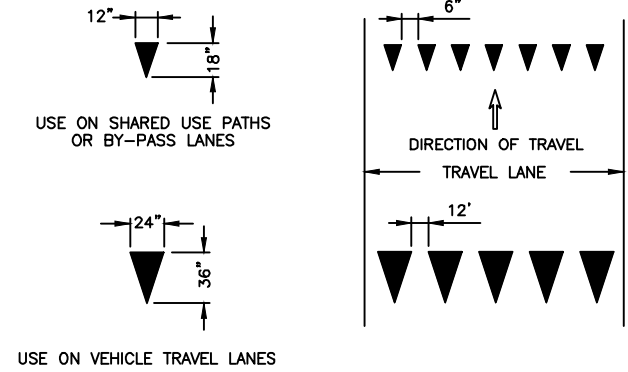
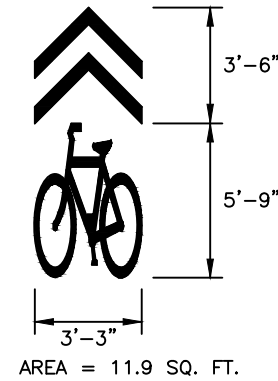
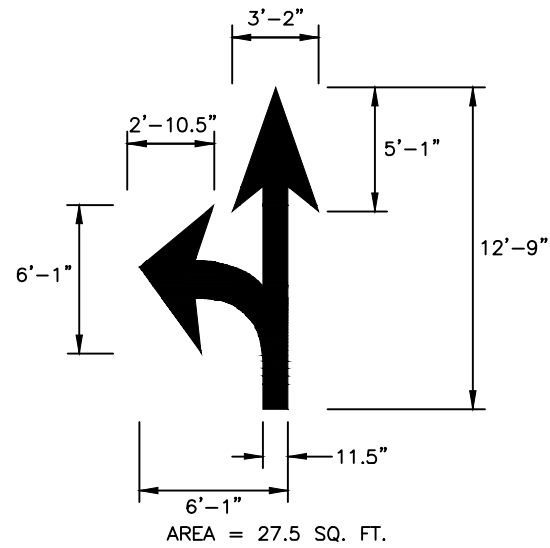
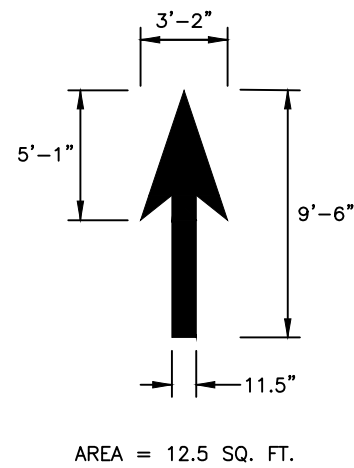
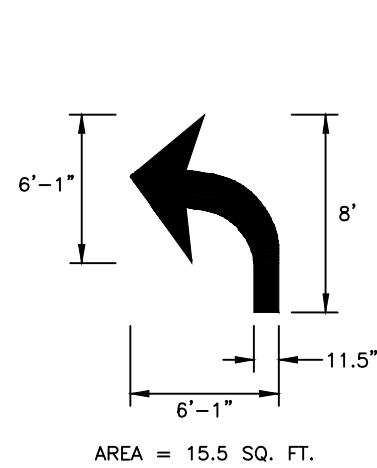


TYPICAL BIKE LANE BUFFER PAVEMENT MARKING

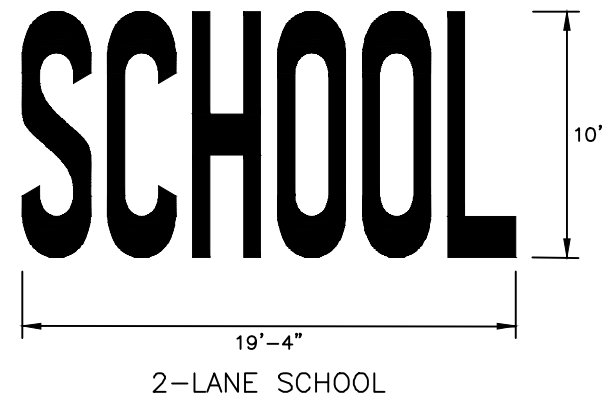
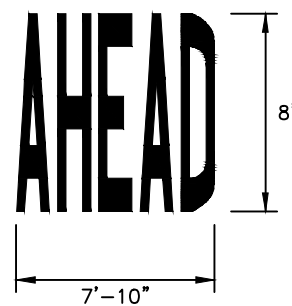
NOTES:

- BIKE LANE PAVEMENT MARKINGS AND SIGNS SHALL FOLLOW MUTCD LATEST EDITION AND THE COLORADO SUPPLEMENT TO THE MUTCD.
- BIKE SYMBOL MARKINGS SHALL BE INSTALLED ON FAR-SIDE OF ALL INTERSECTIONS, ARTERIAL CROSSINGS AND MAJOR DRIVEWAYS AT 50 FEET FROM TANGENT OF CORNER CURB RADIUS.
- BIKE SYMBOL MARKINGS SHALL BE INSTALLED AT THE BEGINNING AND END OF BIKE LANE POCKETS AT APPROACHES TO AN INTERSECTION.
- IN RURAL AREAS, THE MAXIMUM SPACING OF BIKE LANE MARKINGS SHALL NOT EXCEED 1,320 FEET. IN URBAN AREAS, THE SPACING SHOULD NOT EXCEED 600 FEET.
- THE 6-INCH WHITE STRIPE ON THE LEFT OF THE BIKE LANE SHALL BECOME A DOTTED 2-FOOT LINE WITH A 6-FOOT GAP AT BUS STOPS WITH ALIGHTING PADS TO CLARIFY THAT BUSES ARE TO MOVE RIGHT TO ALLOW TRANSIT RIDERS TO DISEMBARK OFF OF THE ROADWAY.
- GREEN PAVEMENT MARKINGS ARE OPTIONAL AND SHALL BE USED AS DIRECTED BY APPROVED PLANS.
- BIKE LANES SHALL BE A MINIMUM OF 4 FEET AND MAXIMUM OF 6 FEET WIDE, WITH 5 TO 6 FEET WIDTH PREFERRED.
- IF MORE THAN 5 FEET OF WIDTH IS AVAILABLE FOR THE BIKE LANE, A STRIPED BUFFER SHALL BE CONSIDERED. BUFFER SHALL BE A MINIMUM WIDTH OF 1.5 FEET.
BUFFER 1.5 FEET TO LESS THAN 2 FEET: BLANK BUFFER SPACE
BUFFER 2 FEET TO 4 FEET: CROSS HATCH ON 20 FOOT INTERVALS
BUFFER GREATER THAN 4 FEET: CHEVRONS ON 20 FOOT INTERVALS

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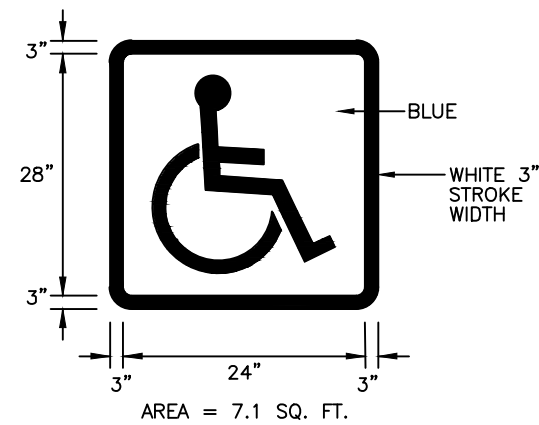
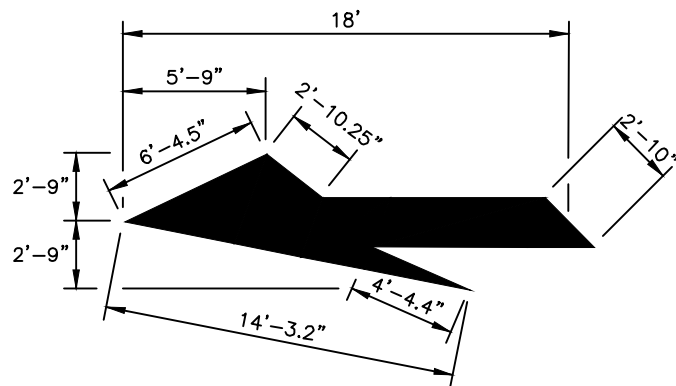
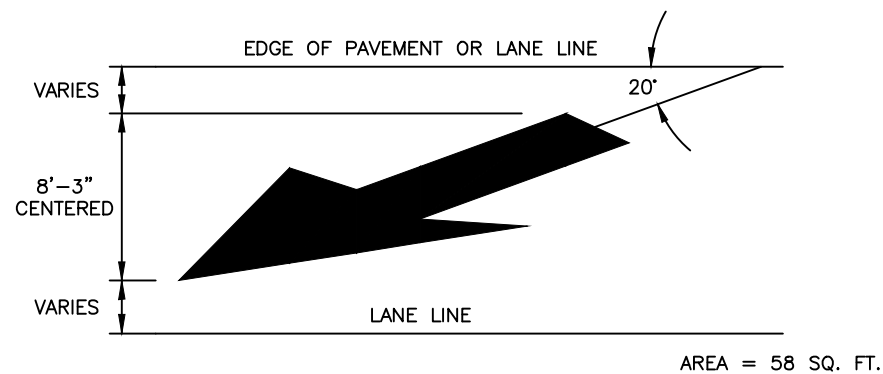


TYPICAL LETTER MEASUREMENTS



H = 8' WORDS

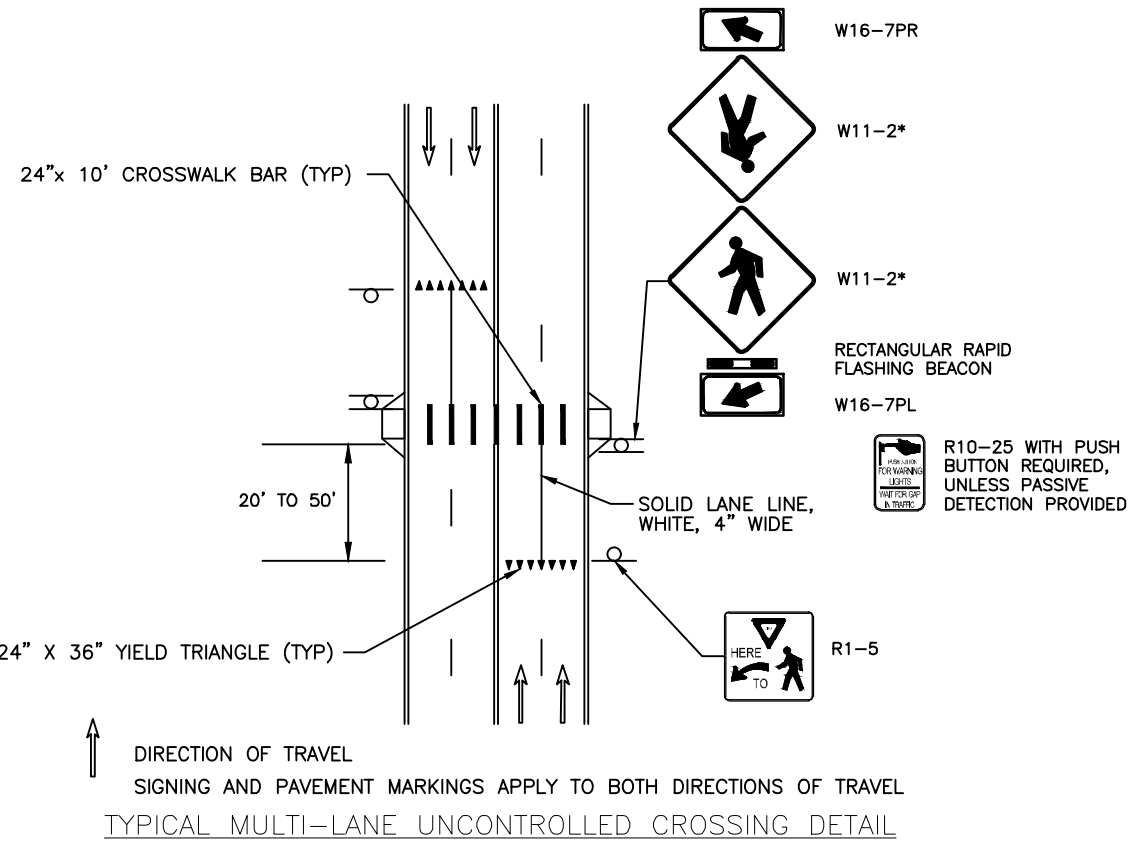
STOP	23.0 SQ. FT.
AHEAD	29.0 SQ. FT.
SCHOOL (1L)	33.0 SQ. FT.
SCHOOL (2L)	85.0 SQ. FT.



NOTES:

- REFER TO FHWA STANDARD HIGHWAY SIGNS AND MARKINGS, CURRENT EDITION, AND CDOT STANDARD PLANS FOR WORD AND SYMBOL DETAILS NOT SHOWN.

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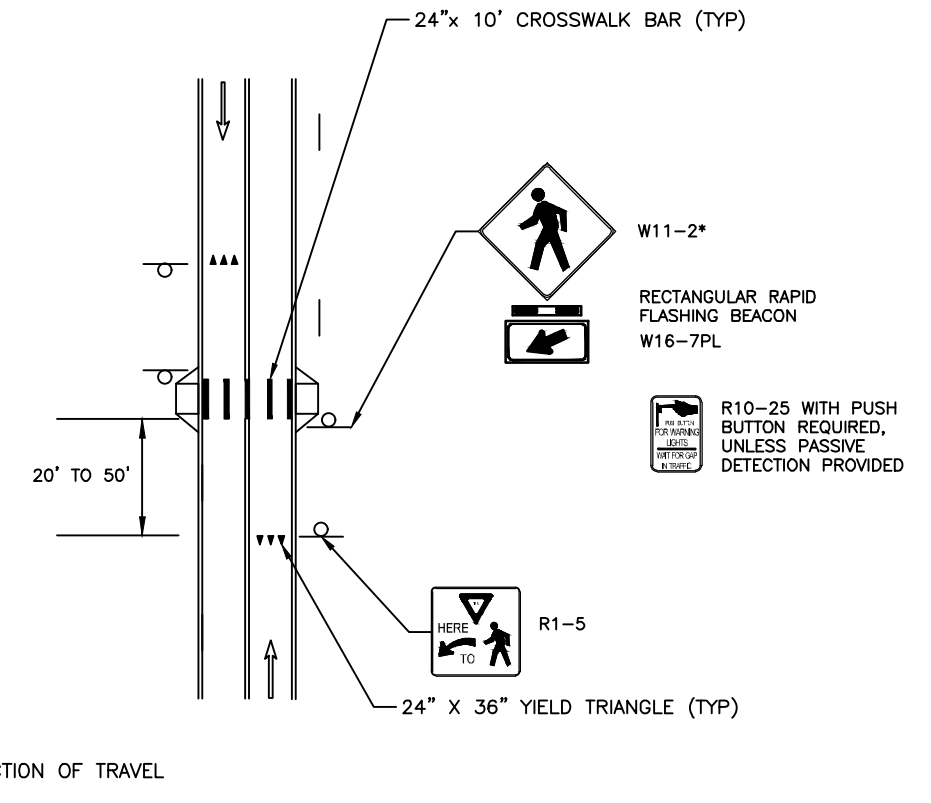
TYPICAL MULTI-LANE UNCONTROLLED CROSSING DETAIL



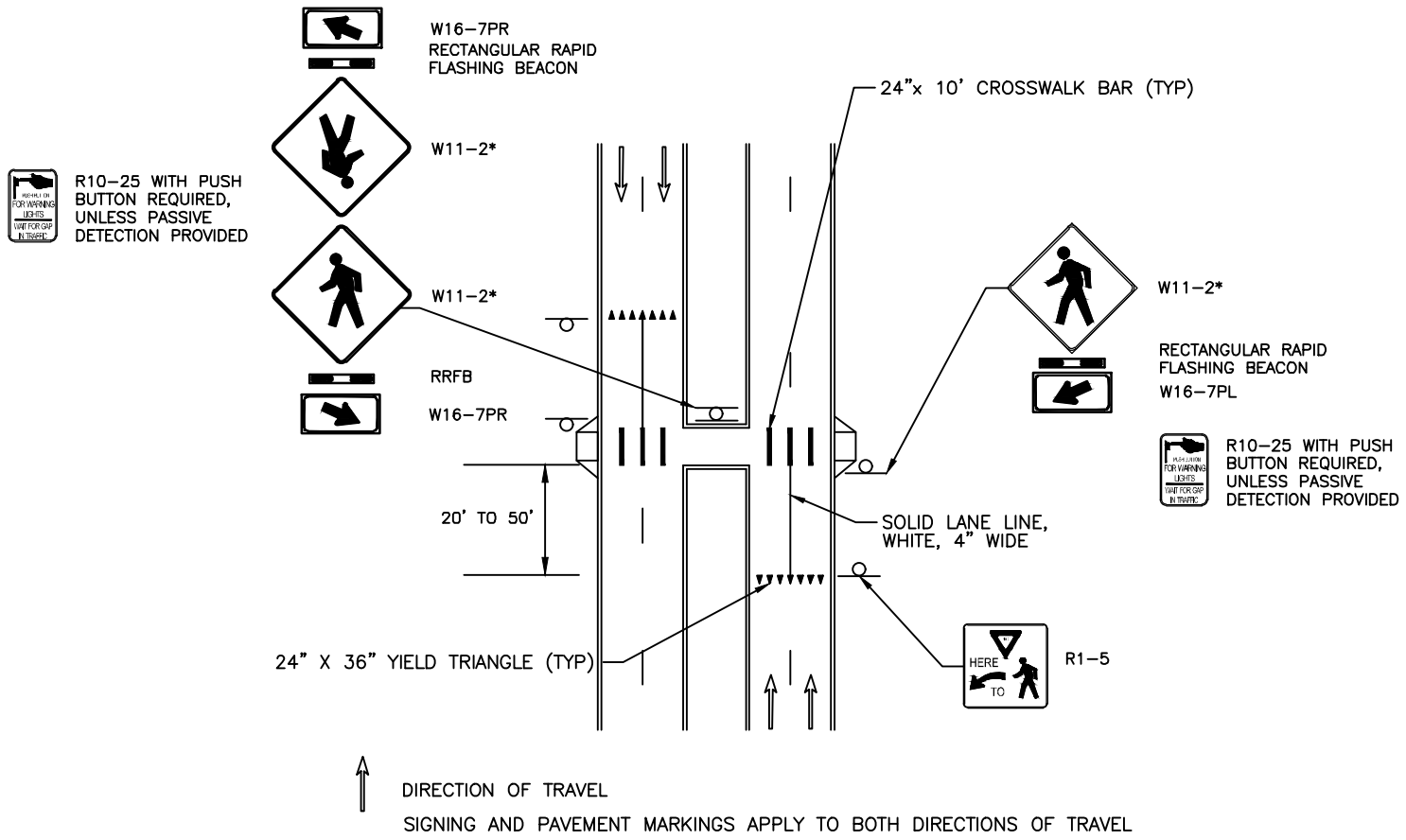
* W11-2 SIGN SHALL BE REPLACED WITH W11-15 SIGN FOR MULTI-USE CROSSINGS, OR AS DIRECTED BY ARAPAHOE COUNTY.

NOTES

1. SEE THE MUTCD, LATEST EDITION ADOPTED BY ARAPAHOE COUNTY, FOR ADVANCED SIGNAGE THAT MAY BE REQUIRED.
2. SEE ARAPAHOE COUNTY'S ENHANCED CROSSWALK GUIDE FOR ADDITIONAL CROSSING REQUIREMENTS.
3. UNCONTROLLED CROSSINGS WITHOUT RECTANGULAR RAPID FLASHING BEACONS SHALL REQUIRE PRE-APPROVAL BY ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT.



TYPICAL TWO-LANE UNCONTROLLED CROSSING DETAIL



TYPICAL MULTI-LANE UNCONTROLLED CROSSING WITH MEDIAN DETAIL

REVISIONS			
NO.	DATE	DESCRIPTION	
	12/2024	ORIGINAL	
ARAPAHOE COUNTY, COLORADO DEPARTMENT OF PUBIC WORKS AND DEVELOPMENT			
PAVEMENT MARKING STANDARD DETAILS			
UNCONTROLLED CROSSING DETAILS			
PROJECT NO.	DATE:	DESIGNED BY:	JOB NO.
PROJECT NAME:	SCALE:	DRAWN BY:	SHEET NO.
			7 OF 7