Standards and Specifications for the Design and Construction of Public and Private Improvements

October 2012

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SECTION 100 - INTRODUCTION

101 GENERAL PROVISIONS

These regulations shall be known as the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements, 2012 Edition, as may be amended from time to time by the City, and may be cited as such and shall be referred to herein as the Standards and Specifications. They were adopted by the City of Thornton City Council on October 23, 2012.

101.1 Purpose

The purpose of these Standards and Specifications is to provide minimum standards for safety, health, and the general welfare of the City by regulating the design of, construction of, choice of materials used for, location of, maintenance and use of all Public and Private Improvements. These include, but are not limited to, sanitary sewer systems, water supply systems, private utility service lines for water and sewer, public and private storm drainage systems, public and private streets, landscape areas, open space, parks and recreation facilities, traffic signals and devices, public and private parking lots and appurtenances thereto. All equipment and material used in the construction of all public and private improvements shall be new unless approved by the City.

These Standards and Specifications represent minimum requirements and design values. Additional requirements or higher design values, commensurate with conditions, may be required by Development Engineering when they are in the best interest of the City.

101.2 Scope

The provisions of these Standards and Specifications shall apply to the planning, design, construction, enlargement, alteration, moving, removal, conversion, demolition, repair, and excavation of any Public or Private Improvements specifically regulated herein. These Standards and Specifications present the minimum standards for construction of Public and Private Improvements completed by Responsible Parties. These Standards and Specifications do not relate to the City's capital improvement projects, unless specifically noted in the contract documents. With the exception of maintenance practices, the City shall follow these Standards and Specifications where practicable.

In the case of those improvements that are required by the City, and are not specifically covered in these Standards and Specifications, the City will require the Responsible Party to follow applicable local, state, and federal guidelines, or standards promulgated by professional organizations. Development Engineering shall be consulted for guidance on proper references.

102 DEFINITIONS AND ABBREVIATIONS

102.1 Definitions

Whenever the following terms are used in these Standards and Specifications, they shall be defined as follows:

Accessory dwelling unit - a second dwelling unit that is either located within a single-family detached dwelling or in an attached or detached structure on the same lot as the single-family detached dwelling.

Approved Construction Drawings – Plans that were reviewed for compliance with City Codes. The Engineer of record is responsible for adequacy of design and ensuring that the Improvements meet all City Codes and these Standards and Specifications.

As-Built Plans – A modified version of the full set of the approved construction drawings with actual physical documentation of any changes based on field measurements and certified by a Professional Engineer (PE) or Professional Land Surveyor (LS).

Balled and Burlapped - Plant material established in the ground that is dug for transplanting with an undisturbed ball of earth containing the roots of the plant wrapped in burlap or other similar fabric.

Caliper - The diameter of the tree trunk measured six (6) inches above the ground for trees up to and including four (4) inch caliper size and 12 inches above the ground for larger sizes.

Certified Arborist - An individual holding certification by the International Society of Arboriculture who is engaged in the profession of arboriculture and who, through experience, education and related training, possesses the competence to provide for, or supervise the management of, trees and other woody ornamentals.

City - City of Thornton, Colorado, a municipal corporation, organized pursuant to Article XX, Colorado Constitution as a home rule municipality and shall include the City Manager or his designee or other official, body or agency designated by Charter or Ordinance to act on behalf of the City.

City Code - The latest, officially adopted version of the Thornton City Code.

Clear Zone - The minimum width area adjacent to a pedestrian pathway or fire hydrant or other utility structure.

Contractor - A person, partnership, corporation, subcontractor or other legally formed entity or organization that undertakes to construct, install, alter, move, demolish, repair, replace, excavate or add to any Public or Private Improvements covered by these Standards and Specifications.

Days - Calendar days, unless otherwise specified.

Deciduous - A plant with foliage that is shed annually.

Developer - Any and all owners of the Property, and shall include any owner acting through a duly executed power of attorney granting the attorney-in-fact full authority to act in the stead of the owner.

Developer's Agreement - An agreement between a developer and the City which clearly establishes the developer's responsibility regarding project phasing, the provision of Public and Private improvements and any other mutually agreed to terms and requirements adopted by the City.

Development Code - Chapter 18 of the City Code established in accordance with the Comprehensive Plan for the purpose of promoting the health, safety, morals, and the general welfare of the City in connection with development.

Development Engineering Manager –The City of Thornton Development Engineering Manager or an authorized designee. Herein after also referred to as Development Engineering.

Dripline - A vertical line extending downward from the tips of the outermost branches of a tree or shrub to the ground.

Evapotranspiration - A measure of water depletion from the soil due to evaporation from the soil surface and transpiration through plant foliage.

Evergreen - A plant with foliage that persists and remains green year-round.

Final Acceptance – The acknowledgement by the City that the warranty period has expired and there are no outstanding items to be corrected under provisions of the guaranty.

Fire hydrant branch main – The public 6" DIP waterline that connects to the 8" or larger public main.

Grade - The average of the finished ground surface elevations measured at the highest and lowest exterior corners of a structure; or the slope of a road, street or other public way, or the slope of the ground surface elevations.

Grading - The act of excavating or filling or combination thereof and which changes the existing topography.

Ground cover - Living plant material, other than turf grass, normally reaching an average maximum height of not more than 24 inches at maturity and which grows or spreads in such a manner as to provide continuous plant coverage. Annuals, herbaceous perennials, weeds, mulches and deciduous tree canopies are not ground cover.

Ground Cover, Woody - Evergreen perennial and sub-shrub plant material as Mahonia repens, Vinca minor, and Euonymous fortunei 'Coloratus' that satisfies Tree Equivalent requirements.

Hardscape - Non-living site improvements at the ground plane such as pavement, walkways, parking areas, and other similar improvements as determined by the City.

High Water Demand Landscape – Landscape areas that require approximately 75-100% of Reference Evapotranspiration, or 15-20 gallons per square foot per average year.

Hydrozone - A portion of a landscape area having plants with similar water needs.

Improvements – Is intended to define both public and private improvements as defined herein.

Initial Acceptance – An acknowledgement by the City that, to the best of the City's knowledge, all Improvements have been completed in accordance with the approved plans and these Standards and Specifications.

Inspector - The authorized representative of the Development Engineering Manager assigned to make detailed inspection of construction work to assure compliance with these Standards and Specifications and the plans as approved by the City.

Irrigation Controller - A fully automatic, electrically operated mechanism used to regulate the timing of irrigation valve operations.

Irrigation System - An artificial watering system designed to transport and distribute water to landscape plant material.

Landscape - Any combination of living plant material, such as trees, shrubs, vines, ground covers, flowers, vegetables, turf, or grass as categorized as follows:.

Landscape Area - The land area within a lot or property not comprised of buildings and hardscape and that is planted with cultivated vegetation at the ground plane. Landscape area does not include bare dirt or weeds. Areas dedicated to edible plants such as orchards or vegetable gardens may be included in the calculation of landscape area as approved by the City.

Landscape Area, Private Common - A landscape area within a development owned and maintained by an owners association or Metropolitan District.

Landscape Canopy - The upper vegetative cover of a tree or plant material grouping, and may also be referred to as “overstory”.

Landscape Fabric - A porous geotextile fabric installed below mulch.

Landscape Mitigation Plan - A plan for the replacement of plant material that is removed, destroyed or otherwise negatively affected by the development of a property.

Landscape Plan - A plan drawn to scale that shows the layout of all landscape components and their specifications for a site.

Letter of Completion – Letter notifying the Responsible Party that the Private Improvements were constructed in accordance with the approved plans, and these Standards and Specifications.

Low Water Demand Landscape – Landscape areas that require approximately 25-50% of Reference Evapotranspiration, or 5-9 gallons per square foot per average year.

May - Permissive.

Moderate Water Demand Landscape – Landscape areas that require approximately 50-75% of Reference Evapotranspiration, or 10-14 gallons per square foot per average year.

Mulch - Nonliving organic wood, rock or stone materials used in the landscape industry to cover bare ground, to provide a protective covering around plants and to retard erosion, retain soil moisture, reduce weed growth, and maintain even soil temperatures.

Normal Work Hours - 8:00 a.m. - 5:00 p.m., Monday through Friday, except holidays, as defined in the City Code.

Open Space - An area of land that is kept in or returned to its natural state to protect or preserve wildlife habitat, to protect, preserve, or enhance wetlands, or to provide, preserve, or support view, vista, or wildlife corridors. Open space may include agricultural uses and natural features located on a site, including, but not limited to, meadows, forested areas, steep slopes, floodplains, hazard areas, unique geological features, ridgelines, unique vegetation, and critical plant communities, stream corridors, wetlands, and riparian areas, wildlife habitat and migration corridors, areas containing threatened or endangered species and archeological, historical, and cultural resources.

Owner - Any individual, corporation, partnership, or other legal entity holding title to real property which is the subject of improvements covered by these Standards and Specifications or which are intended to come under the ownership or control of the City.

Plant Material Protection Zone - An area fenced off from use during construction work designated to protect plant material from potential damage.

Person – an individual firm, organization, corporation, partnership or other legal entity including contractors or subcontractors authorized to act on behalf of an owner

Practical Turf Areas - A landscape design and management concept promoting high water-demand turf only in those areas of a property that are functional for recreation and the efficient management of supplemental irrigation required for those areas.

Private Improvements - Improvements under the private ownership or control and/or maintained by the private owners, including but not limited to, portions of water systems, sewer systems, street systems and storm drainage systems, the construction of which are governed by these Standards and Specifications.

Public Improvements - Improvements under the ownership or control of the City and maintained by the City including but not limited to the components of the water system, sewer system, street system, park and open space system, and storm drainage system covered by these Standards and Specifications. The term also includes similar improvements being built in connection with a subdivision which are intended to be dedicated to the City.

Rain Sensor or Rain Shutoff Device - A device connected to an irrigation controller that overrides scheduled irrigation when significant precipitation has been detected.

Reference Evapotranspiration – The combined water losses of transpiration and evaporation experienced by a 5-inch stand of cool-season, pasture-type grasses.

Responsible Party - Any individual, corporation, partnership, or other legal entity involved in developing improvements covered by these Standards and Specifications. Includes subcontractors, contractors, developers, and owners, as applicable in the development process.

Right-of-way – Real property dedicated to public use including, but not limited to, pedestrian, equestrian, or vehicular movement; railroads; public utilities; and water and sanitary sewer facilities.

Service Area - An area, whether inside or outside city limits, that receives water and/or sanitary sewer utility service from the City of Thornton.

Shall - Mandatory.

Soil Amendment - Organic and inorganic materials added to soil to improve texture, nutrients, moisture holding capacity, and infiltration rates.

Stop Work Order – Official written notice from the City to cease any and all construction or development activities on a site or lot due to a violation of, including but not limited to, the approved plans, the City Code, the Standards and Specifications, building codes, storm water runoff regulations. This notice will also include, but not be limited to, the restriction on issuance of building permits, certificates of occupancy, and additional provisions of utility services until the identified violations are corrected and approved by the City.

Street Tree - A tree planted within the street right-of-way between the curb or edge of road and the adjoining property line to provide shade and spatial definition, and to enhance the street environment.

Surety - Performance, labor and material payment bonds, irrevocable letters of credit, cash, and other instruments of security furnished to the City by the Responsible Party.

Tree Equivalent – One (1) balled and burlapped two (2) inch caliper or six (6) foot tall clump deciduous tree or six (6) foot tall evergreen tree or 10 No. 5 container size evergreen or deciduous shrubs or 20 No. 1 container size woody, evergreen perennial ground covers or ornamental grasses or other substitutions as may be allowed in the Development Permit process.

Turfgrass (Turf) – A continuous ground cover of improved grass plants growing intimately with an upper soil stratum of intermingled roots and stems.

Ultra-Low Water Demand Landscape – Landscape areas that require approximately 0-25% of Reference Evapotranspiration, or 0-4 gallons per square foot per average year.

Vegetation - Plants in general or the sum total of plant life in an area.

Warranty Period - Shall be the time frame during which the Responsible Party is held liable for all work performed and materials utilized prior to final acceptance by the City of Thornton.

Water-Wise Landscape - A water efficient landscape adapted to the local environment.

Wetland – An area defined and controlled by the Army Corps of Engineers that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support vegetation, and that under normal circumstances, will support a prevalence of vegetation typically adapted for life in saturated soil conditions.

102.2 Abbreviations

AASHTO American Association of State Highway and Transportation Officials

AC	Asphalt Content
AC	Alternating Current
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
AISC	American Institute of Steel Construction
ALCC	Associated Landscape Contractors of Colorado
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AWWA	American Water Works Association
AWG	American Wire Gauge
BMP	Best Management Practice
CBR	California Bearing Ratio
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
cfs	cubic feet per second
CP	Colorado Testing Procedures
CP-L	Colorado Lab Testing Procedures
CPSC	Consumer Product Safety Commission
CRS	Colorado Revised Statute
CUHP	Colorado Urban Hydrograph Procedure
DIP	Ductile Iron Pipe
DRC	Dry-Rodded Condition
DU/Ac	Dwelling Units per Acre
EDLA	Equivalent Daily Load Application
ESAL	Equivalent Single Axel Load
ET	Evapotranspiration
FAA	Federal Aviation Administration
fps	Feet per second
Gal	gallons
gpd	Gallons per day.
gpm	Gallons per minute.
GRC	Galvanized Rigid Conduit.

GVW	Gross Volume Weight
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
HMA	Hot Mix Asphalt
IMSA	International Municipal Signal Association
IPC	International Plumbing Code
IPEMA	International Play Equipment Manufactures Association
ISA	International Society of Arboriculture
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
LABCAT	Laboratory for Certification of Asphalt Technicians
Lbs	pounds
LS	Land Surveyor
MAPC	Manual of Accident Prevention in Construction
MGD	Million gallons per day
MS4	Municipal Separate Strom Sewer System
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PC	Point of Curvature
PCC	Portland Cement Concrete
PE	Professional Engineer
PG	Performance Grade
PI	Point of Intersection
PRV	Pressure Reducing Valve
psi	Pounds per square inch
PT	Point of Tangency
PVC	Polyvinyl Chloride
RAP	Reclaimed Asphalt Pavement
RCP	Reinforced Concrete Pipe
ROW	Right-of-way
RPS	Roller Pass Study
SDR	Standard Dimension Ratio

sf	Square Foot
SZFL	School Zone Flashing Light
SMA	Stone Mastic Asphalt
SN	Structural Number
SWMP	Stormwater Management Plan
UL	Underwriters Laboratories, Inc.
UDFCD	Urban Drainage and Flood Control District
USGS	United States Geological Survey
VCA	Voids in the Coarse Aggregate
VFA	Void Filled Asphalt
VMA	Voids in the Mineral Aggregate
VTM	Voids in the Total Mix
WMA	Warm Mix Asphalt
WQCD	Water Quality Control Division

102.3 Terms

A. Whenever, in these Standards and Specifications, the words "as ordered", "as directed", "as required", "as permitted", "as allowed", or words or phrases of like meaning are used, it shall be understood that the order, direction, requirement, permission, or allowance of the City is intended.

B. Similarly, the words "approved", "reasonable", "suitable", "acceptable", "properly", "satisfactory", or words of like meaning, unless otherwise specified herein, shall mean approved, reasonable, suitable, acceptable, proper, or satisfactory in the judgment of the City.

C. Whenever, in these Standards and Specifications, the words “Development Engineering Manager” are used, it shall be understood that the City employee named therein shall be whoever is designated by the City Manager.

103 GENERAL CONDITIONS

103.1 Authority of the City

A. Engineering and Landscaping Services

The Responsible Party shall procure at its sole expense all engineering and landscaping services necessary and appropriate in conjunction with the development of the property, which shall fully conform to the City's applicable ordinances, and these Standards and Specifications. Professional services shall be performed by engineers, surveyors, landscape architects, or other professionals duly licensed by the State of Colorado as may be appropriate.

B. Public Utility Fees

The Responsible Party shall pay all installation charges for lighting, electric, and/or gas services required by Public Service Company (Xcel Energy) or United Power for the property/project. Payment for street lights shall be made in a timely fashion to assure that street lights within and adjacent to residential lots are installed prior to the certificate of occupancy of the adjacent lots. At the discretion of the Development Engineering Manager the City may withhold inspections and/or initial acceptance if the street lights have not been installed prior to certificate of occupancy.

C. Variances

Whenever there are practical difficulties involved in carrying out the provisions of these Standards and Specifications, Development Engineering may grant variances for individual cases, provided that Development Engineering shall first determine that a specific reason exists making these procedures impractical and that the variance is in conformance with the intent and purpose of these Standards and Specifications, and providing that such variance does not lessen any design requirement or any degree of

integrity and shall result in a level of safety, service and quality equal to or greater than that intended by the application of the Standards and Specifications minimum requirements. The Responsible Party shall provide a written request for variance, and if approved by the City, a variance will be issued in writing by the Development Engineering Manager, stating what the variance is and why it is being granted.

D. Alternate Materials and Methods of Construction

1. The provisions of these Standards and Specifications are not intended to prevent the use of any material or method of construction not specifically prescribed by these procedures, provided any alternate in the Standards and Specifications is approved in writing by the Development Engineering Manager, and thus authorized by the City.

2. The Development Engineering Manager shall require that sufficient evidence or proof be submitted to substantiate any request that may be made regarding the alternate method or material. The details of any action granting approval of an alternate shall be recorded and filed with the City.

E. Tests

1. The Responsible Party shall employ at its sole expense a professionally qualified, independent testing company to perform all testing of materials or construction that may be required by the City to ensure compliance with these Standards and Specifications. The Responsible Party shall furnish the City with certified copies of test results, and agrees to release and authorize full access to the City and its designated representatives to all work-up materials, procedures, and documents used in preparing the test results.

2. Whenever there is insufficient evidence of compliance with any of the provisions of these Standards and Specifications or evidence that any material or construction does not conform to the requirements herein, Development Engineering may require that the Responsible Party, at its expense, shall provide test results to establish compliance. Such tests shall be as specified by these Standards and Specifications or by other recognized test standards approved by Development Engineering. If there are no recognized and accepted test methods for the proposed alternate, Development Engineering shall determine test procedures. All tests shall be made by an agency approved prior to testing by Development Engineering.

F. Organization and Enforcement

The Development Engineering Manager shall have the power to enforce all provisions of these Standards and Specifications The Development Engineering Manager may appoint a project manager, construction inspector, landscape architect, or other related technical officer or inspector, or other employee to act as an authorized representative.

Whenever any work is being done contrary to the provisions of these Standards and Specifications or approved plans, the Development Engineering Manager may order the work stopped by a written notice which shall be served on any persons engaged in the doing or causing of such work to be done, and any such persons shall forthwith stop such work until authorized by the Development Engineering Manager to proceed.

G. No Waiver of Legal Rights

The City shall not be precluded or estopped by any measurement, estimate, or certificate made either before or after the completion and acceptance of the work from showing the true amount and character of the work performed and materials furnished by the Responsible Party, or from showing that any such measurement, estimate or certificate is untrue or incorrectly made, or that the work or materials do not conform in fact to these Standards and Specifications.

H. Control of Work

1. Authority of Development Engineering Manager

The Development Engineering Manager shall have the authority to stop the work whenever such stoppage is deemed reasonably necessary to protect public's health, safety and welfare. The Development Engineering Manager shall resolve all questions which arise as to the quality and acceptability of materials furnished, work performed, interpretation of the plans and specifications, and acceptable fulfillment of the requirements of these Standards and Specifications.

2. Authority and Duties of Inspector

a. Inspectors are authorized to inspect all work completed and all material furnished. Inspections may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The Inspector is not authorized to revoke, alter, or waive any

requirements of these Standards and Specifications. The Inspector shall notify the Responsible Party of any failure of the work or materials nonconformity of these Standards and Specifications. The Inspector shall have the authority to reject materials until any questions at issue can be resolved by Development Engineering.

b. The Inspector shall, in no case, act as foreman or perform other duties for the Responsible Party, or interfere with the management of the work done by the Responsible Party. Any "advice" which the Inspector may give the Responsible Party shall not be construed as binding upon the City in any way, or release the Responsible Party from fulfilling all of the terms of these Standards and Specifications.

c. The presence or absence of the Inspector shall not relieve, in any degree, the responsibility or the obligation of the Responsible Party to follow these Standards and Specifications.

d. The Development Engineering Manager, or an authorized designee, shall, at all times, be provided reasonable and safe access to inspect the work whenever it is in preparation or progress.

3. Responsible Party's Responsibility for Work

In case of suspension of work for any cause whatsoever, the Responsible Party, before leaving the job site, shall take such precautions as may be necessary to prevent damage to the work, provide for proper drainage and erect any necessary barricades, signs, or other facilities, at the Responsible Party's expense, as required by applicable standards.

4. Removal of Unacceptable Work

Work which does not conform to the plans and these Standards and Specifications, and which results in an inferior or unsatisfactory product, shall be considered unacceptable work. Unacceptable work, whether the result of poor workmanship, poor design, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be immediately removed and replaced or corrected by, and at the expense of, the Responsible Party. This expense includes total and complete restoration of any disturbed surface to original or better than the original condition which existed before the repairs or replacement, regardless of improvements on lands where the repairs or replacement are required.

5. Requirements of Other Jurisdictions

Where proposed construction will affect other agencies such as the CDOT, adjacent cities and counties, railroads, ditch companies, etc, said construction shall be subject to the review and approval of said agencies. Generally, where more than one requirement is imposed, the more restrictive requirement shall govern. Exceptions must be authorized by the Development Engineering Manager in writing.

104 CONSTRUCTION PLANS

In addition to any other requirements for the issuance of a construction permit pursuant to the Thornton City Code, the developer shall submit to the Development Engineering Manager, prior to or contemporaneously with the application for construction permit, plans, engineering calculations, traffic reports, drainage reports, utility reports, geotechnical reports and other data as required to allow the Development Engineering Manager to determine compliance with these Standards and Specifications. All such reports, plans, computations, and specifications shall be prepared and designed by a professional engineer licensed in the State of Colorado, in accordance with the rules and laws of the Colorado Board of Registration of Professional Engineers. All park construction plans shall be prepared and designed by a professional landscape architect.

The Development Engineering Manager may waive the submission of plans, calculations, or other analysis, if in the Development Engineering Manager's judgment. The nature of the work applied for is such that reviewing of plans is not necessary to obtain compliance with these Standards and Specifications.

104.1 Construction Plan Requirements

Construction plans shall be checked for conformance with City minimum design standards prior to approval by the City. This approval shall be for conformance to City design standards and other requirements; engineering and landscaping design or needs shall remain the responsibility of the professional design engineer or landscape professional. Construction plans and all required reports shall be submitted in an electronic format to the Development Engineering Manager for review. The drawings shall be submitted in “pdf” format. Once all review comments have been addressed and the plans are final, four (4) sets of plans, signed and sealed by a professional engineer, or as appropriate by a landscape architect, shall be submitted and retained. One (1) set of construction plans shall be 22" x 34" in size and three (3) sets shall be 11”x17” in size. The approval of all required reports and construction plans is valid for one (1) year.

A. General Requirements

1. Plans and specifications shall be drawn to scale and shall have sufficient clarity to indicate the location, nature, and extent of the work proposed and show in detail that it shall conform to the provisions of these Standards and Specifications and all relevant laws, ordinance, rules and regulations.

2. The following items shall be shown on all plans:

   a. Cover Sheet, including Title Block (lower right-hand corner preferred).

   b. Scale (1"=50' horizontal and 1"=5' vertical for plans and profiles are a minimum).

   c. Legend including all line types and symbols

   d. Revision number and date.

   e. Name of professional engineer or landscape architect and firm.

   f. Professional engineer's (PE) number, signature, landscape architect as applicable, and stamp

   g. Drawing number(s)

   h. Statement: "Work shall be constructed to City of Thornton Standards and Specifications. This approval is for conformance to these Standards and Specifications and other City requirements. The design and concept remains the responsibility of the professional engineer or landscape professional."

B. General Notes:

The contractor shall be solely and completely responsible for conditions at and adjacent to the job site; including, safety of persons and property during the performance of work. This requirement shall apply continuously and not be limited to normal working hours. The City construction review of the contractor's performance is not intended to include review of the adequacy of the contractor's safety measures in, on, or near the construction site.

The type, size, location, and number of all known underground utilities are approximate when shown on the drawings. It shall be the responsibility of the contractor to verify the existence and location of all underground utilities along the route of the work. Location of existing utilities shall be verified by contractor prior to date of construction. For information contact: Utility Notification Center of Colorado (UNCC) – 1-800-922-1987. It is the Contractor’s responsibility to field verify size and horizontal and vertical locations of existing facilities prior to construction and notify the City of any discrepancies.

Materials and workmanship shall conform to the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements and work shall be subject to inspection and approval by authorized City of Thornton personnel.

All trenches shall be adequately supported and the safety of workers provided for as required by the most recent Occupational Safety and Health Administration (OSHA) "Safety and Health Regulations for Construction." These regulations are described in Subpart P, Part 1926 of the Code of Federal Regulations. Sheeting and shoring shall be utilized where necessary to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe being placed, to trees, or to any existing structure where excavations are made under severe water conditions. The contractor may be required to use an approved piling instead of sheeting and shoring.

The Contractor shall furnish the engineer the "as constructed" locations of facilities installed and, this in turn, shall be submitted to the City of Thornton on as-built mylar drawings and electronic files prepared by the Engineer.

The Contractor shall be responsible for cleaning nearby public streets of mud or debris due to construction activity initiated by said contractor on a daily basis or as otherwise directed by authorized City personnel.

Prior to the beginning of work, a preconstruction conference shall be held between the City, the Responsible Party who is scheduled to perform the work, the designated on-site field representative, the consulting engineer or landscape professional, and any other entities involved in the construction.

Development phasing of any project must be shown on the construction plans and made a part of the application procedure. No phasing shall be permitted unless this requirement has been adhered to.

No work shall begin until the installing Responsible Party is in possession of an approved set of plans and the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements, and all necessary permits for the Improvements has been issued by the City. Development Engineering's approval shall be for general conformity to the utility specifications and shall not constitute blanket approval of all dimensions, quantities and details of the material or equipment shown. Nor shall such approval relieve the Responsible Party, consulting engineer, or landscape architect of their responsibility for errors contained in the drawings. A copy of the approved plans and all permits shall be onsite at all times.

The Responsible Party shall furnish reasonable aid and assistance required by Development Engineering for the proper examination of the materials and work. Work shall be performed in accordance with accepted workmanship practices and the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements. Any work not accepted by Development Engineering shall be redone until compliance with these standards is achieved. Instructions given by Development Engineering relating to quality of materials and workmanship must be obeyed at once by the Responsible Party. Development Engineering shall not supervise set out work, or give line and grade stakes.

The materials used in projects shall be new and subject to the inspection and approval of the Inspector at all times. The Inspector has the right to perform any testing deemed necessary to ensure compliance of the material with these standards. No material shall be used before being inspected and approved by the Inspector. Failure or neglect on the part of the Inspector to condemn or reject inferior materials or work shall not be construed to imply their acceptance should their inferiority become evident at any time prior to final acceptance of the work. Inspectors have the authority to reject defective or inferior materials and/or defective workmanship and to suspend work until such time as the Responsible Party shall correct the discrepancies in question.

Whenever defective materials and work are rejected, the Responsible Party shall promptly remove such defective materials and construction from the job site and replace all defective portions to the satisfaction of Development Engineering. In the event the Responsible Party fails to remove rejected items from the job site within a reasonable length of time, Development Engineering may arrange for such removal at the expense of the Responsible Party.

Inspection shall not relieve the Responsible Party from any obligation to perform the work strictly in accordance with the plans and specifications or any modifications thereof. Work not so constructed shall be removed and corrected by the Responsible Party at his sole expense, whenever so ordered by Development Engineering, without reference to any previous error or oversight in inspection.

Except in cases of emergency, maintenance, or protection of work already completed, no work shall be allowed between the hours of 7 p.m. and 7 a.m.; nor on Saturday, Sunday, or legal holidays unless approved by Development Engineering in each case. When any inspector is required to work outside the hours of 7 a.m. to 4 p.m. on regular City business days, overtime shall be charged to the Responsible Party. However, such Inspectors shall remain employees of the City for all purposes. Requests for overtime shall be made to Development Engineering at least 48 hours in advance. Payment for such overtime work shall be made to the City prior to final acceptance.

In the event one or more inspectors representing private consulting engineering firms are also inspecting a project along with Development Engineering, the instructions given by Development Engineering shall prevail in the event of conflicting instructions.

The work shall be surveyed and staked under the supervision of a licensed Land Surveyor in accordance with the approved plans.

If irrigation ditches are involved, an approval block for the ditch company shall be provided.

If a foundation underdrain system is installed in the public right-of-way, the following statement shall be included in the as-built drawings:

> "The foundation underdrain system is the responsibility of the owner/developer or its assigns. The City is not responsible for the maintenance or repair of said system."

Construction shall adhere to the following sequence unless otherwise specified by the Development Engineering Manager: Sanitary sewer installation, water main installation, curb and gutter installation, water service installation.

Compaction of all trenches must be attained and compaction test results submitted to the engineer and the City of Thornton prior to final acceptance.

All work, including correction work, shall be inspected by a City Representative who shall have the authority to halt construction when standard construction practices are not being adhered to.

Developer and builder shall regularly patrol the public lands adjacent to the development to remove construction debris and keep the site clean and safe.

All site grading (excavation, embankment, and compaction) shall conform to the recommendations of the latest soils investigation for this property and shall further be in conformance with the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements", latest edition. A CDPS General Permit for stormwater discharges associated with construction activities shall be obtained prior to any grading being performed on sites one (1) acre or larger in size. These permits can be obtained from the State Water Quality Control Division.

Natural vegetation shall be retained and protected wherever possible. Exposure of soil to erosion by removal or disturbance of vegetation shall be limited to the area required for immediate construction operation and for the shortest practical period of time.

Topsoil shall be stockpiled to the extent practicable on the site for use on areas to be revegetated. Any and all stockpiles shall be located and and proper measures taken to control erosion and sediment movement.

At all times, the property shall be maintained and/or watered to prevent wind-caused erosion. Earthwork operations shall be discontinued when dust significantly impacts adjacent property. If earthwork is complete or discontinued and dust from the site continues to create problems, the owner/developer shall immediately institute mitigative measures and shall correct damage to adjacent property.

Permanent slopes shall not exceed 4:1 (H:V) in areas to be seeded or sodded. Retaining walls shall be reviewed and approved by separate application to the Development Engineering Division.

This erosion and sediment control plan has been submitted to the City of Thornton and is in general conformance with the City's erosion control standards. Additional erosion and sediment control measure may be required of the owner and his or her agents due to unforeseen erosion problem or if the proposed erosion control measures do not function as intended. The requirements of this erosion control plan and the obligation of the landowner shall run with the land until such time as the erosion control plan is properly completed, officially modified, or voided.

Installation of water mains shall not be permitted until all compaction results for sanitary sewers have been submitted to and approved by the City, all design slopes for sanitary sewer installations have been verified and approved by the City, and all applicable testing procedures have been conducted and approved in writing.

New water mains 12 inches or less shall be AWWA Standard C-900-07 PVC DR -25 pressure pipe. Water mains larger than 12 inches shall meet AWWA C-905 PVC DR-21 or DR-18 as determined by the Development Engineering Manager. Hydrant leads shall only be DIP.

Water mains shall be laid in conformance with the latest edition of the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements and shall be subject to City inspection and approval.

Fire hydrants shall be limited to the following manufacturers only and shall be painted according to the latest edition of the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements prior to acceptance.

Mueller Company – 5-1/4" Super Centurion
Waterous Company - Model WB-250-Pacer

There shall be a minimum of four and one half (4.5) feet of cover from finished grade to the top of waterlines.

Bedding and backfill materials for both water and sewer shall conform to the latest edition of the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements.

Thrustblocks shall be placed at fittings, tees, bends, crosses, plugs, etc., in accordance with the latest edition of the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements.

In all cases, 10 feet of horizontal distance, as measured from edge of pipe to edge of pipe, shall be maintained between water and any sanitary or storm sewer.

Contractor shall notify all residents and/or businesses in writing 48 hours prior to any shut-off in service. The notices must have contractor's phone number and name of contact person, and emergency phone

number for after hours calls. All shut-off's must be approved by the City's Infrastructure Department, and City valves and appurtenances shall be operated by City personnel, unless written permission is given otherwise.

Rim elevations of manhole shown on the plan and profile sheets are approximate only and are not to be taken as final elevations. The pipeline contractor should allow approximately the top one (1) foot of rim elevation to be adjusted either up or down in order to match final pavement elevation. The maximum adjustment to final grade is 12 inches with concrete rings.

During construction, care must be taken to avoid any ground water, storm water, construction debris, soil, or any other foreign materials from entering any active City of Thornton sewer. The use of the sanitary sewer system for the purposes of dewatering is strictly prohibited.

All construction activities dewatering must comply with the State of Colorado permitting process for "Stormwater Discharges Associated With Construction Activity." For information, please contact Colorado Department of Health, Water Quality Control Division.

After any overlay of an existing roadway, where City utilities are present, the Developer shall open all manholes and valve boxes following the paving operation to ensure that manhole and valves were not paved over nor filled with asphalt.

When an existing asphalt street is cut, the street must be restored to a condition equal to or better than its original condition. The existing street condition shall be documented by the City of Thornton's Construction Inspector before any cuts are made. Patching shall be done in conformance with the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements. The finished patch shall blend smoothly into the existing surface. All large patches shall be paved with an asphalt lay-down machine. In streets where more than one cut is made, an overlay of the entire street width, including the patched areas, may be required. The determination of need for a complete overlay shall be made by the Development Engineering Manager.

Paving shall not start until a Geotechnical Report and Pavement Design have been approved by the City of Thornton's Development Engineering Division and Subgrade Compaction Test and Proof Roll have been performed and the results have met with the approval of the City of Thornton. The pavement design report must be submitted three (3) weeks prior to the anticipated date of paving.

All damaged existing curb, gutter, and sidewalk shall be repaired prior to acceptance of completed improvements.

All curb returns within public right-of-way shall be constructed with sidewalk ramps in accordance with the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements. All sidewalk ramps shall include a truncated dome detectable warning pattern as shown on the detail sheets.

The contractor shall provide, erect and maintain proper traffic control devices until the site is open to traffic. The Contractor shall submit a traffic control plan to the City of Thornton for approval prior to construction.

Repair of any damage to existing improvements or landscaping is the responsibility of the contractor.

C. Plan Details

1. Key Map
2. Legend of symbols
3. North arrow, pointed to the top of the page, or to the right side of the page
4. Property lines - Indicate lots with lot number and block number to be served by solid lines
5. Survey monuments
6. Ownership or subdivision information
7. Street names, ROW, and easements with width dimensions
8. The location of existing utility lines - water, gas, telephone, storm drain, irrigation ditches, sanitary sewers, and other pertinent details, such as houses, curbs, water courses, cable television, etc.
9. Vicinity map
10. All bench marks

D. Profile Details

1. Vertical and horizontal grids with scales and stationing.
2. Ground surface existing (dashed) and proposed (solid)
    a. Existing utility lines
    b. Bench marks (City of Thornton 88 datum) and project bench mark noted
    c. Existing manhole inverts and rim elevations

E. Overall Utility Plan (Single Sheet)

F. Water Supply Construction Plan

In addition to the above general plan and profile details, all water supply construction plans shall include the following items:

1. Proposed water mains (Include Profile):
    a. Size
    b. Length
    c. Materials, types of joints, and proposed depth
    d. Location dimensions. Other information including elevation top of valve nut, rim elevation of valve box, meter box, etc. may be required.
2. Fittings (size and type), for example:
    a. Tees
    b. Crosses
    c. Reducers
    d. Bends
    e. Plugs
    f. Blow-offs
    g. Kickblocks
3. Valves (size and type)

4. Fire Hydrants
5. Irrigation tap locations and meter sizes with spot elevations.
6. Plan, profile, and complete details for off site transmission mains, pump stations, valves, vaults, tanks, service locations, etc.
7. Complete material list included in drawings
8. Crossings (clearance, show sleeving, if needed) Details
9. Detail Sheets with all pertinent City of Thornton Details

G. Sanitary Sewer Construction Plan

In addition to the general plan and profile details, sanitary sewer construction plans shall include the following:

1. Proposed sanitary sewers (Profile Sheets):
   a. Diameters
   b. Materials and types of joints
   c. Gradients
   d. Length between manholes
2. Proposed manholes and cleanouts:
   a. Stationing and other number designation
   b. Elevation of inverts in and out of manhole
   c. Elevation of manhole rim
3. Location control dimension
4. Manhole stub-outs
5. Proposed future extensions
6. Proposed wye and riser connection for services
7. Proposed service connections or stub-ins
8. Proposed underdrain
9. Proposed concrete encasement
10. Proposed cutoff walls

H. Storm Drainage Construction Plan

In addition to the above general plan and profile details, storm drainage construction plans shall include the following:

1. Drainage area plan; an overall plan of the area under study showing:
   a. North arrow
   b. Contours (maximum two (2) foot intervals) on site and off site
   c. Location and elevation of City or USGS bench marks
   d. USGS datum
   e. Property lines

f. Boundary lines (counties, districts, tributary area, etc.)

g. Streets and street names and approximate grades

h. Subdivision (name and location by section)

i. Existing irrigation ditches

j. Existing drainage ways including gutter flow directions

k. Drainage sub-area boundaries

l. Easements required

m. Proposed curbs and gutters and gutter flow directions

n. Proposed cross pans and flow directions

o. Proposed piping and open drainage ways

p. Flow volumes for the five (5) year and 100 year storm runoff conditions. (Identify at inlets and outfalls)

q. Path of 100 year storm runoff flows delineated

r. Critical minimum finished floor elevations for protection from 100 year runoff

s. Proposed inlet locations and inlet sizes

t. Floodplain information, indicating land in floodplain, and land not in floodplain

u. Path of the emergency overflow spillway

v. High water line and overland flow path for all inlets in sags and for all culverts under inlet control conditions

w. Area grading plans for final stage

x. Plant material protection plan

2. Proposed pipes

   a. Plan showing stationing

   b. Profile (include 5 and 100 year HGLs)

   c. Size, lengths between manholes, and type material

   d. Grades, capacity

   e. Inlet and outlet details

   f. Manhole details (station number and invert elevations)

   g. Typical bedding detail

3. Proposed open channels and detention facilities

   a. Plan showing stationing

   b. Profile (include the 5 and 100 year HGLs)

   c. Grades and capacities

   d. Typical cross sections for both channels and ponds

   e. Lining details

4. Proposed special structures (manholes, headwalls, trash racks, etc.)

a. Plan

b. Elevation

c. Details of design and appurtenances

5. Retaining Walls

a. Retaining walls equal to or greater than four (4) feet are required to be designed and stamped by a registered professional engineer and must be approved and permitted through the City.

b. Retaining walls must have sufficient resistance against overturning and sliding, and they must possess adequate structural strength against bending outward.

c. The retaining wall submittal package shall be in accordance with the following outline and contain the applicable information listed:

i. Plans

ii. Spot elevations

iii. All proposed retaining walls should show top and bottom of wall elevations every 10 feet or on both sides of a step

iv. Sections

v. Details to include geofabric, drainage, foundation, etc.

vi. Calculations

vii. A Geotechnical Report – type of soils, specific weight, allowable bearing pressure, etc.

viii. Loading diagram - include surcharge loads and slopes

ix. Factor of Safety against overturning shall be a minimum of 1.5 for granular soils (i.e. sand) and 2 for cohesive soils (i.e. clay)

x. Factor of Safety against sliding shall be a minimum of 2 which includes the passive resultant.

xi. For multiple tiered walls loads from upper wall need to be applied to the lower wall. In addition, the walls need to be analyzed as a single unit for bearing failure and slope stability.

I. Storm Water Management Plan (SWMP)

1. Pursuant to City's authority through Ordinance No. 2935 and the MS4 permit from the CDPHE, WQCD, through the MS4 permit issued to the City, requires the City to control and reduce the discharge of pollutants to protect stormwater quality and to satisfy the appropriate water quality requirements of the Colorado Water Quality Control Act and the Colorado Discharge Permit Regulations (Colorado Regulation 61). The MS4 permit requires the implementation of a program to reduce the discharge from public and private construction sites.

2. All new development and redevelopment projects are required to develop and implement a SWMP to reduce and ensure that BMP's are in place to prevent or minimize pollutants in stormwater runoff from construction activities that disturb one or more acres; or less than one acre if part of a larger common plan of development or sale that discharge storm water into the City's storm water system.
3. Stormwater Management analysis and design shall meet or exceed these Standards and Specifications which were developed to support and supplement the policies and standards set forth by the Colorado Department of Public Health and Environment (CDPHE) and Urban Drainage Flood Control District (UDFCD). Policies and technical criteria not specifically addressed in this document shall follow the provisions of the CDPHE Colorado Water Quality Control Division (CWQCD) and the Criteria Manual (UDFCD Manual). The Responsible Party is also referred to the Colorado Department of Transportation's Standard Plans ("M-Standards") for additional design details not covered in these Standards and Specifications or the UDFCD Manual.

4. Development or redevelopment projects which disturb one (1) or more acres will require both sediment and erosion control plans and a CDPS General Permit for stormwater discharges associated with construction activities at least 10 calendar days prior to the commencement of

construction activities. In fill lots or sites less than one acre of disturbance will require a sediment and erosion control plan.

5. The SWMP shall follow all the applicable requirements defined in the CDPS General Permit for Stormwater Discharges Associated with Construction Activity (Permit No. COR-30000) section "C. Stormwater Management Plan (SWMP) – Contents".

    1. Site Description
    2. Site Map
    3. Stormwater Management Controls
    4. Final Stabilization and Long-term Stormwater Management
    5. Inspection and Maintenance

6. The SWMP shall contain a bar scale schedule of the earth disturbing activities for the construction site (in monthly increments). Major earth-disturbing activities and stabilization measures should be included.

7. The SWMP shall delineate the limits of disturbance for the project site including all earth disturbing activities, staging areas, and construction exits.

8. The SWMP shall be shown in a minimum of two (2) phases. Phase I shall show the existing conditions of the site with the initial BMP's required for construction. Phase II shall show the proposed conditions of the site with the BMP's required for stabilization. For complex projects, additional phases may be added to properly manage the stormwater.

9. Permit Coverage

    A. The Owner/Contractor is responsible for obtaining a permit from the CDPHE at least 10 calendar days prior to the commencement of construction activities for any earth disturbance of one (1) acre or greater. The Owner/Contractor shall provide the City with a copy of permit prior to receiving a grading/construction permit. The Owner/Contractor is responsible for all fees associated with the permit.

    B. If the Owner/Contractor transfers responsibility for stormwater discharges to another entity, a notice of transfer and acceptance of terms form shall be submitted to the CDPHE and a copy to the City.

    C. If the Owner/Contractor no longer has control of a specific portion of a permitted site and wishes to transfer coverage of that portion of site to another, the Owner/Contractor shall submit a notice of reassignment of permit coverage form to the CDPHE and a copy to the City.

    D. The Owner/Contractor is responsible for submitting an inactivation notice form to the CDPHE when the site has been finally stabilized in accordance with the SWMP. A copy of the inactivation notice shall also be submitted to the City.

J. Erosion Control Plans

1. The erosion control plans shall complement the phases described in the SWMP. At a minimum the erosion control plan phase I shall show the existing conditions of the site with the initial BMPs required before site disturbance begins. Phase II shall show the proposed conditions of the site with the BMP's required for final stabilization. For complex projects, additional phases may be added to properly manage stormwater runoff.

2. All erosion control BMP details shall conform to the latest edition of the City of Thornton Standards and Specifications, UDFCD Volume III or CDOT M-Standards.

3. BMPs shall be installed before any earth disturbing activities commence.

4. Stormwater discharges from construction activities shall not cause, have the reasonable potential to cause, or measurably contribute to an exceedance of any water quality standard.

5. Construction shall be phased in a manner to limit earth disturbing activities (i.e. the entire project site should not be disturbed if construction will only be occurring in one particular section).

6. Sediment caused by accelerated soil erosion shall be removed from runoff water before it leaves the construction site.

7. Bulk storage structures for petroleum products and any other chemicals shall have secondary containment or equivalent protection to contain all spills and prevent any spilled material from entering State waters.

8. A copy of the SWMP and site maps must be available at all times on the construction site unless otherwise approved by CDPHE or the City.

9. The SWMP and site maps shall be continuously updated to reflect new or revised BMPs due to changes in design, construction, operation, or maintenance of the construction site. Updates must be made within 72 hours following the change in BMPs.

10. The Responsible Party shall inspect the construction site (including all BMPs, storage containers, and construction equipment) a minimum of every 14 calendar days and within 24 hours after a precipitation event or snow melt that cause's surface erosion. Inspections shall continue until an Inactivation Notice is filed with CDPHE and copied to the City.

11. The Responsible Party shall keep a record of all inspections on site and available for review by CDPHE or City staff. Inspection reports must identify any incidents of noncompliance with the terms and conditions of the Permit.

12. BMPs requiring maintenance or adjustment shall be repaired immediately after observation of the failing BMP.

13. For all instances of noncompliance based on environmental hazards and chemical spills and releases, all needed information must be provided orally to CDPHE spill reporting line (24-hour number for environmental hazards and chemical spills and releases: 1-877-518-5608) within 24 hours from the time the Owner/Contractor comes aware of the circumstances.

14. Straw bales shall not be used for primary erosion or sediment control (i.e. straw bales may be used for reinforcement behind another BMP such as silt fence).

15. BMPs intended for sheet flow sediment runoff shall be placed parallel to the slope.

16. All BMPs shall be cleaned when sediment levels accumulate to half the design of the BMP unless otherwise specified.

17. A vehicle tracking pad shall be placed at all exits from the site to prevent track-out onto City streets. If track-out does occur, the Owner/Contractor shall immediately sweep the street of debris. Recycled crushed concrete or asphalt shall not be used for vehicle tracking pads.

18. All sediment collected in BMPs shall be removed upon at the reques of the Development Engineering Manager and prior to initial acceptance.

19. Permanent erosion control measures for slopes, channels, ditches, or any disturbed land area shall be completed within 14 calendar days after final grading or the final earth disturbance has been completed. When it is not possible to permanently stabilize a disturbed area after an earth disturbance has been completed or where significant earth disturbance activity ceases, temporary soil erosion control measures shall be implemented within 14 calendar days. Temporary erosion control measures shall be maintained until permanent soil erosion measures are implemented.

20. Final stabilization has been achieved when all earth disturbing activities at the site have been completed, and uniform vegetative cover has been established with an individual plant density of at least 70 % of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed.

21. All temporary BMPs shall be removed from the site upon final stabilization and submitting the Inactivation Notice.

22. All site wastes (including trash and building materials) must be properly managed to prevent potential pollution of State waters.

K. Street Construction Plan

In addition to the above general plan and profile details, all street construction plans shall include the following:

1. Existing irrigation ditches to be relocated, removed or piped.

2. Proposed curb, gutter, and sidewalk.

3. Proposed cross pans including flow direction.

4. Storm drainage facilities.

5. Location and elevation of City bench marks.
6. Horizontal curve data, with radii, tangents, PC, PI, and PT.
7. Typical section of street construction showing structure and dimensions.
8. Stations and elevations of radius points (back of curb).
9. Proposed profile of center lines, top of curb, flow lines, or back of sidewalk.
10. Stations, lengths, and elevations of vertical curve PC, PI, and PT.
11. % slope of tangent lines.
12. Limits of construction.
13. Show sufficient existing or future construction to assure continuity of construction.
14. Stations, details, and elevations of drainage facilities and other structures.
15. Street, park and trail lights, and underground service cable locations.
16. Complete material list.
17. High point, low point, K factor, and design speed for curve.
18. Medians.
19. Street, park, and trail signage and pavement marking plan.
20. Underpasses.
22. Intersection detail drawings may be required by the Development Engineering Manager.
23. Traffic Signal Modification Plans at 1" = 20' or larger scale.
24. Traffic Signal design plans, if required by the City, at 1" = 20' or larger scale.

L. Irrigation Plan

1. Existing irrigation, graphically distinguished from proposed irrigation.
2. Improvements or site conditions that will materially affect the successful operation of the system, such as buildings, sidewalks, slopes, swales, plant groupings, ditches, etc.
3. Point of connection and size of tap and meter.
4. Irrigation material schedule including pipe type and size, head type, arc and nozzle, valve type and size, etc.
5. Trench depth schedule from top of pipe.
6. Standard City meter detail.
7. Label size of all pipe on plan.
8. Indication at each zone valve of zone number, valve size, and gpm.
9. All miscellaneous details required to construct the system.
10. Irrigation schedule on plans demonstrating ability of system to comply with these Standards and Specifications.
11. Plan and details for a physical delineation between privately maintained landscaping and City maintained landscaping. The delineation may be a fence, wall, mow strip, or planter as approved by the Development Engineering Manager.
12. Existing and design water pressure.

13. Confirmation that system provides head to head coverage.

14. Turf and planting beds irrigated with different zones.

15. Pressure loss calculation sheet.

M. Park Construction and City-Maintained Landscape Plan

1. Scale 1"=30' minimum.

2. Existing and proposed (design) contours maximum of two (2) foot intervals, including spot elevations.

3. Existing plant material, including material to be removed and plant material protection zone, if applicable, noting methods of protection. Indicate size and species.

4. Plant material schedule indicating graphic representation, alphabetized common name and botanical name including: genus, species, variety or cultivar, size, quantity, and plant material totals.

5. Proposed plant material shown at mature size. Plants with one (1) irrigation zone shall have similar water demand requirements.

6. All miscellaneous improvements and appurtenances including playgrounds, sidewalks, drives, curbs, manholes, parking lots, etc.

7. All existing and proposed miscellaneous improvements and appurtenances including playgrounds, sidewalks, hardscape play areas, trails, pavilions, site furniture, lighting including trail and street lights, signage, drives, curbs, manholes, parking lots, berms, water features, etc.

8. Graphic representation of all groundcover types (sod, seed, bedding plants, mulch, rock, etc.).

9. All proposed retaining walls or slope retention methods.

10. Seed blend, amendment required, and application rate for all seeded areas.

11. Amount and type of soil amendment required for landscape areas not seeded.

12. Existing and proposed utility easements.

13. Sight triangles.

14. Recreation athletic facilities (such as softball, baseball, soccer, football, tennis, basketball, playground equipment, etc,) shall be reviewed on a case by case basis and be approved by the City prior to beginning any construction on the site. At a minimum, all such facilities plans shall meet the requirements of section 800 of these Standards and Specifications.

15. Regional trail profiles and cross sections.

16. Listing of total linear footage of sidewalks and trail, square footage of all planting beds, square footage of sod, and square footage of seeded areas.

17. Natural features relevant to the site.

18. All appropriate details.

104.2 Final Drainage Report

The purpose of the Final Drainage Report is to provide a detailed study and analysis of the proposed development. It shall include calculations for all runoff and for all drainage structures of facilities within the development. Also, any change to the Preliminary concept shall be presented.

The Final Drainage Report shall be submitted with the civil construction drawings for the site. The Final Report (which updates the Preliminary Drainage Study) shall be reviewed with the submittal of the construction plans and approved by the Development Engineering Manager prior to issuance of construction permit.

Reports shall be typed on 8-½ " x 11" paper and bound. The drawings, figures, charts, plates and/or tables shall be bound with the report or included in a folder/pocket attached at the back of the report.

The report shall include a cover letter presenting the final design for review and shall be prepared by or under the direction of an engineer licensed in Colorado. The report also shall contain a Responsible Party certification sheet as follows:

"*(Name of Responsible Party)* hereby certifies that the drainage facilities for *(Name of Development)* will be constructed according to the design presented in this report. I understand that the City of Thornton does not and shall not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that the City of Thornton reviews drainage plans but cannot, on behalf of *(Name of Development),* guarantee that final drainage design review will absolve *(Name of Responsible Party)* and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Plat and/or Development Permit does not imply approval of my engineer's drainage design."

Attest: _____
Name of Responsible Party

_____ _____
Notary Public Authorized Signature

"I hereby certify that this report (plan) for the final drainage design of *(Name of Development)* was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements for the Responsible Parties thereof. I understand that the City of Thornton does not and shall not assume liability for drainage facilities designed by others."

_____
Registered Professional Engineer
State of Colorado No. _____
(Affix Seal)

The Final Drainage Report shall be prepared in accordance with the following outline. The report drawings shall include the following:

A. Report Contents

The Report shall be in accordance with the following outline and contains the applicable information listed:

1. General Location and Description

   a. Location

      i. Township, range, section, one-quarter (¼) section.

      ii. Streets within and adjacent to the subdivision with ROW width shown.

      iii. Major drainageways, facilities, and easements within and adjacent to the site.

      iv. Names of surrounding developments.

   b. Description of Property

      i. Area in acres.

      ii. Ground cover (type of trees, shrubs, vegetation, general soil conditions, topography, and slope).

      iii. Major drainageways.

      iv. General project description.

      v. Irrigation facilities.

      vi. Proposed land use.

2. Drainage Basins and Sub-basins

   a. Major Basin Description

      i. (Reference to major drainageway planning studies such as flood hazard delineation reports, major drainageway planning reports, and flood insurance rate maps.

      ii. Major basin drainage characteristics, existing, and planned land uses.

iii. Identification of irrigation facilities within the basin which will influence or be influenced by the local drainage.

b. Sub-Basin Description

i. Discussion of historic drainage patterns of the property in question.

ii. Discussion of off-site drainage flow patterns and impact on development under existing and fully developed basin conditions.

3. Drainage Design Criteria

a. Regulations: Discussion of the optional provisions selected or the deviation from the criteria, if any, and its justification.

b. Development Criteria Reference and Constraints

i. Discussion of previous drainage studies (i.e., project master plans) for the site in question that influence or are influenced by the drainage design and how the plan will affect drainage design for the site.

ii. Discussion of the effects of adjacent drainage studies.

iii. Discussion of the drainage impact of site constraints such as streets, utilities, existing structures, and development or site plan.

c. Hydrological Criteria

i. Identify design rainfall.

ii. Identify runoff calculation method.

iii. Identify detention discharge and storage calculation method.

iv. Identify design storm recurrence intervals.

v. Discussion and justification of other criteria or calculation methods used that are not presented in or referenced by the criteria.

d. Hydraulic Criteria

i. Identify various capacity references.

ii. Discussion of other drainage facility design criteria used that are not presented in the criteria.

e. Variances from Criteria

i. Identify provisions by section number for which a variance is requested.

ii. Provide justification for each variance requested.

4. Wetland Mitigation and Preservation

5. Drainage Facility Design

a. General Concept

i. Discussion of concept and typical drainage patterns.

ii. Discussion of compliance with off-site runoff considerations.

iii. Discussion of the content of tables, charts, figures, plates, or drawings presented in the report.

iv. Discussion of anticipated and proposed drainage patterns.

v. Rip Rap Details and Design

b. Specific Details

i. Discussion of drainage problems encountered and solutions at specific design points.

ii. Discussion of detention storage.

iii. Discussion of maintenance access and aspects of the design.

iv. Discussion of easements and tracts for drainage purposes, including the conditions and limitations for use.

6. Conclusions

a. Compliance with Standards

i. "Criteria".

ii. "Major Drainageway Planning Studies".

iii. "UDFCD Manual".

b. Drainage Concept

i. Effectiveness of drainage design to control damage from storm runoff.

ii. Influence of proposed development on the Major Drainageway Planning Studies recommendation(s).

7. References

Reference criteria and technical information used.

8. Appendices

a. Hydrologic Computations

i. Land use assumptions regarding adjacent properties.

ii. Initial and major storm runoff at specific design points.

iii. Historic and fully developed runoff computations at specific design points.

iv. Time of concentration and runoff coefficients for each basin.

b. Hydraulic Computations

i. Detention area/volume capacity and outlet capacity.

ii. Downstream/outfall system capacity to the Major Drainageway System.

iii. Culvert capacities.

iv. Storm sewer capacities including hydraulic grade lines (HGL), both 5 year and 100 year, for culverts 18 inches and larger.

v. Gutter capacity, including depth of flow during the major storm, as compared to allowable.

vi. Storm inlet capacity, including inlet control rating, at connection to storm sewer.

vii. Rip Rap design.

viii. Open channel design.

ix. Check and/or channel drop design.

Two (2) copies of the Final Drainage Report including the Final Drainage Plan shall be submitted to the Development Engineering Manager for review.

104.3 Final Utility Report

The purpose of the Final Utility Report is to provide a detailed study and analysis of the proposed development. It shall include calculations for all sanitary sewage flows and all water systems demands and for all appurtenances within the development. Also, any change to the Preliminary concept shall be presented.

The Final Utility Report shall be submitted with the civil construction drawings for the site. The Final Report (which updates the Preliminary Utility Study) shall be reviewed with the submittal of the construction plans and approved by the Development Engineering Manager prior to issuance of construction permit.

Reports shall be typed on 8-½ " x 11" paper and bound. The drawings, figures, charts, plates, and/or tables shall be bound with the report or included in a folder/pocket attached at the back of the report.

The report shall include a cover letter presenting the final design for review and shall be prepared by or under the direction of an engineer licensed in Colorado. The report also shall contain a Responsible Party certification sheet as follows:

"(Name of Responsible Party) hereby certifies that the sewer and water system for (Name of Development) will be constructed according to the design presented in this report. I understand that the City of Thornton does not and shall not assume liability for the sewer and water system designed and/or certified by my engineer. I understand that the City of Thornton reviews utility plans but cannot, on behalf of (Name of Development), guarantee that final utility design review will absolve (Name of Responsible Party) and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Plat and/or Development Permit does not imply approval of my engineer's utility design."

Attest: _____
Name of Responsible Party

_____ _____
Notary Public Authorized Signature

"I hereby certify that this report (plan) for the Final Utility Design of *(Name of Development)* was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements for the Responsible Parties thereof. I understand that the City of Thornton does not and shall not assume liability for utilities designed by others."

_____
Registered Professional Engineer
State of Colorado No. _____
(Affix Seal)

The Final Utility Report shall be prepared in accordance with the following outline. The report drawings shall include the following:

A. Report Contents

The Report shall be in accordance with the following outline and contains the applicable information listed:

1. General Location and Description

a. Location

i. Township, range, section, one-quarter (¼) section.

ii. Streets within and adjacent to the subdivision with ROW width shown.

iii. Major facilities and easements within and adjacent to the site.

iv. Names of surrounding developments.

b. Description of Property

i. Area in acres.

ii. Ground cover (trees, shrubs, vegetation, general soil conditions, topography, and slope).

iii. Major drainage ways.

iv. General project description.

v. Proposed land use.

2. Basins and Pressure Zones

a. Major Basin Description

i. Reference to sewer master plan studies,reports for adjacent subdivisions, and the City Utility Masterplan.

ii. Major basin characteristics, and existing and planned land uses.

3. Design Criteria

a. Regulations: Discussion of the optional provisions selected or the deviation from the criteria, if any, and its justification.

b. Development Criteria Reference and Constraints

i. Discussion of previous utility studies (i.e., utility reports, project master plans, etc) for the site in question that influence or are influenced by the design.

ii. Discussion of the effects of adjacent utility studies.

iii. Discussion of the impact of site constraints such as streets, other utilities, existing structures, and development or site plan.

c. System Design Criteria

i. Refer to Section 200 and 300 for water and sanitary sewer design criteria.

ii. Provide all supporting calculations and information.

iii. Discussion and justification of other criteria or calculation methods used that are not presented in or referenced by the criteria.

5. Conclusions

a. Compliance with Standards

6. References

Reference criteria and technical information used.

Two (2) copies of the Final Utility Report including the Final Utility Plan shall be submitted to the Development Engineering Manager for review.

104.4 Traffic Impact and Access Study

A. Submittal Format

All reports shall be bound in an 8-½" x 11" folder and shall include the seal and signature of the Professional Engineer registered in the State of Colorado who is responsible for the report contents. In addition, all reports shall include the following statement:

"We acknowledge that the City of Thornton's review of this study is only for general conformance with submittal requirements, current design criteria, and standard engineering principles and practices. We are also aware of the provisions of Section 18 of the City Code of the City of Thornton."

B. Content

The following is the information that is required in a Traffic Impact and Access Study for each development.

1. A cover letter identifying the traffic engineering consultant who completed the report and for what development.

2. Background information

    a. Description of development location with adjacent roadway characteristics (i.e. speed limit, cross section, exiting accesses, level of service, etc). Provide site drawing as part of report.

    b. Copy of the applicable sections of Transportation Plan with development location shown. The engineer shall include a comparison of the transportation plan to the report's projections.

    c. Proposed types of development land use for the site.

    d. The building site layout with square footage for each type of proposed land use.

3. General existing traffic conditions

    a. Include roadway classifications.

    b. Existing traffic volumes on adjacent streets. Include 24-hour count data in appendix of report. Count data shall be reported in 15-minute increments.

    c. If appropriate, turning movement counts during the morning, noon, and evening peak hours.

    d. Description of the existing roadway and intersection configurations including number of lanes, existing speed limit, and lane designations.

    e. If appropriate, data on the gaps in traffic for pedestrians and the number of pedestrians in the peak hour.

    f. Level-of-service analysis of existing conditions per the Highway Capacity Manual, latest edition.

4. Development site characteristic

    a. Location of all existing and proposed accesses, including geometric layout.

    b. Trip generation rates, both daily and peak hour, used per I.T.E. Trip Generation Manual or other sources identified and provided as backup.

    c. Distribution of generated traffic, both daily and peak hour on, to the adjacent streets. Distribution method(s) used. Recommend discussing distribution with Development Engineering prior to submitting Traffic Study.

    d. List all assumptions used in the distribution of generated traffic loading.

    e. Also to be included for review is the parking layout, loading area location, and all proposed fire lanes.

    f. A comparison of trip generation rates, both daily and peak hour in existing and proposed zoning or land use (if applicable).

5. Traffic Assignments and Off-Site Traffic Analysis

    a. Analysis of traffic assignments and assumptions made.

    b. Tables of existing peak hour traffic on adjacent streets, traffic developed by site during the streets' peak hour, and resulting peak hour with development. This is to include any development that is currently under review by the City or construction within one (1) mile radius of the proposed development.

    c. List all intersections that will need to be or could be signalized with the proposed development at the first phase or in the future. Supporting analysis, per the latest edition of the MUTCD, shall be included.

    d. If appropriate, traffic signal progression by analysis of existing streets and the impact by the proposed access(es). Existing signal timing shall be utilized as a base for the analysis.

    e. City of Thornton is the local authority for the Colorado Department of Transportation Access Code and Permitting process.

    f. Critical lanes and intersection analysis for all intersections adjacent to the development that are major collectors and arterials.

g. Level-of-service analysis per the Highway Capacity Manual, latest edition, of all adjacent intersections based on existing volumes combined with volumes generated by the development and anticipated future volumes at intersections combined with anticipated future volumes generated by the development.

6. Additional Study Requirements

a. Conduct all analysis as outlined by the City for inclusion in the report.

7. Summary of Report Findings and Recommendations

a. List all intersections that will need to be or could be signalized with this development currently or within 20 years from the start of the development.

b. List all proposed intersection configurations for existing intersections to be modified and for proposed new intersections.

c. List all proposed lanes for existing streets to be modified and for proposed new streets.

d. If any of the requirements of the traffic report are more stringent than these Standards and Specifications, the report shall govern.

105 PERMITS AND INSPECTIONS

105.1 Construction Permits

A. Application for Permit

1. Applicants shall complete an application for a construction permit. Each application shall:

a. Describe the land on which the proposed work is to be done, by legal description, street address, or similar description that shall readily identify and definitely locate the proposed work location.

b. Be accompanied by approved construction plans, diagrams, computations, and specifications, and other data as required by these Standards and Specifications.

c. State the valuation of the work to be performed.

d. Be signed by the applicant, or an authorized agent, who may be required to submit evidence to indicate such authority. The permit shall not be changed, modified, or altered without authorization from Development Engineering, and all work shall be done in conformance with the approved plans.

e. Provide a plan for removal of prairie dogs that currently inhabit the site. The plan shall conform to the policies adopted by the City of Thornton.

f. Provide a copy of the approved State discharge permit, proof of application for a State Discharge Permit, or proof that a permit is not required.

B. Construction Permit Issuance

1. The issuing and granting of a construction permit shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of these Standards and Specifications or of any regulations of the City. No permit presuming to give authority to violate or cancel the provisions of these Standards and Specifications shall be valid.

2. The issuing of a construction permit based on approved construction plans, specifications, or other data shall not prevent the Development Engineering Manager from requiring the correction of errors in said plans, specifications, and other data, or from stopping construction operations which are in violation of these Standards and Specifications or any other regulations of this jurisdiction.

C. Permit Expiration

1. Every construction permit issued by the City under the provisions of this section shall expire if the work authorized by such a permit is not substantially begun within one (1) year from the date of the permit or if the construction of work authorized by the permit is suspended or abandoned for a period of 180 days at any time after the work is begun. Before such work can be resumed, a new construction permit shall be issued and full permit fees shall be paid, unless no changes have been made or required by the Development Engineering Manager from the originally approved plans. In

this case, permit fees shall only be paid to cover the difference in the cost of the improvements from the original date of the permit compared to the new permit.

2. Any permitee holding an unexpired construction permit may apply for an extension of the time within which work may begin under that permit if the permitee is unable to begin work within the time required by this section for good cause, and that the cause is acceptable to the Development Engineering Manager. The Development Engineering Manager may extend the time for action by the permitee for a period not exceeding one (1) year upon written request by the permitee, showing that circumstances beyond the control of the permitee have prevented action from being taken. No permit shall be extended more than one (1) time. In order to renew action on an expired construction permit the permitee shall pay a new, full permit fee.

D. Construction Permit Suspension or Revocation

The Development Engineering Manager may suspend or revoke any permit, in writing, issued under the provisions of these Standards and Specifications whenever the permit is issued in error or on the basis of incorrect information supplied by the applicant or whenever such permit may have been issued in violation of any ordinance or regulation of any of the provisions of these Standards and Specifications. In the event a permit is suspended or revoked, no refund of permit fees shall be made.

105.2 Fees, and Material Sales and Use Tax

A. Plan Review, Inspection Fees, and Material Sales and Use Tax

Plan review, inspection fees, and material sales and use tax shall be paid in full prior to the issuance of a construction permit by Development Engineering. The fees and taxes shall be in accordance with the City's Code.

B. Investigation Fees (Working without a Permit)

1. Whenever any work for which a permit is required by these Standards and Specifications has begun without the required permit having been obtained, a special investigation shall be made before a permit may be issued for such work. All work shall cease immediately upon written notice by the Development Engineering Manager.

2. An investigation fee shall be collected whether or not a permit is then or subsequently issued. The investigation fee shall be as determined by the City. The payment of such investigation fees shall not exempt any person from compliance with all other provisions of these Standards and Specifications nor from any penalty prescribed by law.

C. Fee Refunds

1. The Development Engineering Manager may authorize the refunding of any fee which was erroneously paid, collected, or when no work has been done under a public improvement permit issued in accordance with these procedures.

2. The Development Engineering Manager shall not refund any fee except upon written application filed by the original permitee. The written application must be filed not later than 180 days after the date of the fee payment.

105.3 Improvements Required and Security

A. Improvements

The Responsible Party shall provide applicable performance surety requirements as set forth in these Standards and Specifications and/or any other applicable agreement for construction of all improvements, both public and private governed by these Standards and Specifications. The construction and installation of the improvements shall be in accordance with the standard construction plans for construction of all improvements and these Standards and Specifications. A schedule of the estimated costs of the improvements, as approved by the City, shall be provided for establishing surety estimates. The construction plans are intended to represent the improvements set forth in the cost estimate. If there is a conflict between the cost estimate and the construction plans stamped as approved by the City, the construction plans shall govern. It shall be the responsibility of the responsible party at its sole cost and expense to design, construct and install such improvements for initial acceptance by the City and repair and maintain such improvements until final acceptance by the City. The responsible party shall, at all times, promptly make payments in all amounts due to persons supplying labor, materials and services in connection with construction of the improvements identified in the approved construction plans, and to persons who may otherwise be entitled to assert a lien against the property by virtue of state law.

B. Security for Improvements

The Responsible Party's obligation to provide the Improvements as identified in the approved construction drawings and as required by any applicable agreements shall be secured by a Performance Guarantee or Building Permit Restriction as identified herein.

C. Performance Guarantee

1. The Responsible Party shall obtain a Performance Guarantee which shall be furnished to the City prior to the issuance of any construction permit by payment of cash, a cashier's check, an irrevocable letter of credit, assignment of funds, or a performance bond, or approved equivalent as determined by the Development Engineering Manager.

2. The type of performance guarantee chosen by the Responsible Party shall be in a form and substance acceptable to the City ,but in no event shall it be less than 100% of the total estimated costs of the Improvements except as provided in paragraphs 3 and 4 of this Subsection. In addition, any Improvements within existing improved rights-of-way require a security deposit in accordance with Section 2-272.IV (c) of the Code.

3. The performance guarantee for commercial development under 20 acres shall be furnished to the City, prior to the issuance of a construction permit, as cash, a cashier's check, a performance bond or an irrevocable letter of credit in an amount equal to $25,000 + $1,000 per acre or a letter of credit for 100% of the value of proposed Public Improvements within City right-of-way, whichever is greater.

4. If, at any time prior to the City's acceptance of the Improvements, the Performance Guarantee expires or the entity issuing the Performance Guarantee becomes non-qualifying, or the estimated cost of Improvements is reasonably determined by the City to be greater than the amount of the security provided, then the City shall furnish the Responsible Party with written notice of such condition, and within 15 days of receipt of such notice the Responsible Party shall provide the City with a substituted qualifying Performance Guarantee, or augment the deficient security to achieve 100% of the estimated cost of Improvements other than Landscaping Improvements. If such Performance Guarantee is not timely furnished, then a Stop Work Order shall be issued,

5. The Responsible Party providing the Performance Guarantee shall have no direct or indirect ownership interest in or managerial control over an entity issuing any type of Performance Guarantee.

D. Licensing of Contractors and/or Subcontractors

The Responsible Party shall ensure that all contractors and/or subcontractors employed by the Responsible Party shall be licensed by the City before any work on the Improvements is commenced.

105.4 Construction Procedure

Following final approval of the plans and obtaining necessary permits, the Responsible Party may proceed with construction. In addition to construction requirements contained in other portions of these Standards and Specifications, the Responsible Party shall observe the following:

A. Prior to the beginning of work, a preconstruction conference shall be held between the City, the Responsible Party who is scheduled to perform the work, the designated on-site field representative, the consulting engineer or landscape professional, and any other entities involved in the construction.

B. Development phasing of any project must be shown on the construction plans and made a part of the application procedure. No phasing shall be permitted unless this requirement has been adhered to.

C. The work shall be surveyed and staked under the supervision of a licensed Land Surveyor in accordance with the approved plans.

D. Construction shall adhere to the following sequence unless otherwise specified by the Development Engineering Manager: Sanitary sewer installation, water main installation, curb and gutter installation, water service installation

E. Installation of water mains shall not be permitted until all compaction results for sanitary sewers have been submitted to and approved by the City, all design slopes for sanitary sewer installations have been verified and approved by the City, and all applicable testing procedures have been conducted and approved in writing.

F. Work relating to water and sanitary sewer utilities shall be inspected by the City. Water mains shall be tapped only after having been installed to the satisfaction of the Inspector, chlorinated, pressure tested, and clearwater tested and approved by the City for tapping. Service lines, from the main to the meter pit as well as the water meter pit, and hole must be installed prior to tapping. No tapping of dry mains shall be made or allowed.

G. Mains shall be chlorinated and hydrostatically tested in accordance with Subsection 206 of these Standards and Specifications.

H. Paving shall not be permitted until manhole, valve box, and water meter pit installations have been verified in the field through a pre-paving walk-through and design slopes on all sanitary sewer lines have been verified by the City.

I. A geotechnical report for pavement design is required for all new Public and Private street and parking lot construction prior to paving.

J. A phase I Environmental Report is required for all developments that are dedicating rights-of-way and/or exclusive easements to the City. Additional information may be required as a result of the findings of this report.

K. Excavation & Embankment

1. Excavations shall be made to the lines and grades as established by the approved drawings in open cut, through whatever material encountered. Pipe trenches shall be excavated to a minimum depth of six (6) inches below the bottom of the pipe, and shall be excavated in such a manner as will afford adequate drainage. Where material encountered within the limits of the work is considered unsuitable by the Development Engineering Manager, such material shall be excavated below the grade shown on the drawings to a depth necessary to ensure a stable, firm foundation and refilled with one and one-half (1½) inch crushed rock uniformly graded to provide a firm foundation, and shall be backfilled per these Standards and Specifications. Then polyethylene (8 mils) shall be installed prior to normal bedding installation. Excavated materials which are considered unsuitable and any surplus of excavated material shall be disposed of by the Responsible Party.

2. The construction of embankments by deposition, placing, and compacting materials of acceptable quality above the natural ground or other surface shall be in accordance with the lines, grades, and cross sections shown on the approved plans and/or as required by the Development Engineering Manager. Each lift of the embankment material shall not exceed eight (8) inches in loose depth. The Responsible Party shall thoroughly mix the different materials to secure a uniform moisture content and to ensure uniform density and proper compaction. Each layer shall be thoroughly compacted by roller or vibratory equipment which is suitable for the type of embankment material, to the densities specified in these Standards and Specifications.

3. Existing asphalt or concrete surfacing shall be cut vertically in a straight line as specified in this section and removed from the job site prior to starting the trench excavation. This material shall not be used in any fill or backfill.

4. The trench shall be excavated so that a minimum clearance of six (6) inches is maintained on each side of the pipe for proper placement and compaction of the bedding or backfill material. The maximum trench width measured at the top of the pipe shall be the outside diameter of pipe plus 24 inches.

5. The trench shall be adequately supported and the safety of workers provided for as required by the most recent standards adopted by OSHA.

6. If the Development Engineering Manager is of the opinion that at any point the trench walls are not properly supported, the Development Engineering Manager may require the placement of additional supports by and at the expense of the Responsible Party, and compliance with OSHA Standards is the responsibility of the Responsible Party for the safety of work being conducted. The City is not responsible for the safety of any party constructing the utility project.

7. Trench excavation shall not advance more than 400 lineal feet ahead of pipe laying and backfilling work.

8. Excavation for structures shall be of such dimensions as to allow for the proper installation and to permit the construction of the necessary pipe connections.

L. Subgrade

1. The bottom of the excavation for the pavement, or top of the fill, shall be known as the pavement subgrade and shall conform to the lines, grades, and cross sections shown on the approved plans.

2. Prior to the street being excavated, service cuts shall be tested to see if the backfill meets density requirements. If deficient, they shall be recompacted and brought up to the density specified.

3. After excavation and embankment is completed and the subgrade brought to final grade, it shall be rolled with a rubber-tired or sheep foot roller which is a minimum size of eight (8) to 12 tons and other compaction equipment as required to bring the subgrade to the required density and stability. Soils shall be compacted to a minimum of 95% of maximum dry density as determined by AASHTO T-99. The minimum moisture content shall not be less than two (2)% below "Standard Optimum" or as required to comply with the approved geotechnical report. Additional wetting may be required when the minimum water requirement is not sufficient to produce a stable condition in the subgrade soil.

4. No paving, subgrade, or base shall be placed on soft, spongy, frozen, or unstable subgrade which is considered unsuitable by the Development Engineering Manager.

5. Heavy construction equipment or loaded trucks (over 50,000 pounds tandem) shall be driven over the finished subgrade and deflections noted. Soft and yielding material and portions of the subgrade which show deflection shall be scarified and re-rolled or shall be removed and replaced with approved course subgrade material, then placed and compacted as specified herein. Subgrade shall not be approved for base course construction until it is uniformly stable and unyielding.

M. Subgrade Construction

1. Materials

Subgrade material shall be composed of granular material consisting, essentially, of sand, gravel, rock, slag, disintegrated granite or a combination of such materials. The coarse portions of the material shall be sound fragments of the crushed or uncrushed materials enumerated above. Supplied material shall be a well-graded mixture containing sufficient soil mortar, crusher dust, or other proper quality binding material which, when placed and compacted in the roadway structure, shall result in a firm, stable foundation. Material composed of uniform size particles, or which contains pockets of excessively fine or excessively coarse material, shall not be acceptable for use.

This material need not be crushed, but shall be graded within the following limits:

Standard Size of Sieve	% By Weight Passing Sieve
2½ inch	100
2 inch	95 - 100
No. 4	30 - 60
No. 200	5 - 15
Liquid Limit	35 Maximum
Plasticity Index	6 Maximum

2. The construction of subgrade shall consist of furnishing and placing approved subgrade material to form a stable foundation on which to construct base course, in conformity with the lines, grades, and typical cross sections shown on the plans, and as staked by a Colorado registered surveyor. In addition, subgrade material shall be used to replace unsuitable foundation materials at locations shown on the plans, or as directed by the Development Engineering Manager.

3. Each layer of material shall be placed and spread so that after compaction it shall conform to the width and crown of the typical cross sections. The wetting of subgrade layers shall be done with sprinkling equipment of a type which ensures uniform and controlled distribution of the water. Wetting shall be done by uniformly sprinkling each layer of material being placed with only that amount of water needed to obtain maximum density of the material.

4. Travel may be allowed over subgrade to assist in compaction of the material. Mixing and blading of the subgrade material on the street shall be required if the material is spotty and non-uniform. However, blading shall be held to a minimum in order to avoid the floating of the heavier rock particles to the surface.

5. Concurrently with the wetting operations, the material shall be uniformly compacted by rolling. Rolling equipment shall consist of one (1) or more of the following: rubber tired roller, sheep foot roller, and flat wheel steel roller.

N. Dewatering

Pipe trenches or structure excavation shall be kept free from water during pipe laying and other related work. The method of dewatering shall provide for a completely dry foundation at the final lines and grades of the excavation. Water shall be disposed of in accordance with the requirements specified by the CDPS General Permit for Construction Dewatering Activities. The dewatering operation shall continue until such time as it is safe to allow the water table to rise in the excavations. Pipe trenches shall contain enough backfill to prevent pipe flotation. The use of sanitary sewer system for the purposes of dewatering is strictly prohibited.

O. Pipe Bedding

After completion of the trench excavation and proper preparation of the foundation, a minimum of six (6) inches and maximum of 12 inches of bedding material shall be placed on the trench bottom for support under the pipe. Bell holes shall be dug deep enough to provide a minimum of two (2) inches of clearance between the bell and the bedding material according to the pipe manufacturer's recommended bedding practices. Pipe shall be installed in such a manner as to ensure full support of the pipe barrel over its entire length. After the pipe is adjusted for line and grade and the joint is made, the bedding material shall be carefully placed and tamped under the haunches of the pipe up to spring line and in the previously dug bell holes. The bedding shall then be installed to a minimum of six (6) inches and a maximum of 12 inches above the top of the pipe, no matter what type of pipe is being installed. The bedding material shall be squeegee, non-fractured, rounded, and shall conform to the following limits when tested by means of laboratory sieves:

Sieve Size	Total % Passing by Weight
3/8-inch	100
No. 200	0-5

P. Backfill

1. It is expected that the trench excavation shall provide suitable backfill material. Wet, soft, or frozen material, pieces of asphalt or concrete or other undesirable substances shall not be used for backfill. The backfill material shall be free from rubbish, stones larger than five (5) inches in diameter, clods, and frozen lumps of soil. If the excavated material is not suitable for backfill as determined by the Development Engineering Manager, suitable material shall be hauled in and utilized and the rejected material hauled away and disposed of. Snow shall be removed from the trench prior to proceeding with backfill operations.

2. Backfilling shall be conducted in a manner to prevent damage to the pipe or its coating and shall be kept as close to the pipe laying operation as possible.

3. Backfill around structures shall be consolidated by mechanical tamping.

4. In areas where existing pavement is to be cut and replaced, backfill, and compaction shall be done as specified in these Standards and Specifications. Excess material shall be removed prior to surfacing. Squeegee shall not be considered backfill material and shall not extend more than 12 inches above the top of the pipe.

Q. Compaction

1. Compaction method shall be by means of a mechanized "REX" or approved equal, and in such a manner that the backfill material is uniformly compacted throughout the depth of the trench to at least 95% of the maximum density obtainable using standard proctor. The minimum moisture content shall not deviate above or below the standard optimum by more than two (2)%. Equipment mounted sheep's foot compactors may not be utilized unless specifically approved by the Development Engineering Manager.

2. If, in the judgment of the Development Engineering Manager, the trench shows signs of being improperly backfilled or if settlement occurs, the trenches shall be reopened to a depth required for proper compaction, refilled and recompacted, in accordance with these specifications.

3. Compaction tests, taken by an independent commercial laboratory, shall be taken every 200 feet, or at the discretion of the Development Engineering Manager, while construction is proceeding. The Development Engineering Manager shall pick the location and depths at which compaction tests shall be taken. Compaction tests shall be taken at depths below finish subgrade ranging from one (1) foot above the top of squeegee to one (1) foot below grade at an interval not exceeding two (2) feet. The City Inspector shall be present when each test is taken and the results shall be forwarded to the City. The Responsible Party shall bear the costs of compaction tests.

R. Trench Maintenance

For a period of one (1) year after initiation of the warranty period, the Responsible Party shall maintain and repair any trench settlement which may occur and shall make suitable repairs to any pipe, fitting, valve, valve box, pavement, sidewalks, or other structures which may be damaged as a result of backfill settlement as determined by the Development Engineering Manager. The Responsible Party is also responsible for material defects.

S. Traffic Control

1. The flow of vehicular, pedestrian, and bicycle traffic on public streets and roadways shall be maintained at all times during construction in accordance with the rules, regulations, and conditions as set forth in the traffic control permit issued by the Development Engineering Manager. Signs, barricades, lights, and warning devices shall be constructed and used in accordance with the MUTCD and the Colorado supplement. The ATSSA Guide shall be strictly followed by the Responsible Party during the progress of the work.

2. The Responsible Party shall be responsible for the provision of a safe travel way on all streets, roadways sidewalks, and trails on and adjacent to the job site. The Responsible Party shall erect or cause erection of proper traffic control warning devices around all excavations, embankments, and obstructions and shall be responsible for the proper maintenance of said erected devices, in accordance with the traffic control permit and the MUTCD.

3. The Responsible Party shall cause suitable warning lights to be provided and kept lighted at night or other times when visibility is limited. The Responsible Party shall provide flaggers and/or off-duty police protection as may be determined by the Development Engineering Manager for the protection of the public, as well as workers on the job site.

4. The Responsible Party shall coordinate with the Development Engineering Manager so that arrangements may be made by the Responsible Party for detours, parking, and access to property adjacent to work, etc., 48 hours prior to their need. A minimum notification of one (1) week is required when detouring a street.

5. The Responsible Party shall not work within any portion of a street without receiving a Traffic Control Permit from the Development Engineering Managerprior to such work. Full roadway closures will be reviewed on a case by case basis. The City reserves the right to refuse to allow full road closures. Requirements for such closures will be determined at the time of issuance of permit. The responsible party will be responsible for all public notices, public meetings, and requirements as outlined in the Traffic Control Permit.

6. No work shall be allowed at signalized intersections or on arterial roadways which impedes normal traffic flow from 5:00 a.m. to 9:00 a.m., and 3:30 p.m. to 7:00 p.m., except during emergencies or with prior approval of the Development Engineering Manager. Failure to complete work within the traffic control permit may result in a “stop work” order.

7. The Responsible Party shall be responsible for all damages to the work due to failure to place barricades, signs, lights, flaggers, and other workers to protect it. Whenever evidence of such damage is found prior to acceptance, the Development Engineering Manager may order the damaged portion immediately removed and replaced by the Responsible Party.

T. Street Cuts

1. The City shall specify minimum pavement sections for replacement on the basis of standards developed by the City and the classification of the street cut for utility installation.

2. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Where utilities must cross these facilities, the exact width of the cut shall exceed the width of the trench at the subgrade by at least 12 inches on both sides of the cut. Portland Cement concrete or asphaltic concrete surfaces shall be cut with a pavement saw to a depth of four (4) inches, or more than one-half (½) existing thickness, whichever is greater as requested by the Development Engineering Manager, prior to breaking. Cutting shall be limited to straight lines and acute angles shall be avoided. Concrete removed shall be replaced to the next contraction joint in full stone increments only. No partial stone replacement shall be permitted.

3. Within street pavement (public and private), parking lots, drive aisles, driveways, or curb, gutter and sidewalk, the native material shall be removed from the site and the trench shall be backfilled with flow/flash fill and the material shall be vibrated into place. The replacement of Portland Cement concrete sidewalks, driveways, or curb and gutter shall be to the same horizontal dimensions as that removed for the utility installation. Portland Cement concrete driveways and sidewalks shall have a minimum thickness of six (6) inches. Portland Cement concrete design mix shall conform to any and all applicable City standards regarding streets, curb and gutter, and sidewalks.

U. Clearing and Grubbing

1. Work shall consist of clearing, grubbing, removing, and disposing of the vegetation and debris within the limits of the project and such other areas as may be indicated on the plans or required by the work, except such objects as are designated to remain or are to be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury or defacement of vegetation and objects designated to remain.

2. The City shall approve construction areas that are to remain. The Responsible Party shall preserve things designated to remain.

3. Surface objects and trees, stumps, roots, and other protruding obstructions not designated to remain shall be cleared and/or grubbed as required, to ensure complete removal; however, nonperishable, non-toxic objects which shall be a minimum of two (2) feet below subgrade may remain when such objects will not impede other subsurface operations.

4. Except in areas to be excavated, stump holes, and other holes from which obstructions are removed shall be backfilled with suitable material and compacted in accordance with these Standards and Specifications. Materials and debris shall be disposed of in a manner acceptable to the Development Engineering Manager.

5. Burning of any materials shall not be permitted without prior written approval of the Development Engineering Manager, the County Health Department, and Fire Department.

6. The Responsible Party shall make necessary arrangements for obtaining suitable disposal locations. If disposal will be at other than established dump sites, the Development Engineering Manager may require the Responsible Party to furnish written permission from the property owner on whose property the materials and debris will be placed.

7. Branches of trees or shrubs shall be removed as directed by the Development Engineering Manager. Branches on trees extending over the road bed shall be trimmed to give a clear height of 16 feet above the road bed surface. Trimming shall be done by skilled workmen and in accordance with good tree pruning practices.

8. The Responsible Party shall strip areas where construction is to occur. Scalping shall include the removal of material such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and other vegetative matter from the surface of the ground.

9. Hedges shall be pulled or grubbed in such a manner as to assure complete and permanent removal. Sod not required to be removed shall be thoroughly disked before construction of embankment.

105.5 Removal of Miscellaneous Materials

A. General

1. The Responsible Party shall raze, remove, and dispose of foundations, signs, structures, fences, pavements, utilities, traffic signal materials, and other obstructions, which are designated for demolition within the project limits, except for utilities and for materials which are to be preserved.

2. Pedestals and bases from sign posts and similar structures shall be removed to one (1) foot below the proposed subgrade.

3. Where portions of structures are to be removed, the remaining portions shall be prepared to fit new construction. The work shall be done in accordance with plan details and in such a manner that materials to be left in place shall be protected from damage. Damage to portions of structures which are to remain in place shall be repaired at the expense of the Responsible Party. Reinforcing steel, projecting from the remaining structure, shall be cleaned and aligned to provide bond with new extension. Dowels shall be securely grouted with City-approved grout. Remaining structures are to be delineated in the as-built drawings.

B. Pavements, Sidewalks, Curbs, Etc.

1. Portland Cement Concrete (PCC) or asphaltic concrete that is to remain shall be cut in a straight, true line with a vertical face. PCC or asphaltic concrete may be cut with a cutting wheel, jackhammer (demolition of structure following surrounding clean cuts), or saw, or may be broken to the directed point of removal. The Responsible Party shall be responsible for the cost of removal and replacement of overbreak as identified on the construction plans.

2. If the Responsible Party cannot maintain a straight, true break line by other means, the Development Engineering Manager shall order sawing. The sawing shall be done carefully, and damages to PCC or asphaltic concrete to remain in place, which are caused by the Responsible Party's operations, shall be repaired by the Responsible Party at his expense. The minimum depth of saw cuts in concrete shall be two-thirds (2/3) of the thickness of the concrete section.

105.6 Protection of Existing Facilities

A. The Responsible Party shall notify the Utility Notification Center of Colorado (UNCC) prior to beginning work in accordance with state statutes and shall have the City's utilities, irrigations systems, electric, gas, telephone, cable television, and all other underground facilities staked and located in the field in order to ensure that there shall not be interruptions of these services during progress of the work

B. The Responsible Party shall preserve intact any underground pipes or other utilities encountered during construction. The Responsible Party shall be liable for all damages done to such existing facilities and structures and shall hold the City harmless from any liability or expense for injuries, damages or repairs to such facilities. The type, size, approximate location, and number of all known underground utilities shall be shown on all drawings. It shall be the responsibility of the Responsible Party to verify the existence and location of all underground utilities along the route of the work.

C. The Responsible Party shall be required to take reasonable and proper precautions to insure against damage to all existing power lines, telephone lines, water mains and services, gas mains and services, sanitary and sewer mains and services, roadways, curbs, gutters, sidewalks, trails, electrical pipes and conduits, drainage ways, irrigation ditches, railroad tracks, buildings, structures, walls, fences, trees, shrubbery and other landscaping, wetlands, or other properties and/or structures in the vicinity of any work or which may be damaged during the excavation work. In addition, the Responsible Party shall take further precautions to insure against injury or damage to property, persons, animals, and vehicles. Wherever necessary, fencing or railing shall be placed around any excavation and a sufficient number of amber lights shall be on from twilight until sunrise. One (1) or more guards shall be employed as additional security wherever they are needed or required by the Development Engineering Manager.

D. In the event that it is determined during construction, through potholing or other appropriate method, that any underground utility conduit, including sewers, water mains, gas mains, and drainage structures or any above ground utility facilities are required to be relocated, the Responsible Party shall notify the utility owner well in advance of approaching such utility so that arrangements with the City and/or owners of the affected utility can be made without delay to the work. All relocations shall be done at the Responsible Party's expense and upon approval by the Development Engineering Manager.

E. Should potholing be performed, the hole shall be filled with flow/flash-fill within 24-hours of the operation.

F. Fire hydrants shall be visible and accessible to the fire department from the street at all times. No permanent or temporary obstructions (including, but not limited to, fencing, street lighting, landscaping, and mailboxes) shall be placed within three (3) feet of a fire hydrant.

G. The Responsible Party shall not hinder or interfere with any person in the protection of such property, or with the operation of utilities at any time, except with permission of the owner of the utility. The Responsible Party must obtain all necessary information in regard to existing utilities, protect such utilities from damage, and avoid unnecessary exposure so that they shall not cause harm to the public.

H. The Responsible Party shall obtain all necessary information in regard to the planned installation of new utilities, cables, conduits, and transformers, make proper provision and give proper notification so that new utilities and electrical equipment can be installed at the proper time without delay to the Responsible Party or unnecessary inconvenience to the Responsible Party.

I. When the work involves excavation adjacent to any properties or structures along the work site, the Responsible Party shall give such property owners written notice a minimum of 48 hours thereof, and shall furnish a copy of such notice to the City.

J. The Responsible Party shall protect and carefully preserve all land boundary and all survey control monuments until the Responsible Party or an authorized surveyor has referenced their location for relocation. All monuments disturbed or removed by the Responsible Party or subcontractors, shall be replaced by a licensed surveyor at the Responsible Party's expense.

K. The Responsible Party shall be liable for the damage or destruction of property resulting from neglect, misconduct, or omission in the manner or method of execution or non-execution of the work, or caused by defective work or the use of unsatisfactory materials. It shall restore such property to a condition similar to or better than that existing before such damage or injury was done, by repairing, rebuilding, or replacing it as may be directed.

L. The Responsible Party shall take all necessary precautions to prevent pollution of streams, lakes, reservoirs, and irrigation ditches with fuels, oils, bitumens, sodium chloride, calcium chloride, or other harmful materials. The operations shall be conducted and scheduled to avoid or minimize siltation of streams, lakes, and reservoirs. A plan for erosion protection, as referenced herein, shall be submitted to the Development Engineering Manager.

M. A plant material protection zone shall be identified on a plan and be submitted with the approved construction drawings.

1. The existing condition of all plant material in the construction area shall be reviewed by a third party ISA Certified Arborist or City Staff at the discretion of the Senior Landscape Architect.

2. Any activity determined to be injurious to existing plant material shall not be permitted within the plant material protection zone. These activities include grading, rototilling, equipment storage, vehicle parking, stockpiling of soil, or other activities which may cause soil compaction or disruption. Plant material damaged during construction and not included on the approved mitigation plan shall be valued toward additional replacement plant material in accordance with City policy.

3. One of the following methods shall be used to determine the plant material protection zone:

   a. Dripline Method: Protect the area within the tree's dripline for broad-canopied trees, or up to 1.5 times the tree's dripline for narrow-canopied trees.

   b. Tree Height Method: Protect a circular area around the tree with the radius being equal to the height of the tree. This is the preferred method and should be used if there is enough space available. This method should also be used for narrow-canopied trees that have root systems extending beyond the tree's dripline.

   c. Trunk diameter Method: for every inch of trunk diameter at 4.5 feet above the grade, allow for 1-1.5 feet of circle radius from the trunk.

N. The plant material protection zone on a site shall be enclosed with protective fencing. Protective fencing shall be orange plastic or metal chain link, a minimum four (4) feet in height, secured with metal posts and signed to indicate that the area is set aside for the protection of plant material. Absolutely no grading shall be permitted within the plant material protection zone. Supplemental irrigation may be required for protected plant materials from May-October.

O. Pruning shall be required for all plant material to be saved in the work area to the extent required to permit clean and workmanlike finish grading, seeding, or sodding operation under and around plant material.

P. If authorization has been granted to excavate within the dripline of plant material, do so in a manner that will cause minimum damage to root systems. Prune the injured roots cleanly and backfill as soon as possible. Do not leave surface roots exposed. To minimize damage to the roots, boring may be required within the dripline, as directed by the Senior Landscape Architect.

   1. Do not cut any root over two (2) inches in diameter within the dripline except when authorized by the Senior Landscape Architect.

   2. Do not use trees for any purpose such as crane stays, guy anchors, shaded material storage, etc.

Q. No paint, oil, volatile materials, or any substance that might cause damage to existing or future vegetation shall be spilled or buried in the vicinity of the construction area. Any spillage shall be immediately removed and properly disposed of at the direction of the Development Engineering Manager.

105.7 Outages

In the event loss of service is necessary, the Responsible Party shall notify the City at least 48 hours in advance. Such services shall in no case be interrupted for more than four (4) hours. Outages for schools, medical clinics, and various commercial businesses must be conducted at approved times as specified by the owner or chief administrator of each establishment and upon approval by the Development Engineering Manager. If outages for more than four (4) hours are necessary, they must be conducted at times to cause the least inconvenience to the customers and upon the approval of the Development Engineering Manager. Under all circumstances, the work must continue until such affected services are resumed. If, in the process of installing a connection, there exists an industry or building that must have water at all times, as designated by the Development Engineering Manager, such as a hospital, appropriate temporary means shall be taken to provide and deliver water to such industry or building. The method of delivery of the water shall be approved by the Development Engineering Manager and at the expense of the Responsible Party.

105.8 Safety

Machinery, equipment, materials, and all hazards shall be guarded or eliminated in accordance with the MAPC and all applicable federal regulations, including OSHA, state, county, and municipal laws and regulations. No blasting shall be done without the prior approval of the City. Safety equipment, devices and clothing shall be utilized by personnel where required by federal, state, and local laws. The Responsible Party shall strictly comply with MUTCD.

105.9 Work Conditions

A. Emergency Conditions

1. When, in the opinion of the Development Engineering Manager, the Responsible Party has not taken sufficient precautions for the safety of the public or the protection of the work to be constructed, or of adjacent structures or property which may be damaged by processes of construction on account of such insufficient precautions, and an emergency may arise and immediate action is considered necessary in order to protect public or private, personal or public interests, the Development Engineering Manager, with or without notice to the Responsible Party, may provide suitable protection by causing such work to be done and material to be furnished and placed as the Development Engineering Manager may consider necessary and adequate. The cost and expense of such work and material so furnished shall be borne by the Responsible Party and shall be paid within 30 calendar days upon presentation of the invoice by the City.

2. The performance of such emergency work under the direction of the Development Engineering Manager shall in no way relieve the Responsible Party of responsibility for damages which may occur during or after such precaution has been taken.

3. In an emergency threatening loss of life or extensive damage to the work or to adjoining property, and where the Responsible Party is unable to obtain special instructions or authorization from the Development Engineering Manager, the Development Engineering Manager shall be notified of such emergency work within four (4) hours of the action. After diligent attempts to obtain such special instruction or authorization in sufficient time to take the necessary action, the Responsible Party is hereby permitted to act to prevent such threatening loss or damage.

B. Cleanup

1. The Responsible Party shall be responsible for daily cleanup on the project area and shall remove and properly dispose of all surplus and discarded materials, rubbish, and temporary structures from the project area and adjacent areas, and where appropriate leave the project area swept and in a neat and clean condition. The Responsible Party shall restore all work areas which have been damaged by the operations, to general conformity with the specifications for the area or areas involved, and to the original condition.

2. The Responsible Party's work shall conform to the requirements set by the SWMP and sediment and erosion control drawings as described in the statutes, ordinances, and regulations. The Responsible Party shall be responsible, at its own expense, for keeping the site and adjacent areas affected by the construction activity in conformance with these Standards and Specifications and the state discharge permit. The Responsible Party shall, within 24 hours of the City's notification of noncompliance with this section, commence clean-up operations and shall diligently pursue completion of said operations to the satisfaction of the City. If the Responsible Party fails to respond within 24 hours, or the City is unable to contact the Responsible Party after reasonable effort, or the Responsible Party fails to complete clean-up operations to the satisfaction of the City, the Development Engineering Manager may issue to the Responsible Party a "stop work" order which would be in effect until clean-up operations by the Responsible Party are completed to the satisfaction of the Development Engineering Manager. The Development Engineering Manager may also, at its discretion, choose to have the streets and rights-of-way cleaned by City crews or an outside contracted firm and invoice the Responsible Party for all costs incurred by the City.

3. If the City, in its sole discretion, determines a violation to these Standards and Specifications exists, the City may immediately issue a "stop work" order to the Responsible Party and take corrective action to clear the affected area and invoice the Responsible Party for all costs incurred by the City. A "stop work" order issued by the City stops all ongoing work within the subdivision in question and includes the stoppage of building permit inspections. The Responsible Party shall pay the City's invoice for remedy within 30 days of receipt of the invoice. Failure to pay the invoice within said 30 days will result in another "stop work" order being issued, to be in effect until the invoice is paid.

105.10 Use of City Water

A. If the Responsible Party requires City water for any part of the project, the following steps must be taken:

1. Obtain and complete a fire hydrant meter permit form. (a water use permit may be required prior to issuance of a hydrant meter permit in times of drought as referenced in the City Code.)

2. Pay a refundable deposit, all monthly rental and water usage charges, and all damages other than normal wear and tear to the hydrant, meter, street, or other public improvements that may result from the hydrant use.

3. Return the hydrant meter immediately when no longer required.

4. The hydrant meter may only be used at the approved fire hydrant location noted on the permit. Use of a hydrant at another location must receive prior approval from the City.

105.11 Phasing

In the event that phasing is permitted and undertaken by the Responsible Party, no building permits may be issued for buildings within any subsequent phase, as determined by the Developer's Agreement. The receipt of a performance guarantee by the City does not satisfy the condition of Initial Acceptance as defined in this section.

105.12 Inspections

A. All construction work for which a site construction permit is required shall be subject to inspection by the City and certain types of construction shall have continuous inspection.

B. At all times during construction of the Improvements, and until final acceptance thereof by the City, the City shall have the right, however, not the duty, to inspect materials and workmanship in order to ascertain conformance with the approved plans and City standards and specifications.

C. The Responsible Party shall notify the City that such work is ready for inspection at least 48 hours before such inspection is desired. Such request may be in writing or by telephone, at the option of Development Engineering.

D. The Responsible Party shall reasonably cooperate and assist the City to gain appropriate access to the areas designated for inspection.

E. It shall also be the duty of the Responsible Party to notify the City upon discovery of any non-conformance with the said plans and these Standards and Specifications.

F. Inspection of work by the City shall not relieve the Responsible Party of any responsibility for construction of Improvements in accordance of these Standards and Specifications or other applicable agreements.

G. Additional Inspections and Reinspections

1. Development Engineering may make or require additional inspections of any work as deemed necessary to ascertain compliance with the provisions of these Standards and Specifications and other provisions of the City Code.

2. This subsection is not to be interpreted as requiring reinspection fees the first time a job is rejected for failure to comply with the requirements of these Standards and Specifications, but rather as controlling the practice of calling for inspections before a job is ready for such inspection or reinspection. Reinspection fees may be assessed when the permit is not in the possession of the permit holder, or an authorized agent, at the work site, when the approved plans are not readily available to the Inspector, for failure to provide access on the date for which inspection is requested or for deviating from plans approved by Development Engineering.

3. To obtain a reinspection, the applicant must pay a fee as determined by the City. In instances where reinspection fees have been assessed, no additional inspection of the work shall be performed until the required fees have been paid.

105.13 Initial Acceptance

In situations where the City does not require a Developer's Agreement for construction/installation of Public Improvements due to the scope and nature of the construction/installation as determined by the Development Engineering Manager, the procedures outlined in sections 105.13, 105.14, 105.15, 105.16, and 105.17 shall apply.

A. Conveyance to the City

1. Prior to initial acceptance of Public Improvements, and unless such conveyance has not been previously made to the City, the Responsible Party by good and sufficient documents of conveyance shall dedicate and/or convey to the City in perpetuity all easements, rights-of-way, and fee title to real property, without expense to the City, and free and clear of all encumbrances as may be reasonably required to construct, place and maintain the Improvements. Said instruments of conveyance shall be in a form acceptable to the City Attorney and shall be furnished to the City.

2. In the event that the Responsible Party is not record title owner of a property interest which Responsible Party is required to convey or dedicate to the City pursuant to these Standards and Specifications, it shall be the sole obligation of Responsible Party to acquire title to such property.

3. As to any conveyance required by the City pursuant to these Standards and Specifications, the Responsible Party shall at its sole expense provide the City with a policy of title insurance insuring the title to the Property conveyed to the City to be free of liens and encumbrances superior to the City's interest in the Property unless otherwise approved by the City.

4. The Responsible Party shall be solely responsible to pay all general taxes attributable to the Property, as applicable, interests conveyed to the City until the date of conveyance, and at the request of the City shall submit such estimated taxes, prorated to the date of conveyance, in conjunction with the conveyance.

5. At the time of acceptance of any Public Improvements listed in the Developer's Agreement, such Public Improvements shall be deemed to be conveyed to the City.

B. The Responsible Party shall submit a written request for initial acceptance of all Public Improvements for a phase or the entire project a minimum of seven (7) days before the estimated completion date of the Improvements identified in the request for initial acceptance. The City shall inspect the Improvements within 10 working days of the City's receipt of the Responsible Party's written request for initial acceptance. Upon inspection, the City will either issue a letter of initial acceptance or issue a punch list of items needing correction before an initial acceptance letter will be issued. The Responsible Party will have 60 calendar days to complete the punch list. If the items on the punch list are not completed within 60 calendar days, the City reserves the right to stop building permits or routine inspections, issue additional punch lists, and call on the Performance Guarantee until all punch list items have been completed and a letter of acceptance has been issued.

C. Upon a finding of satisfactory completion of the Public Improvements in compliance herewith and all applicable ordinances and standards of the City, the City shall issue a letter of initial acceptance to the Responsible Party, which shall constitute the date of commencement of the warranty period. Upon the issuance of the letter of initial acceptance the City shall require the Responsible Party to obtain and deliver to the City a warranty guarantee, and provide the City all applicable mechanics lien statements with respect to the project. The City will issue a letter of completion for all Private Improvements, as there is no warranty period for these improvements.

D. The City shall, within 30 days of issuance of the letter of initial acceptance, return the surety to the appropriate party, by a letter of transmittal from the City to the appropriate party, subject to these Standards and Specifications.

105.14 As-Built Drawings Requirements

A. Certification Statement

It is the duty of the Responsible Party to record and document the physical dimensions and any changes on a set of as-built drawings and to certify as to their accuracy. The as-built drawings will be a modified version of the full set (including cover page, detail sheets, plan and profile sheets, and sheets without record information) of the approved construction drawings, with actual physical dimensions and documentation of any changes from approved construction drawings based on field measurements and certified by a Professional Land Surveyor (LS) or Professional Engineer (PE) duly licensed in the State of Colorado. The certification shall also have the date of certification by the LS or PE. All as-builts will have a PE or LS stamp on mylar only.

Certification Statement:

"These drawings are a correct as-built of the final construction of improvements shown on these plans, as per the Standards and Specifications for the City of Thornton."

_____	_____	_____
LS or PE Name	LS/PE Number	DATE

B. As-Built Information

An LS or PE shall document the following information to certify the construction plans as being as-built:

1. Streets

a. Elevation check at maximum 150 foot intervals in each flow line along street, at the point of curb return of each radius, and at the center of each cross pan.

b. Elevation at flowline on each side of storm inlets.

c. Elevations at all points shown on the cul-de-sac detail, and at the center and high points in the flowline.

d. Traffic Signals

2. Sanitary and Storm Sewers

   a. Elevation, size, and material of all in and out inverts at manholes, inlets, and outlets.

   b. Pipe lengths, pipe diameters, pipe material, and stationing from manholes. Sanitary sewer service connection location information is to be supplied by the contractor to the Responsible Party.

   c. Rim elevations on all manholes and drainage inlet structures.

   d. Elevation checks every 100 feet in the thalweg of drainage channels, including elevation at drop structures.

   e. Final detention pond volume from cross sections, detailed as constructed topographic map of the detention pond (including the overflow weir and the circumference of the top of the pond), and the final release rates per drainage criteria (PE certification only). This survey shall be completed after all landscaping and irrigation lines have been installed.

   f. Overland flow path from the detention pond's emergency overflow to the receiving stream.

3. Water Mains

   a. Pipe lengths, diameters, materials, standard depth of bury stationing of valves, and bends.

   b. Horizontal verification of all waterlines, water valves, fire hydrants, plugs, blow-offs, meter pits, and service connections.

   c. Horizontal and vertical verification of all lowered crossings showing extent of casing pipe or concrete encasement.

4. Public and Private Park, Landscape, and Irrigation Improvements

   a. Redraw to accurate scale of a minimum of 1"=30'. Noted dimensions on construction drawings shall not be accepted.

   b. List of all plant material installed including size and quantities.

   c. Vertical and horizontal verification of all sidewalks, trails, and hardscape play and gathering areas.

   d. Verification of all slopes shown on the construction plans.

   e. Horizontal verification of all physical features, including trees, back stops, goals, lights, signage, playground equipment, bleachers, site furniture, restrooms, fences, bike racks, pavilions, water features, etc.

   f. Irrigation as-builts shall include horizontal verification of all irrigation pipes, irrigation heads, valve boxes, wiring (24 volt and 110 volt), electrical boxes, controller, and backflow protection device. Noted information shall include all pipe size, zone number, valve location, head type, valve type and model number, controller type and model number, design operating pressure chart, and drip emitter chart. Irrigation as-builts shall show pertinent physical features, such as sidewalks, fences, ponds, buildings, parking lots and athletic fields. No contour lines shall be shown on irrigation as-builts unless required by the City. A color-coded, laminated reduced copy of the irrigation system sized to fit the controller is required.

5. Overlot Grading

6. A certification of quantity and cost for all infrastructure including, but not limited to streets, drainage, water, sanitary sewer, parks, etc that was constructed as a part of the development.

7. As-builts may be field verified by the City and shall be approved by the City prior to Initial Acceptance by the City.

105.15 Submittal of Certified As-Built Plans and Documents

It shall be the duty of the engineer, land surveyor, or preparer of the as-builts to record any and all changes on as-built drawings at the completion of the project as well as make corrections to the AutoCAD files in the plan

and profiles. Changing of the labels and stationing alone are not sufficient, the actual drawings should be adjusted to scale appropriately.

The LS or PE shall submit one (1) complete set of certified plans, 22" x 34" in size, to the Development Engineering Manager. Once those have been approved by the City, a scanned electronic copy of the certified and stamped as-built plans shall be provided in an electronic format (both in an AutoCAD compatible format as well as a copy in a .pdf format or approved equal).

The AutoCAD compatible as-built file shall be one file (no external references) that encompasses the entire project layout and the following information: boundary lines, lot lines, right-of-way lines, street centerlines, waterlines, valves, hydrants, plugs, blow-offs, meters, sanitary sewer lines, sanitary sewer manholes, storm sewer lines, storm sewer manholes, storm sewer inlets, detention ponds, outlet structures, landscaping, curb, gutter, and sidewalk. Said electronic drawing shall be constructed using the certified field measurement data with correct lengths and relative locations.105.16 Warranty

A. Responsible Party warrants that all proposed Public Improvements to be provided under the construction permit be free from defects, including, but not limited to, defects of materials, workmanship and design, and that the Improvements will otherwise fully comply with all applicable City Standards and Specifications for a period of no less than two (2) years.

B. A warranty guarantee shall be equal to 15% of the total estimated cost of the public Improvements, excluding landscape improvements. The warranty guarantee for public landscaping will be equal to 50% of the total estimated cost of landscape improvements in the public rights-of-way or on public tracts, including all vegetative materials, irrigation, and recreation facilities. The warranty guarantee shall be in the form of cash, a cashier's check, an irrevocable letter of credit, or a warranty bond. The entity issuing a warranty bond shall have at least an "A" rating from Moody's, or an equivalent rating as designated by a nationally recognized ratings firm, and shall additionally be included in the most recent listing of companies holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies, Department of Treasury, Circular 570. Warranty bonds shall be on the standard bond form as approved and provided by the City. An irrevocable letter of credit shall be on the standard letter of credit form as approved by the City and in accordance with finance directive 92-1. The warranty guarantee shall provide security for the costs which may be incurred in repairing and/or replacing Improvements during the warranty period of two (2) year following Initial Acceptance by the City.

C. In the event that any substantial repair or replacement is required to any of the Improvements during the warranty period and such repair or replacement is not timely made upon notice of defect or in any event before the expiration of the warranty period, the City may elect to:

    1. extend the warranty period for up to one (1) additional year following Initial Acceptance of the completed repair or replacement;

    2. adjust the amount or term of the warranty guarantee, as may be appropriate;

    3. call the warranty guarantee and secure repair or replacement of the nonconforming Improvements; or

    4. order the denial or suspension of building permits, utility services or certificates of occupancy outstanding until repair or replacement of any nonconforming Improvements have been performed and initially accepted by the City.

D. Landscape and Park Amentity Requirements for Public Improvements

    1. The Responsible Party shall guarantee all materials to be free from defects in workmanship and materials for a period of at least one (1) year from the date of Initial Acceptance. Defects shall include, but are not be limited to: edge unraveling, loss of resiliency in excess of specified limit, binder disintegration, and cracking, color fading, or inadequate bonding. The Warranty Period only applies to parks that will be owned and maintained by the City.

    2. In the event that the Responsible Party is unable to complete the Landscaping Improvements identified in the Developer's Agreement because of periods of adverse weather or for other similar reasons as approved by the City, the Responsible Party may submit to the City a performance guarantee for landscaping in the form of a cash payment, a cashier's check or an irrevocable letter of credit payable to the City in an amount equal to one and one-half times (1.5) the estimated cost of all uncompleted landscaping. Upon receipt of any performance guarantee for landscaping authorized by this paragraph, in a form acceptable to the City, the City may issue building permits. These landscape improvements shall be completed at a time agreeable to both parties; however, no later than eight (8) months from the date of approval of the request for a performance guarantee for landscaping by the City. The City shall release the performance guarantee for landscaping only upon completion of all landscaping obligations by the Responsible Party. In the event that the Responsible Party defaults upon the obligations specified in this paragraph, the City may retain and apply all those funds represented by the performance guarantee for landscaping toward completion of the

Responsible Party's landscape obligations. The method and manner in which the City elects to construct and install the landscaping obligations shall be within the discretion of the City provided, however, that nothing herein shall obligate the City to install or complete the Landscaping Improvements and nothing herein shall prevent, prohibit or limit the remedies available to the City to enforce the obligations of the Responsible Party requiring completion of landscaping improvements. Any remaining funds will be returned to the Developer after the City determines the construction has been completed. The City, however, shall not be deemed to have accepted any payment responsibility or liability in conjunction with any documents identified in this section.

3. The Responsible Party shall be responsible for all maintenance of the landscape project until Initial Acceptance; the City shall maintain the landscape project following Initial Acceptance.

   a. Maintenance shall include but may not be limited to repair and/or replacement of damaged or eroded hardscape or softscape areas, watering, mowing, weeding, trimming, fertilizing, trash removal, replanting, mulching, wrapping, spraying, tightening and repairing of guy wires, removal and replacement of dead materials, resetting of plants to proper grades and positions and reseeding. Contractor shall guarantee against settlement for one (1) full year after Initial Acceptance. Any corrections required to meet this specification, including repair/replacement of concrete, sod, irrigation, or other site improvements shall be at the Contractor's expense.

   b. For mowing operations, sound horticultural practices shall be followed so that no more than one-third (1/3) of the leaf surface is removed during mowing and that the height of the grass is at least three (3) inches after the final cut. For initial acceptance of irrigated areas, all areas shall have uniform dense growth in accordance to Section 800. Maintenance shall provide an even, fixed healthy growth of grass and stand of plant material. Any areas deemed by the City to be unacceptable shall be resodded and/or replanted according to these Standards and Specifications and shall be well-established prior to Initial Acceptance, which shall occur at the time of initial acceptance for the entire project. Damage to seeded areas during the warranty period which is caused by overuse shall be exempt from this warranty coverage.

4. The Responsible Party will erect suitable signs at appropriate points notifying the public to keep off sod and seed areas until the area is well established. Any traffic damage that may occur prior to initial acceptance of the work shall be repaired at the Responsible Party's expense.

5. Following initial acceptance, the City shall pay for all water use during the warranty period except for supplemental winter water. The Responsible Party shall supply all supplemental winter watering. However, during the warranty period, any excessive water consumption as determined by the Development Engineering Manager shall be paid for by the Responsible Party, at current market rates.

6. Trees, shrubs, groundcovers, and perennials shall be warranted for a period of one (1) year from the date of Initial Acceptance of the landscape improvements. Annuals shall be warranted during their normal period of growth. Any materials which must be replaced, as determined by the City, shall be replaced within 30 days upon notification from the City. Replacement of plant material before initial acceptance does not waive normal plant warranty.

7. The entire irrigation system (including materials and workmanship) shall be warranted for a period of one (1) year from date of initial acceptance for the system.

8. During the warranty period, the Responsible Party shall make all adjustments to the system and perform all work required to maintain the designed function of the system and to maintain the desired appearance of the landscape.

9. The Responsible Party shall properly winterize the system in the fall and start up the system in the spring during the warranty period, in response to local weather conditions or as directed by the Development Engineering Manager.

10. Excessively pruned trees and shrubs, which are no longer excellent representatives of their species, shall be replaced prior to Initial Acceptance.

105.16 Final Acceptance

A. No earlier than 60 days nor later than 45 days prior to the date of expiration of the warranty period, the Responsible Party shall submit a written request for final acceptance of Improvements, and within 10 days of such request the City shall conduct a final inspection of the Improvements, or authorized phase thereof. The Responsible Party shall certify to the City in connection with the request for Final Acceptance that all persons and entities having provided labor and/or services in the construction of the Improvements have been fully paid subject to such exceptions as may be disclosed to the City and which are acceptable to the City. If the Improvements, subject to the inspection request fully conform to the City's applicable Standards and Specifications, and/or all repairs (if any are needed), have been made to bring same into such conformance,

then the City shall issue a letter of Final Acceptance of the subject Improvements to the Responsible Party. After final acceptance, the Responsible Party may request, and the City shall release, the warranty.

B. If the Responsible Party fails to have Improvements Finally Accepted within 10 days prior to the date of expiration of the warranty period, then the Responsible Party shall be in default and the City may exercise its rights to secure performance as provided in this section. In the event that the Responsible Party has not requested Final Acceptance 45 days prior to the expiration of the warranty period, the warranty period shall be extended for 60 days, until such time as the responsible party can meet all of the conditions that may be required, if any, as a result of the final inspection, and the City shall have the right at any time thereafter to conduct a final inspection of the Improvements. If pursuant to final inspection requested by the Responsible Party or initiated by the City, any such Improvements are found to not conform to the applicable City Standards and Specifications, the City shall have the rights set forth in the section pertaining to Governing Law, enforcement, and remedies.

C. Nothing herein shall be construed or deemed as requiring the City to finally accept and release from warranty any Improvements that are defective or damaged.

D. Once the requirements of these Standards and Specifications are met for private improvements, the City will issue a letter of completion to the Responsible Party.

E. Street Acceptance Testing

1. A pavement evaluation shall be performed in accordance with good engineering practices prior to final acceptance. The report shall generally embody the following testing and pavement evaluation techniques:

   a. Environmental study (frost cycle, drainage, etc.)

   b. Pavement surface evaluation

   c. Soil borings in areas of high deflections

2. The report shall evaluate the existing condition of the base and binder course by performance of the deflection tests at 100 foot spacing per traffic lane. The report shall determine whether or not the pavement section shall meet a 20 year pavement life or greater.

3. If the pavement section is not projected to meet a life expectancy of 20 years or more, the report shall propose asphalt overlays in excess of the existing pavement section to bring the new pavement section to a 20 year life expectancy. The Development Engineering Manager shall evaluate the results of the report and inform the Responsible Party of the required pavement operation of the section.

F. Landscape Requirements for Private Improvements

1. In the event that the Responsible Party is unable to complete the Landscaping Improvements identified in the Developer's Agreement because of periods of adverse weather or for other similar reasons as approved by the City, the Responsible Party may submit to the City a performance guarantee for landscaping in the form of a cash payment, a cashier's check or an irrevocable letter of credit payable to the City in an amount equal to one and one-half times (1.5) the estimated cost of all uncompleted landscaping. Upon receipt of any performance guarantee for landscaping authorized by this paragraph, in a form acceptable to the City, the City may issue building permits. These landscape improvements shall be completed at a time agreeable to both parties; however, no later than eight (8) months from the date of approval of the request for a performance guarantee for landscaping by the City. The City shall release the performance guarantee for landscaping only upon completion of all landscaping obligations by the Responsible Party. In the event that the Responsible Party defaults upon the obligations specified in this paragraph, the City may retain and apply all those funds represented by the performance guarantee for landscaping toward completion of the Responsible Party's landscape obligations. The method and manner in which the City elects to construct and install the landscaping obligations shall be within the discretion of the City provided, however, that nothing herein shall obligate the City to install or complete the Landscaping Improvements and nothing herein shall prevent, prohibit or limit the remedies available to the City to enforce the obligations of the Responsible Party requiring completion of landscaping improvements. Any remaining funds will be returned to the Developer after the City determines the construction has been completed. The City, however, shall not be deemed to have accepted any payment responsibility or liability in conjunction with any documents identified in this section.

2. The Responsible Party shall be responsible for all maintenance of the landscape project. This maintenance shall include, as required, repair and/or replacement of damaged or eroded hardscape or softscape areas, mowing, fertilizing, trash removal, replanting, reseeding, watering, weeding, trimming, mulching, wrapping, spraying, tightening and repairing of guy wires, removal and

replacement of dead plant material, resetting of plants to proper grade and positions and removal of staking after trees have been staked for one (1) year.

2. The Responsible Party is responsible for maintaining the HOA and or Metro District common landscaping and irrigation systems until the City has inspected and verified that the landscaping and irrigation complies with the approved Development Permit and Irrigation Construction Drawings.

3. The Responsible Party shall provide as-builts per the requirements outlined in this section, irrigation controller schedules and any keys and manuals or tools associated with the irrigation system to the homeowners citizen board/metropolitan district board at the time the maintenance responsibility is transferred to the respective board.

4. Metropolitan district and HOA parks shall follow the as-built requirements outlined in these Standards and Specifications.

5. Areas of native or turf seeding shall be maintained by the Developer/Responsible Party until the City has inspected and verified that the stand of grass meets the uniform growth and density requirements outlined in Section 800.

6. Once the requirements of these Standards and Specifications are met for private landscaping improvements, the City will issue a letter of completion to the Responsible Party.

TABLE 100-1

RESPONSIBILITY FOR PUBLIC IMPROVEMENTS AND FACILITIES DURING WARRANTY

	Residential Development		Commercial/Industrial Development	
Utilities	Thornton	Maintenance	Thornton	Maintenance
	Responsible Party	Repairs and Replacement	Responsible Party	Repairs and Replacement
Roadway	Thornton	Maintenance	Thornton	Maintenance
	Responsible Party	Repairs and Replacement	Responsible Party	Repairs and Replacement
Irrigation	Thornton	Maintenance Except for First Winterization and Spring Turn-on	Thornton	Maintenance Except for First Winterization and Spring Turn-on
	Responsible Party	Repairs and Replacement, First Winterization and Spring Turn-on	Responsible Party	Repairs and Replacement, First Winterization and Spring Turn-on
Landscaping	Thornton	Maintenance	Thornton	Maintenance
	Responsible Party	Repairs and Replacement	Responsible Party	Repairs and Replacement

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SECTION 200 - WATER SYSTEM STANDARDS

201 GENERAL PROVISIONS

These standards are promulgated by the Utilities Director of the City in accordance with the authority contained in the Thornton City Code. Improvements shall also be in conformance with Chapter 74 of the Thornton City Code.

Interpretation, revision, and authority to grant variances and enforcement of these standards has been delegated by the Utilities Director to the Development Engineering Manager.

202 GENERAL SPECIFICATIONS

202.1 Granting of Service

Water services shall be extended at the requestor's expense when it has been determined that the City has the capability and capacity to serve the area, provided that the area to be served is located within the Thornton water service area, and provided that the applicant can show evidence of fee ownership of the property to be serviced. The request for service must be in compliance with stipulations contained in all utilities agreements entered into by the City and said applicant as well as in compliance with all applicable City ordinances, codes, and charter principles.

202.2 Application, Permit, Construction, and Acceptance Procedure

Refer to Section 100 for City application, permitting, construction, and acceptance procedures.

Private contractors installing fire sprinkler system water mains (from the water supply to the sprinkler system riser) must be registered with the Colorado Division of Fire Safety as a Fire Suppression System Contractor – Underground. All fire sprinkler mains shall be designed, constructed, and tested in accordance with the City's currently adopted and effective International Fire Code.

203 WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

203.1 General

Water mains and appurtenances shall be in conformance with these Standards and Specifications and shall be designed by or under the direct supervision of a registered PE licensed to practice in the State of Colorado.

203.2 Demand Factors/Allowed Flows

A. Water mains shall be designed to supply the projected demands of the proposed development as set forth herein. Water main sizing shall be in conformance with the current water system master plan. The Development Engineering Manager reserves the right to size mains to provide service for future needs.

B. The following water flow parameters shall serve as minimum guidelines to determine the estimated flows. Water distribution systems shall be designed using the following scenarios:

1. The High HGL of the zone with no demands on the system. The maximum pressure in this scenario is 100 psi.

2. The Low HGL of the zone with no demands on the system. The minimum pressure in this scenario is 50 psi.

3. The Low HGL of the zone with the peak hour demands (Demand Factor of 3.24 for commercial and 5.76 for residential development) added to the system. The minimum pressure under this scenario shall be 40 psi, with a maximum velocity permitted is 5 fps.

4. The Low HGL of the zone with the maximum daily demands (Demand Factor of 1.8 shall be utilized for Office /Commercial and 3.2 for Residential developments) in addition to the required fire flow. The minimum pressure under this scenario is 20 psi. The maximum velocity under this scenario shall not exceed 11.2 fps for eight (8) inch lines, and 10 fps for all other lines.

C. Pumping facilities may be allowed on mains or service lines only where specifically authorized by the Development Engineering Manager.

Average Day Demands: 150 GPD per person

Densities:	Low	Mid	High
	<5	5 - 12	>12 (DU/Ac.)
Residential:	3.45	2.45	2.20 (Persons/Unit)

Office: 240 gallons per 1,000 square feet of building area per day

Commercial:

Shopping Center	680 gallons per 1,000 square feet of building area per day
Restaurants and Fast Food	1,000 gallons per 1,000 square feet of building area per day
Professional Centers	800 gallons per 1,000 square feet of building area per day

Industrial:

Warehouse	240 gallons per 1,000 square feet of building area per day
Factory	680 gallons per 1,000 square feet of building area per day

203.3 Sizing of Distribution Mains

A. Sizing of on-site mains shall be accomplished by utilizing WaterCAD or approved equal. Results shall be submitted to Development Engineering together with engineered drawings.

B. The minimum diameter for water mains shall be six (6) inches where no hydrants are connected to the mainline, otherwise a minimum diameter of eight (8) inches shall be installed. No more than one (1) hydrant shall be located on dead-end water lines. All hydrant branch lines over 50 feet shall be modeled to show that the required fire flow will be met.

C. Water services and fire sprinkler lines for non-residential facilities and high density residential areas shall be constructed from looped mains. No more than 18 single family units shall be located off of a dead end main.

D. Distribution mains connected to transmission mains greater than 16 inches are required to be a minimum of eight (8) inches in diameter.

E. Oversized mains (all mains that are greater than 16 inches in diameter) may be required by the City. Reimbursement agreements may be entered into so that the Responsible Party may recover up to 50% of the costs incurred for the first 16 inches of pipe diameters, in accordance with Chapter 74 of the Thornton City Code.

203.4 Materials

A. Materials for constructing water mains shall conform to the material requirements as set forth in Subsection 204.1 of these Standards and Specifications.

203.5 Ground Cover

Mains shall be designed so that a minimum of four and one-half (4½) feet of cover exists over the top of the pipe after final grade has been established. No main shall have more than five and one-half (5½) feet of cover.

203.6 Location

A. Water mains shall be installed in exclusive easements granted to the City when, as determined by the Development Engineering Manager, it is not practical to install water mains in the dedicated street. City water mains shall not cross through residential lots, and shall be a minimum of 5 feet from any property line. Under no circumstances shall any structures be constructed within these easements or right-of-way where these mains are installed, without prior approval including terms and conditions, as set by the City. The minimum width requirements for water easements are 20 feet with the pipe centered in the easement, and the easement shall extend 10 feet beyond all side of fire hydrants. In the event two (2) utility mains share the same easement, the minimum width for the easement shall be 30 feet, and for three (3) pubic utilities the width shall be 40 feet, etc. Water mains shall be in an easement of a width at least two (2) times the depth to the invert. Valves shall be located at each end of the easement in order to isolate that portion of the line if necessary. All easements in residential areas shall be in a dedicated tract with a minimum width of 40 feet.

B. Water main installations shall conform to specifications as described in "Design Criteria for Potable Water Systems" as published by the Colorado Department of Health - Water Quality Control Division. The minimum vertical separation shall be 18 inches (refer to details 200-3A and 200-3B for watermain lowering requirements), and horizontal separation shall be a minimum of 10 feet from the edge of any waterline to any sewer. Location for these water mains shall be 10 feet from the center line on the north or east side of the street.

C. When a water main crosses underneath a stream, irrigation ditch, or storm drainage ditch, casing of the facility is required. The type of the material and class of the pipe shall be determined by the engineer. If steel casing pipe is used, then corrosive protection shall be required based on a recommendation from the soils report. Valves are to be located in such a manner that the water main at such crossings can be completely isolated. The casing shall extend to a minimum of 40 feet from the edge of the ditch/bank. Refer to Detail 200-4 for casing requirements.

D. Water mains shall not be installed within five (5) feet of any concrete such as sidewalks, curb, gutter, or cross pans (except for crossings).

203.7 Gate Valves

A. Valves installed in residential distribution systems shall be located in such a manner as to ensure that no more than 600 feet of main or 18 residential units may be out of service for any one (1) single break. Valves installed in commercial and other distribution systems shall be located in such a manner as to ensure that no more than 300 feet of main may be out of service for any one (1) single break.

B. Valve placement shall be such that there are at least two (2) valves at every tee and three (3) valves at every cross. Valves are required between fire hydrants. Valves shall be no further than 1,200 feet apart on transmission mains. The Responsible Party may be required to install a tee and valves on the existing mainline to meet this requirement.

C. When water mains are designed in such a way that a dead end exists at the edge of a subdivision or at the boundary of a filing within a subdivision, the main shall be terminated with a temporary blowoff valve. Where future connections are to be made to temporary dead ends, at least three (3) lengths of pipe are required beyond the valve and before the temporary blowoff valve. For all temporary dead ends the valve shall be restrained back to the mainline or in such a manner as to allow shut-off and connection without impacting the remainder of the distribution system. When a new extension shall connect to an existing main not terminated with a valve, the new main must be valved at the connection in order that the entire, newly constructed system may be pressure tested and chlorinated.

D. The City permits the use of Hydra-Stop, EZ Valve or approved equal for valve installation.

E. Valves larger than 12 inches shall be of butterfly style. Butterfly valve operators shall be located on the north or east side of the water main. Refer to Detail 200-8 for butterfly valve requirements.

F. Whenever possible, water main valves shall be located at a point on the main which is outside of an intersection. Under no circumstances, however, shall a valve be located in concrete areas, such as sidewalks, cross pans, aprons, curbs, or gutters. Any valve located in a green belt area shall have a concrete collar around the valve box as shown in Detail 200-7.

G. All valves shall be installed at a location where they will be accessible by a maintenance vehicle. All access roads shall be designed to carry an H-20 loading, with a maximum grade of seven (7) % and maximum cross slope of four (4) %.

203.8 Blowoff Valves

Blowoff valves are required at the end of water mains which terminate at the subdivision boundary in streets that will be extended at a future date. Blowoffs are also required at low points in waterline less than 12 inches in diameter. Hydrants shall be utilized as blow-offs for lines 12 inches and larger.

203.9 Fire Hydrants

A. The number, location and spacing of fire hydrants shall be determined by the City of Thornton Fire Department in accordance with the City's currently adopted and effective International Fire Code. In cul-de-sacs, hydrants shall be located a minimum 150 feet, and maximum 200 feet from the end of the cul-de-sac. If hydrants are to be installed at locations other than street intersections, they shall be located on lines which are established by extending property lot side lines into the streets. Fire hydrants shall be provided at a spacing not to exceed 1200 feet in areas not requiring fire protection. Fire hydrants shall be located a minimum of five (5) feet from driveways to the center of the hydrant. The fire hydrant shall be located within the ROW and on the same side of the street as the water main. Installation of fences, landscaping or other obstructions shall in no way hinder the operation of the fire hydrant.

B. Fire hydrant branch mains shall be set at 90° to street mains. The maximum length of a fire hydrant branch main shall be 100 feet. The hydrant shall be set at the end of the branch main and shall face the branch main. No horizontal bends or offsets shall be used in installing fire hydrant branch mains. Under no circumstances shall any size or manner of tap be made on a fire hydrant branch main. Hydrants shall be plumbed vertically with the pumper nozzle facing the street and traffic safety flange not less than two (2) inches nor more than three (3) inches above final grade. A six (6) inch gate valve shall be flanged or rodded to the tee on the main in order that the hydrant may be removed from the system for maintenance without affecting the distribution system. No water service main taps shall be made to a distribution main within five (5) feet of a fire hydrant branch main.

203.10 Thrust Block

Bends, tees, plugs, dead ends, wet taps, hydrants, and blowoffs shall be designed and constructed with concrete thrust blocks as set forth in Detail 200-11.

203.11 Pressure Regulating Stations

A. PRV installations are used to control pressures between distribution zones and along transmission mains where pressure fluctuations may occur. When main extension plans are submitted for review, the need for a pressure regulating valve installation shall be determined based on existing pressure zones and the existing distribution system. Plans shall be submitted indicating size, type, and location for the PRV installation. Calculations shall be submitted and approved by the Development Engineering Manager. Shop drawings for the vault and cut sheets for all installed equipment shall be submitted for approval prior to construction. The low flow PRV shall be sized for the max day flow.

B. PRV's shall be located within landscaping or other areas outside of the roadway section as approved by the Development Engineering Manager.

C. Individual PRV installations to bring operating pressures below 100 psi on residential and commercial services shall not be permitted as an alternative to a system PRV.

203.12 Air Release Valves

Air valves shall be installed at each highpoint in all water mains of 12 inch diameter and larger. One (1) inch air valves shall be installed on eight (8) inch mains at high points.

203.13 Water Service Lines

A. Location

1. That portion of the service pipe between the main and the curb stop and/or meter when installed must be in a continuous straight line with no joints and perpendicular with the exception of reducers/expansions, if possible, to the line of the main. A minimum separation of 10 feet is required to any sewer service, and a minimum of five (5) feet to any other water service or fire sprinkler line.

2. Residential meter pits shall be located in a landscaped portion of the right-of-way as per Detail 200-2. Locations for special residential installations, such as multi-family housing and churches, as well as commercial meter locations shall be easily accessible and located within landscaped areas. If, due to limitations, a meter pit needs to be installed elsewhere, Development Engineering will establish the necessary additional measures required. Under no circumstances shall any meter pit/vault be located inside any building, a drainage area, or an area for which access may be difficult such as drive lanes or parking areas.

3. Separate services and meters are required for each single family dwelling (detached/duplex units), multifamily and apartment-style condominium foundation, and commercial/office foundation. All meters utilized for single family applications shall be located in right-of-way or exclusive easements. Accessory dwelling units, which are in compliance with City Code, shall be exempt from the requirements for a separate and independent building sewer and a separate water service connection to the main, with a separate water meter.

4. Separate services are required for each individual townhome-style condominium and townhome.

5. All irrigation connections require a minimum size of a four (4) inch tap, four (4) inch DIP, or C900 PVC service line, and a four (4) inch gate valve with five and one-fourth (5¼) inch valve box placed behind the curb. Refer to Section 800 of these Standards and Specifications for irrigation meter size requirements and details.

B. Meter Sizes

Meter sizes for residential, commercial or industrial use shall be determined by the consulting engineer and calculations submitted to the Building Division for review and approval.
The meter and the tap on the City's main shall be the same size.

203.14 Abandonment

The abandonment of water mainlines shall require physical removal of the abandoned section(s) if required by the Development Engineering Manager, or be filled with flash or flow fill if permitted to be abandoned in place.

204 WATER DISTRIBUTION SYSTEM CONSTRUCTION SPECIFICATIONS

204.1 Materials

Materials furnished shall be new and undamaged. Everything necessary to complete all installations shall be furnished and installed whether shown on approved drawings or not, and all installations shall be completed as fully operational.

Acceptance of materials or the waiving of inspection thereof shall in no way relieve the Responsible Party of the obligation to furnish materials meeting the requirements of these Standards and Specifications.

The City reserves the right to direct or deny use of certain types of materials in specific circumstances. Materials delivered to the job site shall be adequately housed and protected so as to ensure the preservation of their quality and fitness for the work.

A. Ductile Iron Pipe

DIP shall be manufactured in accordance with AWWA Standard C-150 and C-151, "Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-lined Molds for Water or Other Liquids", with the following additional requirements or exceptions:

1. "Push-on single gasket" type conforming with applicable requirements of AWWA Standard C-111, "Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings".

2. The grade of iron shall be 60-42-10 having a minimum tensile strength of 60,000 psi, minimum yield strength of 42,000 psi, and a minimum % of elongation of 10%.

3. Pipe furnished under this specification shall conform to AWWA C-150 and C-151, and have nominal laying lengths of either 18 or 20 feet. Random lengths are not acceptable.

4. Pipe furnished shall have standard thickness cement mortar linings in accordance with AWWA Standard C-104, "Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water", and the exterior coating shall be the standard outside bituminous coating as specified in AWWA C-151.

5. The manufacturer shall furnish a certified statement that the inspection and specified tests have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the Development Engineering Manager upon request.

6. Ductile iron water pipe shall be installed per AWWA C-600.

7. Refer to Detail 200-15 for corrosion protection.

B. Polyvinyl Chloride Pressure Pipe

1. All polyvinyl pipe for water mains 12 inches and less, except that 10 inch diameter is not permitted, shall be manufactured in accordance with AWWA Standard C-900-07, "Polyvinyl Chloride (PVC) Pressure Pipe.", and shall meet the requirements for DR-25 for all distribution mains, and shall meet the requirements of DR-18 for hydrant leads. All PVC pipe larger than 12 inches shall meet C-905-97, and shall be DR-21 or DR-18 as determined by the Development Engineering Manager.

2. Solvent cement joints are strictly prohibited.

3. Each length of pipe shall be a standard laying length of 20 or 12 feet. Random lengths shall only be acceptable at fittings and hydrant branch lines. PVC pipe must be laid with tracer wire (16-gauge wire only).

4. PVC must conform to cast iron outside diameters. Pipe stored outside which may be exposed to sunlight for more than 30 days, shall be covered with an opaque material such as canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering. Sunburned pipe shall not be permitted for installation and shall be removed from the job site immediately. Pipe must be UL approved.

5. The manufacturer shall furnish a certified statement that the inspection and specified tests have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the Development Engineering Manager.

C. Fittings

Cast iron fittings shall be manufactured in accordance with the following AWWA standards: C-104, "Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water," C-150, "Ductile Iron Fittings" and C-111, "Rubber Gasket Joints for Ductile Iron Pressure for Pipe and Fittings," with the following additional requirements or exceptions:

1. Fittings shall be furnished with a cement mortar lining of standard thickness as defined in referenced specifications and given a seal coat of bituminous material.

2. Fittings shall be furnished with mechanical joint, ring tite or flanged ends conforming to referenced specifications and, in addition, the tee-head mechanical joint bolts and hexagon nuts shall be fabricated from a high strength, stainless steel or approved equal. Swivel fittings as approved by the Development Engineering Manager may also be utilized. Under no circumstances shall repair clamps be permitee don new installations.

3. Fittings shall be of the 250 psi pressure rating and shall conform to the dimensions and weights shown in the tables of referenced specifications.

4. The manufacturer shall furnish a certified statement that the inspection and specified tests have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the Development Engineering Manager.

5. Refer to Detail 200-15 for corrosion protection.

D. Gate Valves

Refer to Detail 200-6A and 200-6B for gate valve requirements, and Detail 200-15 for corrosion protection.

E. Valve Boxes

Refer to Detail 200-6B for valve box requirements, and Detail 200-15 for corrosion protection.

F. Butterfly Valves

Refer to Detail 200-8 for butterfly valve requirements.

G. Pressure Reducing and Regulating Valves

1. PRV's shall be Cla-Val 90-01 series or an approved equivalent. The valve shall be designed to reduce a high upstream pressure to a constant downstream pressure by way of a pilot control system. The pilot system shall control the main valve which shall be of the single seated, hydraulically operated, diaphragm, globe valve type. The valve seats shall be stainless steel.

2. Material shall be cast iron for valve body. Flanges and covers shall conform to ASTM Standard Designation A-48. Bronze castings or parts for internal trim shall conform to ASTM Standard B-61.

3. Valves shall be furnished with flanged ends and drilled in accordance with ANSI B-16.1 Class 125 specifications. Flanges shall be machined to a flat face or machined to a flat surface with a serrated finish in accordance with AWWA Standard C-207.

4. The pilot valve for controlling operation of the main valve shall be a single seated, diaphragm operated, spring loaded type. The pilot valve shall be attached to the main valve with piping and isolation valves so arranged for easy access in making adjustments and also for its removal from the main valve while the main valve is under pressure. Pilot control system shall be stainless steel with 316 stainless steel trim.

5. The needle valve shall be bronze and included with the main valve to control the speed of piston travel.

6. The operating pressure shall be 150 psi.

7. The body of the PRV shall be given a hydrostatic test of 50% more than the operating pressure specified herein. A second test to check seating of the cylinder shall be made at the operating pressure.

8. Pressure reducing and regulating valves shall be installed in factory built steel vaults as specified in Detail 200-12. There shall be no dissimilar metals allowed in the piping in the PRV vaults without proper insulation.

9. The manufacturer shall furnish a certified statement that the inspection and specified tests have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the Development Engineering Manager.

10. After approved factory assembly, each valve shall be given the operation and hydrostatic tests in accordance with the referenced specifications.

11. The manufacturer shall furnish a certified statement that the inspection and specified tests have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the Development Engineering Manager.

H. Air Valves

Refer to Details 200-13A and 13B for air valve requirements.

I. Blowoff Assemblies

Refer to Detail 200-9 for blowoff assembly requirements.

J. Vaults

1. Vaults shall be fabricated steel and shall be factory built for underground use as manufactured by Engineered Fluid, Inc., or approved equal. Field welding to complete the structure shall not be allowed.

2. The vault shall have a protective coating for corrosion protection and shall be equipped with packaged magnesium anodes for cathodic protection. The anodes shall be buried equally spaced around the vault and connected by heavy copper wire to bags on the vault provided for that purpose.

3. Vaults shall be designed with wall sleeves and link seal and be capable of handling thrusts caused by operating valves.

4. The designing engineer shall submit shop drawings along with design calculations including the electric layout to the Development Engineering Manager for approval prior to the installation.

K. Thrust Blocks

Refer to Detail 200-11 for thrust block requirements.

L. Concrete

Refer to Section 600 of these Standards and Specifications for all concrete work requirements.

M. Mechanically Restrained Joints

Megalugs, Cam-Lok or approved equal shall be used. Tie rods may be used as approved by the Development Engineering Manager. If tie rods are used, they shall be mild steel, ASTM Standard Designation A-36. Hex nuts shall be ASTM Standard Designation A-307, grade A or B, Hexagon Heavy series. Tie rods shall be used at bends and fittings where thrust blocks cannot be used due to existing field conditions or where harness rods are specifically required by the Development Engineering Manager. Harness rods shall have a bituminous coating for corrosion protection.

N. Fire Hydrants

Refer to Detail 200-10 for fire hydrant requirements.

204.2 Corrosion Protection

DIP, steel pipe, steel casing pipe, harness rods, fittings, valves, and valve boxes shall be protected as specified in Detail 200-15.

204.3 Installation of Pipe

A. Refer to Section 100 for excavation, dewatering, pipe bedding, testing, backfill, and compaction requirements.

B. Pipe shall be installed in accordance with AWWA C-900 along with the following provisions:

1. Pipe and fittings shall be loaded and unloaded by lifting so as to avoid shock or damage. Under no circumstances shall such material be dropped. Before the placing of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of foreign material, kept clean, and examined for cracks or defects before installation. No pipe shall be installed that is damaged by prolonged exposure to the sun or adverse weather conditions.

2. Joint lubricant shall be as supplied by the pipe manufacturer.

3. When laying pipe on curves, the pipe shall be kept in alignment by deflecting joints or using short lengths of pipe. If using deflecting joints, recommended practices and allowances as stipulated by the manufacturer must be adhered to. Pipe shall be laid with the bell ends facing in the direction of laying unless directed otherwise by the Development Engineering Manager.

4. Whenever the pipe is left unattended, temporary plugs shall be installed at openings. Temporary plugs shall be watertight, standard cast iron, and of such design as to prevent children and animals from entering the pipe. Temporary plugs shall be subject to approval by the Development Engineering Manager.

5. Pipe and appurtenant structures shall not be installed upon a foundation into which frost has penetrated or at any time when the Inspector deems there is a danger of ice formation or frost penetration at the bottom of the excavation. Pipe and appurtenant structures shall not be installed unless backfilling can be completed before the formation of ice and frost.

6. Immediately before joining two (2) lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. Caution shall be exercised to ensure that the correct type of gasket is used. A thin film of gasket lubricant shall be applied according to the manufacturer's recommended practices to either the inside face of the gasket or the spigot end of the pipe or both.

7. The spigot end of the pipe shall be placed in the socket with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements. Stabbing shall not be permitted. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to the full depth of the joint.

8. Extra care should be used in handling PVC pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing.

9. Non-disinfected mains which cannot be isolated shall not be connected to an existing, disinfected main. The Responsible Party shall assume any and all responsibility for damage done by heavily chlorinated water entering existing facilities due to negligence on his part. Water mains shall adhere to the following sequence of tests: (1) chlorine, (2) pressure tests, and (3) clearwater test.

204.4 Installation of Valves and Valve Boxes

Refer to Detail 200-6A & 200-6B for installation requirements for valves and valve boxes.

204.5 Testing

Refer to Subsection 206 of these Standards and Specifications.

205 WATER SERVICES AND APPURTENANCES CONSTRUCTION SPECIFICATIONS

205.1 General

Water services construction connecting to the City water system shall be done in accordance with these Standards and Specifications, which shall cover new water services construction from the water main to the meter pit or vault. Refer to Sections 100, 204, and 206 for installation and testing procedures for water services and appurtenances.

205.2 Materials

A. Materials furnished shall be new and undamaged. Everything necessary to complete installations shall be furnished and installed whether shown on the approved drawings or not and installations shall be completed as fully operational.

B. Acceptance of materials or the waiving of inspection thereof shall in no way relieve the Responsible Party of the obligation to furnish materials meeting the requirements of these Standards and Specifications.

C. The City reserves the right to direct or deny use of certain types of materials in specific circumstances.

D. Materials delivered to the job site shall be adequately housed and protected so as to ensure the preservation of their quality and fitness for the work.

E. The minimum size allowable for a water service shall be three-fourths (3/4) inch diameter.

1. Copper Service Pipe - Type "K" only

Type "K" copper shall be used for service lines three-fourths (3/4) inch through three (3) inch diameter. Type “K” copper shall be utilized from the main through the meter pit on residential applications (single family and duplex services). Materials in conformance with the most currently adopted version of the International Plumbing Code (including all adopted amendments) are permitted from the meter to the building for residential applications (single family and duplex services) and from the main to the building for non-residential services.

2. Ductile Iron Service Pipe

DIP shall be used for services larger than three (3) inches.

3. Corporation and Curb Stops

a. A curb stop or valve of the same size as the service pipe and conforming to the following standards shall be installed on every commercial service larger than one (1) inch between the water main and the meter which is at a point at or near the property line.

b. Water service saddles shall be cast bronze with double silicone bronze straps, Type 325 or 327 by Smith-Blair Inc., or an approved equal.

c. Corporation stops shall be AWWA taper thread to copper connection of pack joint and shall be a Ford Type F600 or an approved equal.

d. Curb stops shall be compression to compression connections and shall be Ford Ball Valves, B44-666M (one and one-half (1-1/2) inches) or B44-777M (two (2) inches) or approved equal.

e. Curb stops are set in the service on the inlet side, a minimum of two (2) feet upstream of the vault and provide a means to shut off the service for repairs inside the meter vault.

f. Curb stop service boxes shall be a cast iron box, Minneapolis pattern, extension type. The curb stop box shall be centered over the curb stop valve and in a vertical position. The top lid of the curb stop box shall be installed a maximum of one (1) inch above the final grade.

205.3 Location

Refer to Detail 200-2 for service location requirements.

205.4 Depth

Refer to Detail 200-14 for service depth requirements.

205.5 Connections

Refer to Detail 200-14 for service connection requirements.

205.6 Abandonment

Only one (1) domestic tap is allocated per single family residence. If it is required by the Development Engineering Manager to abandon an existing water tap, it shall be turned off, the connection threads destroyed, and disconnected at the main. City shall inspect disconnection prior to backfilling. If the City does not inspect prior to backfilling the contractor will be required to re-excavate affected area for inspection. A compression fitting shall be utilized if necessary to relocate a meter pit from a driveway area, only if the installation of a new service line would require the cutting and patching of asphaltic concrete surfacing.

206 WATER MAIN ACCEPTANCE PROCEDURE

206.1 Scope

This procedure is to be followed when releasing a newly installed water main or releasing a repaired pre-existing water main. It covers disinfection, bacteriological sampling, and reporting of results.

206.2 New Mains

Installation shall be in accordance with established AWWA standards (AWWA C-600 or C-603) with particular attention paid to the provision for cleanliness within the pipe itself. Flushing and disinfection shall be performed by the Responsible Party in accordance with AWWA Standard C-601 (more detailed instructions shall be found below). Sampling (bacteriological and chlorine residual) shall be performed by personnel from the Thornton Water Quality Control Laboratory. Chlorine residual analysis shall be performed using accepted test procedures in Standard Methods for the Examination of Water and Wastewater's most recent edition. Bacteriological testing shall be performed by personnel from the Thornton Water Quality Control Laboratory. The release form shall be initiated by personnel from the Thornton Water Quality Control Laboratory with copies to Tri-County Health Department and the Colorado Department of Health (with the Water Quality Control Laboratory being responsible for forwarding copies to the health departments and being responsible for notifying the Responsible Party).

206.3 Repaired Mains

After a main has been repaired and flushed, personnel from the Thornton Water Quality Control Laboratory or Operations Department shall inspect the water for color, turbidity, and chlorine residual, prior to restoring the repaired main into service.

206.4 Disinfection

Disinfection shall be accomplished using tablet form Hypochlorite. These shall be affixed to the inside (top) with an approved food grade adhesive such as Permatex Form-A-Gasket No. 2 and Permatex Clear RTV silicone adhesive sealant, or approved equivalent. Dosage shall be calculated for a 100 mg/liter chlorine concentration for volume of installed pipe (this is to allow for the refilling of pre-existing pipe attached to the installed sections). For calculating the weight of chlorine required, see Table 200-2. The chlorine solution shall remain in contact with the piping for a minimum of 24 hours.

TABLE 200-1

MINIMUM NUMBER OF HYPOCHLORITE TABLETS
OF 7 GRAM STRENGTH (5 GRAMS AVAILABLE CHLORINE) FOR A DOSE OF 100 MG/L

Length of Section (feet)	Diameter of Pipe (inches)									
	4	6	8	12	16	18	20	24	30	36
13	1	2	3	6	11	13	16	24	36	52
18	1	2	3	8	15	18	23	32	50	72
20	1	3	4	9	16	20	25	36	56	80
30	2	2	6	14	24	30	37	54	83	120
40	2	5	8	18	32	40	50	71	111	160

206.5 Flushing

After chlorination or disinfection of the pipeline, flushing shall commence to remove the chlorine solution. Flushing shall continue for a minimum of five (5) minutes beyond the time when chlorine residual is present at the same levels as normal distribution system residuals.

206.6 Fire Sprinkler Main Testing

Fire sprinkler system water mains (from the water supply to the system riser) and lead-in connections to sprinkler system risers shall be completely flushed before connection is made to sprinkler piping. The flushing operation shall be continued for a sufficient time to ensure thorough cleaning. The minimum rate of flow shall be not less than one of the following:

A. The hydraulically calculated water demand rate of the system including any hose requirements;

B. That flow necessary to provide a velocity of 10 ft/sec (see Table 200-3);

C. The maximum flow rate available to the system under fire conditions.

TABLE 200-2

FLOW REQUIRED TO PRODUCE A VELOCITY OF 10 FT/S (3 M/S) IN PIPES

Pipe Size Inches	Flow Rate Gpm
4	390
6	880
8	1560
10	2440
12	3520

206.7 Hydrostatic Testing

A. No hydrostatic tests shall be made on any portion of the pipeline until field placed concrete has had adequate curing time as defined for thrust blocks in Detail 200-11 and compaction test results have been submitted to and approved by the Development Engineering Manager. Only potable water may be used in testing procedures.

B. The pipeline shall be tested in accordance with AWWA C-600 or C-900 except as follows:

C. The pipeline shall be tested with water at a pressure of 150 psi or 50 psi above working pressure, whichever is greater.

D. The Development Engineering Manager shall be notified 24 hours in advance of testing. Acceptance testing shall be made in the presence of the Development Engineering Manager only after the pipeline is in a state of readiness for testing.

E. Air in the line shall be properly purged. Where blowoffs or hydrants are not available or effective in purging air from the line, the Development Engineering Manager may require a tap to purge the line. The location and size of the tap shall be at the Development Engineering Manager's discretion. The cost for such a tap shall be borne by the Responsible Party.

F. No leakage is allowed through the bonnet of the line valve. Any valve leaking through the bonnet shall be removed and replaced.

G. The pressure test shall be a two (2) hour test taken at the high point in the line. Every time the water line pressure drops five (5) psi, the pump shall be started to bring the line pressure back to the initial pressure.

H. PVC or DIP shall be considered to have passed the pressure test when the total leakage in (24) hours is less than 11.5 gallons per inch of inside diameter per mile of pipeline. The Development Engineering Manager shall direct the Responsible Party to repair specific leaks regardless of test results, if in his opinion they are serious enough to endanger the future service of the pipeline. Pipelines shall be tested in sections as rapidly as such section may be isolated. Should any leakage of the pipeline become apparent during the one (1) year warranty period, the City shall perform the necessary repairs. The Responsible Party shall be invoiced for all work performed during the one (1) year warranty period. Blowoffs, pressurizing pump, corporation stops, and water measuring apparatus shall be provided by the Responsible Party, or at his expense. At the Development Engineering Manager's discretion, measuring apparatus may be required to be calibrated by Thornton personnel at the Responsible Party expense.

I. The City shall not be held responsible for water tightness of its valves on existing facilities. If existing valves leak, the City shall assist in reducing the influx of water, but the Responsible Party must use methods at his own disposal to work with the resulting leakage.

TABLE 200-3

MAXIMUM PERMISSIBLE LEAKAGE LOSS
FROM WATER MAINS

(Adapted from AWWA C-601 – Formula – Permissible Leakage Loss = 11.5 gal/Inch Dia/Mile/24 hrs)

Pipe Size	6	inch			
Length	**Time (hours)**				
(feet)	**1/2**	**1**	**1 1/2**	**2**	**24**
50	0.01	0.03	0.04	0.05	0.65
100	0.03	0.05	0.08	0.11	1.31
200	0.05	0.11	0.16	0.22	2.61
300	0.08	0.16	0.25	0.33	3.92
400	0.11	0.22	0.33	0.44	5.23
500	0.14	0.27	0.41	0.54	6.53
600	0.16	0.33	0.49	0.65	7.84
700	0.19	0.38	0.57	0.76	9.15
800	0.22	0.44	0.65	0.87	10.45
900	0.25	0.49	0.74	0.98	11.76
1000	0.27	0.54	0.82	1.09	13.07

Pipe Size	8	inch			
Length	**Time (hours)**				
(feet)	**1/2**	**1**	**1 1/2**	**2**	**24**
50	0.02	0.04	0.05	0.07	0.87
100	0.04	0.07	0.11	0.15	1.74
200	0.07	0.15	0.22	0.29	3.48
300	0.11	0.22	0.33	0.44	5.23
400	0.15	0.29	0.44	0.58	6.97
500	0.18	0.36	0.54	0.73	8.71
600	0.22	0.44	0.65	0.87	10.45
700	0.25	0.51	0.76	1.02	12.20
800	0.29	0.58	0.87	1.16	13.94
900	0.33	0.65	0.98	1.31	15.68
1000	0.36	0.73	1.09	1.45	17.42

Pipe Size	12	inch			
Length	**Time (hours)**				
(feet)	**1/2**	**1**	**1 1/2**	**2**	**24**
50	0.03	0.05	0.08	0.11	1.31
100	0.05	0.11	0.16	0.22	2.61
200	0.11	0.22	0.33	0.44	5.23
300	0.16	0.33	0.49	0.65	7.84
400	0.22	0.44	0.65	0.87	10.45
500	0.27	0.54	0.82	1.09	13.07
600	0.33	0.65	0.98	1.31	15.68
700	0.38	0.76	1.14	1.52	18.30
800	0.44	0.87	1.31	1.74	20.91
900	0.49	0.98	1.47	1.96	23.52
1000	0.54	1.09	1.63	2.18	26.14

Pipe Size	16	inch			
Length	**Time (hours)**				
(feet)	**1/2**	**1**	**1 1/2**	**2**	**24**
50	0.04	0.07	0.11	0.15	1.74
100	0.07	0.15	0.22	0.29	3.48
200	0.15	0.29	0.44	0.58	6.97
300	0.22	0.44	0.65	0.87	10.45
400	0.29	0.58	0.87	1.16	13.94
500	0.36	0.73	1.09	1.45	17.42
600	0.44	0.87	1.31	1.74	20.91
700	0.51	1.02	1.52	2.03	24.39
800	0.58	1.16	1.74	2.32	27.88
900	0.65	1.31	1.96	2.61	31.36
1000	0.73	1.45	2.18	2.90	34.85

206.8 Bacteriological Sampling

24 hours after flushing, personnel from the City shall sample fire hydrants, fire lines, and blowoffs for bacteriological contamination. A minimum of two (2) samples shall be analyzed. Samples shall be collected in duplicate, that is, two (2) samples from each hydrant tested. . If the samples show no bacteriological growth and are free from excessive turbidity, the Thornton Water Quality Control Laboratory shall release the main for service and shall initiate the required forms. If samples do not warrant approval for main release from the Thornton Water Quality Control Laboratory, lines must be re-flushed. If again, samples do not warrant approval for main release after flushing, re-chlorination shall be required.

207 WATER METER INSTALLATION STANDARD SPECIFICATIONS

207.1 General Information

A. Jumper Pipes

Jumper pipes are permitted during the construction phase for the purpose of checking the water service and interior plumbing for leaks. The jumper pipe is to be removed from the water meter yoke prior to the request for inspection.

B. Meter Setting Requirements

Prior to a meter setting:

1. Rough plumbing is required to be installed, and required backflow prevention devices and all other plumbing inspections shall be inspected and passed by the City.

2. Grading is required to be completed.

3 All development fees shall be paid to the City's Finance Department.

C. Water Meters

Water meters, regardless of size, connected to the City's utility system, shall be purchased from and remain the property of the City. Under no circumstances shall anyone other than City personnel remove a water meter once the pit or vault has been inspected and approved.

D. Special Meter Installations

For any installation where special or unusual conditions might exist, detailed drawings, accompanied by a letter of explanation, shall be submitted to the City for approval.

E. Water Meters Over Four (4) Inches in Size

For any water meter installation over four (4) inches in size, detailed drawings of the proposed installation shall be submitted to the Development Engineering Manager for approval prior to any construction.

F. Easements

The City shall be provided easements for water meter installations if required. The width of easements shall be determined dependant upon the circumstances (i.e., line depth).

G. Electrical Wiring

There shall be no electrical wiring allowed in any water meter pit or vault with the exception of remote wiring.

H. Tagging

At the time of final building inspection approval, the meter pit/vault shall be tagged in the off position. The tag shall be removed by the City after the meter is set. It is unlawful for unauthorized individuals to remove the tag.

207.2 Meter Installations:

A. 5/8-inch, 3/4-inch, and 1-inch Water Meter Vaults

Water meter vaults for five-eighths (5/8) inch x three-fourths (3/4) inch, three-fourths (3/4) inch x three-fourths (3/4) inch, one (1) inch water meter installations shall be as shown on Detail 200-16.
The design of this vault must be submitted by a registered PE to the Development Engineering Manager.

B. 1-1/2-inch and 2-inch Water Meter Vaults

Water meter vaults for one and one-half (1½) inch and two (2) inch water meter installations shall be as shown on detail drawings 200-17A, 200-17B, and 17C. The design of this vault must be submitted by a registered PE to the Development Engineering Manager.

C. 3-inch and 4-inch Water Meter Vaults

Water meter vaults for three (3) inch and four (4) inch water meter installations shall be as shown on Details 200-18A and 200-18B. The design of the vault must be submitted by a Colorado registered PE to the Development Engineering Manager.

D. Galvanized Pipe

Galvanized pipe and fittings are specifically prohibited.

207.3 Commercial Meter Release Policy

The following procedure shall be adhered to for the installation of commercial meters:

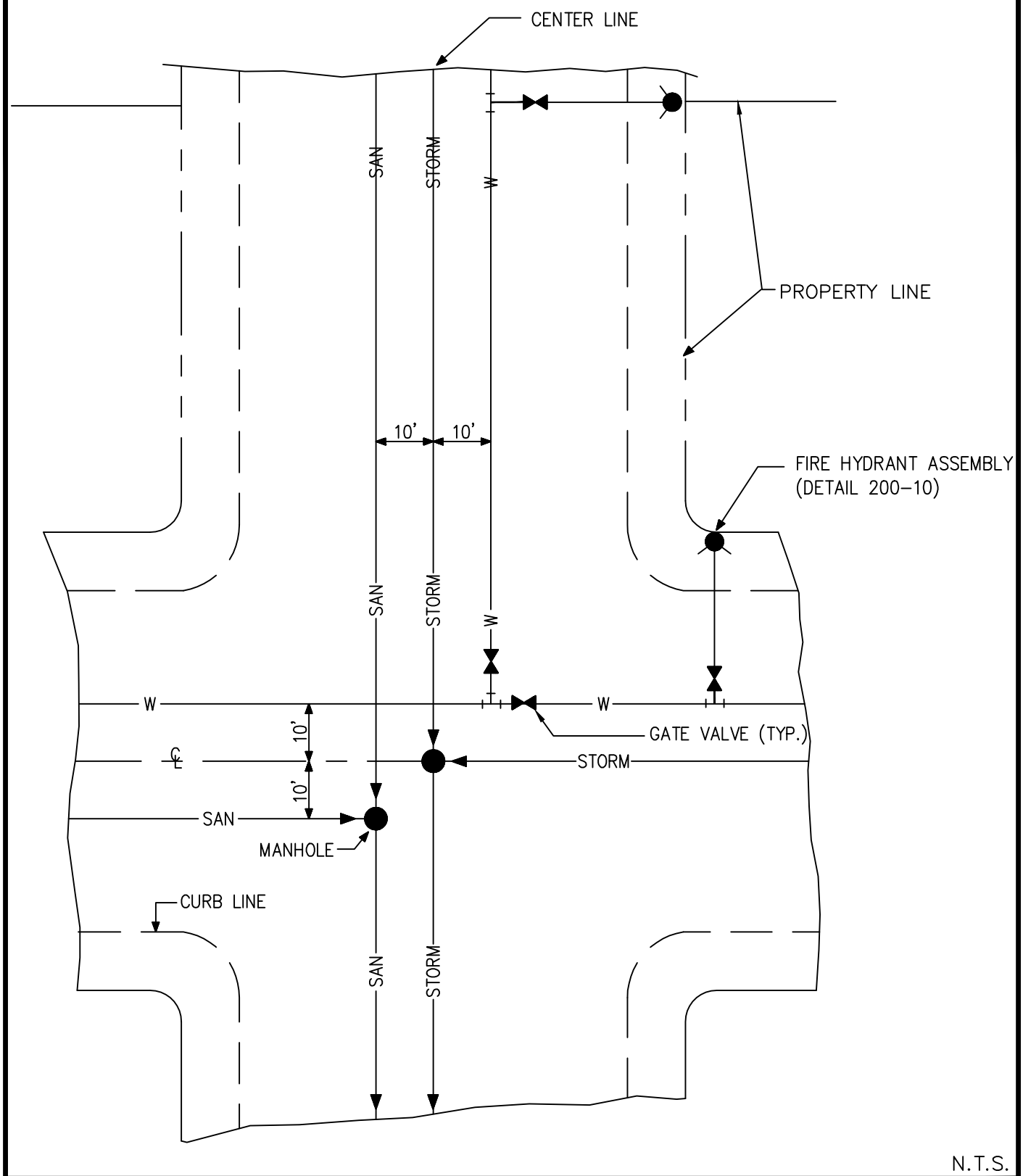
A. The City shall inspect all meter installations.

B. The City may conduct a general courtesy inspection of the meter pit/vault prior to the issuance of the meter to assure that facilities conform to their specifications.

C. The City shall conduct cross connection inspections through the Building Division prior to any meter being set.

D. If the meter pit or vault passes an inspection, the meter shall be set. If the meter vault fails inspection, the installation shall be tagged with a rejection tag with discrepancies noted on the back of the tag as well as time and date of inspection.

E. All meters will be installed by the City with the exception of meters three (3) inches and larger which are required to be installed by a licensed plumber.



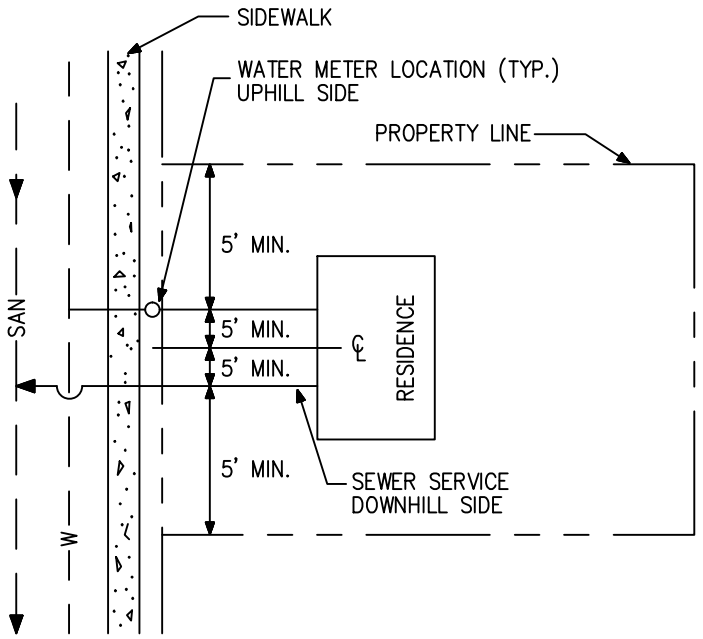
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL UTILITY LAYOUT DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-1



TYPICAL HOUSE SERVICE

ALSO REFER TO DETAIL 200-16

SEWER AND WATER SERVICES SHALL BE A MINIMUM OF TEN (10) FEET APART HORIZONTALLY.

SANITARY SEWER SERVICES SHALL BE CONSTRUCTED ON THE SHORTEST AND STRAIGHTEST ROUTE POSSIBLE. NO MORE THAN TWO 1/4 BENDS SHALL BE PERMITTED IN A SANITARY SEWER SERVICE.

SERVICES SHALL NOT BE ANY CLOSER THAN FIVE (5) FEET TO THE SIDE PROPERTY (EXCEPT ON CUL-DE-SACS), AND NO SERVICE MAY BE CONSTRUCTED THROUGH OR IN FRONT OF ANY ADJOINING PROPERTY.

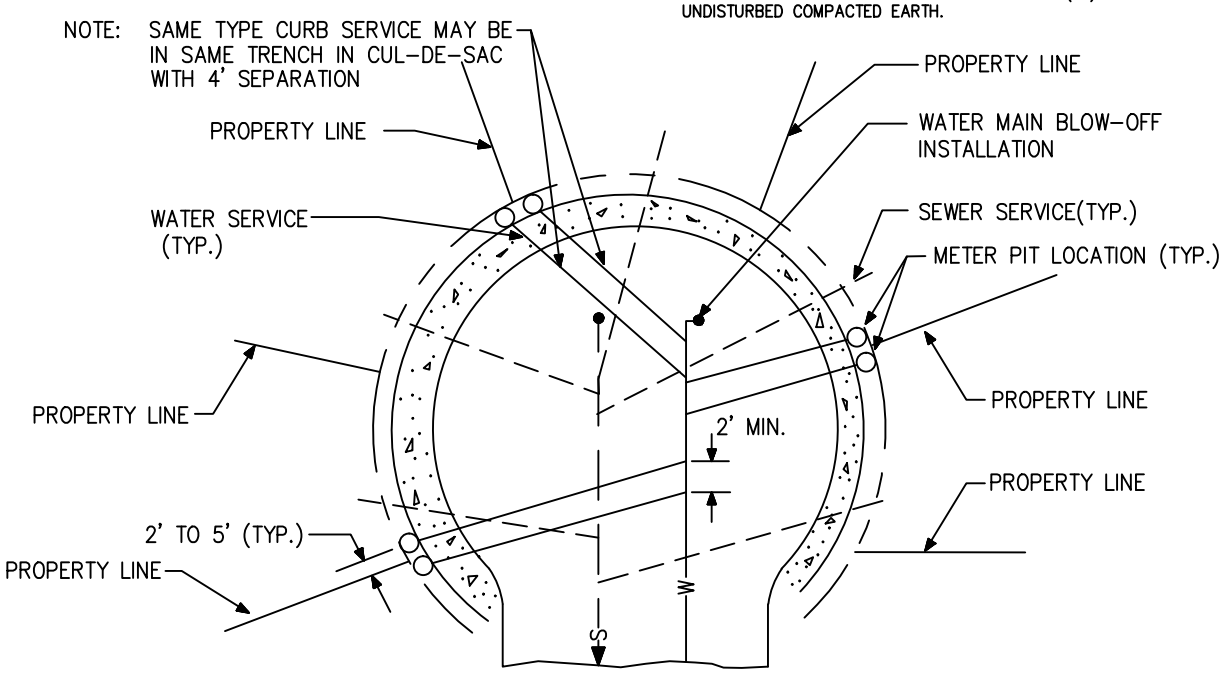
IF SERVICE IS REQUESTED FOR A LOT AT THE END OF A CUL-DE-SAC STREET, THE MAIN TO BE TAPPED MUST NOT BE MORE THAN TWENTY-FIVE (25) FEET FROM THE CURB LINE OR THE PROPOSED CURB LINE AT THE END OF THE CUL-DE-SAC. THE SERVICE PIPE BETWEEN THE MAIN AND THE PROPERTY LINE IN CUL-DE-SACS SHALL BE IN A CONTINUOUS STRAIGHT LINE AND SHALL ENTER THE PROPERTY A DISTANCE OF TWO (2) FEET TO FIVE (5) FEET FROM THE NEAREST LOT CORNER.

WATER SERVICE LOCATIONS SHALL BE MARKED WITH A "V" ON THE CURB. SANITARY SEWER SERVICE LOCATIONS SHALL BE MARKED WITH AN "X" ON THE CURB. MARKINGS SHALL BE NEATLY STAMPED, CHISELED OR SAWCUT, NOT PAINTED.

THAT PORTION OF THE SERVICE PIPE BETWEEN THE MAIN AND THE CURB STOP AND/OR METER WHEN INSTALLED MUST BE IN A CONTINUOUS STRAIGHT LINE, WITH NO JOINTS, EXCEPT REDUCTIONS AND ENLARGEMENTS, AND PERPENDICULAR, IF POSSIBLE, TO THE LINE OF THE MAIN. SERVICES STUBBED INTO THE PROPERTY LINE SHALL BE OF SUFFICIENT LENGTH TO ALLOW DIRECT CONNECTION TO THE METER YOKE.

THE MAIN TO BE TAPPED MUST EXTEND ALONG THE ENTIRE LENGTH OF THE FRONT LOT LINE OF THE PROPERTY TO BE SERVED.

EXCEPT AS HEREINAFTER PROVIDED, SERVICE PIPE SHALL NOT BE INSTALLED IN A TRENCH CONTAINING OTHER CONDUITS WHICH CONVEY ANY SUBSTANCE OTHER THAN POTABLE WATER. THE TRENCH CONTAINING THE SERVICE PIPE SHALL BE SEPARATED LATERALLY FROM TRENCHES CONTAINING OTHER CONDUITS BY AT LEAST TEN (10) FEET OF UNDISTURBED COMPACTED EARTH.



TYPICAL HOUSE SERVICE CONNECTION IN CUL-DE-SACS

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SERVICE DETAIL

ISSUED:
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REVISED:
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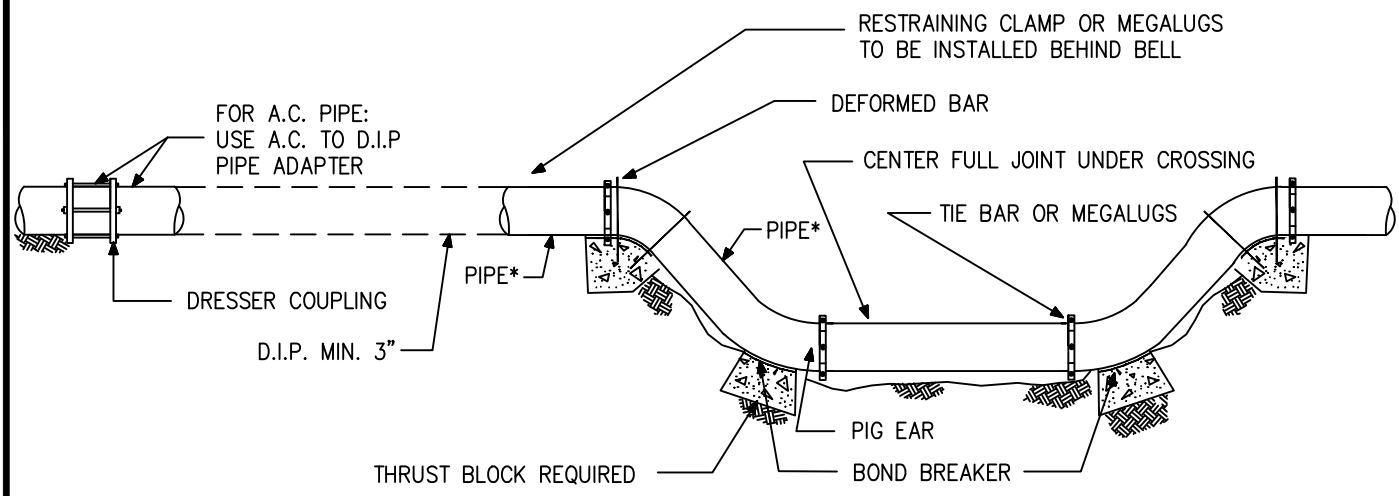
DRAWING NO.
200-2

WATERMAIN LOWERING



PIPE* : D.I.P. OR PVC C-900 DR-14

DIP, STEEL PIPE, HARNESS RODS, STEEL CASING PIPE, FITTINGS, VALVES, AND VALVE BOXES SHALL BE HAND WRAPPED USING POLYETHYLENE WITH A MIN. THICKNESS OF EIGHT (8) MILS AND TWO (2) INCH WIDE, TEN (10) MIL THICK POLYETHYLENE PRESSURE SENSITIVE TAPE TO CLOSE SEAMS OR HOLD OVERLAPS. THE POLYETHYLENE SHALL BE APPLIED TO PREVENT THE CONTACT OF BACKFILL MATERIAL WITH THE FITTING. THE RAW MATERIAL USED TO MANUFACTURE POLYETHYLENE FILM SHALL BE TYPE 1, CLASS A, GRADE E-1 IN ACCORDANCE WITH ASTM STANDARD DESIGNATION D-1248. POLYETHYLENE ENCASEMENT MATERIAL SHALL BE MANUFACTURED IN ACCORDANCE WITH AWWA STANDARD C-105.

BITUMINOUS MATERIAL IS TO BE USED FOR CORROSION PROTECTION ON ALL STEEL CASING PIPES. INSTALLATION SHALL BE IN ACCORDANCE WITH ESTABLISHED AWWA STANDARDS (AWWA C-600 OR C-603).

PIPE SHALL BE INSTALLED IN ACCORDANCE WITH AWWA C-900. BEFORE THE PLACING OF PIPE IN THE TRENCH, EACH PIPE OR FITTING SHALL BE THOROUGHLY CLEANED OF FOREIGN MATERIAL, KEPT CLEAN AND EXAMINED FOR CRACKS OR DEFECTS BEFORE INSTALLATION. THE DEVELOPMENT ENGINEERING MANAGER MAY REJECT ANY PIPE WHICH SHOWS DISCOLORATION DUE TO THE SUN.

JOINT LUBRICANT SHALL BE SUPPLIED BY THE PIPE MANUFACTURER.

WHEN LAYING PIPE ON CURVES, THE PIPE SHALL BE KEPT IN ALIGNMENT BY DEFLECTING JOINTS OR USING SHORT LENGTHS OF PIPE. IF USING DEFLECTING JOINTS, RECOMMENDED PRACTICES AND ALLOWANCES AS STIPULATED BY THE MANUFACTURER MUST BE ADHERED TO. PIPE SHALL BE LAID WITH THE BELL ENDS FACING IN THE DIRECTION OF LAYING UNLESS DIRECTED OTHERWISE BY THE DEVELOPMENT ENGINEERING MANAGER.

WHENEVER THE PIPE IS LEFT UNATTENDED, TEMPORARY PLUGS SHALL BE INSTALLED AT OPENINGS. TEMPORARY PLUGS SHALL BE WATERTIGHT, STANDARD CAST IRON AND SHALL BE SUBJECT TO APPROVAL BY THE DEVELOPMENT ENGINEERING MANAGER.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

WATERMAIN LOWERING DETAIL

ISSUED:
APRIL 1992
REVISED:
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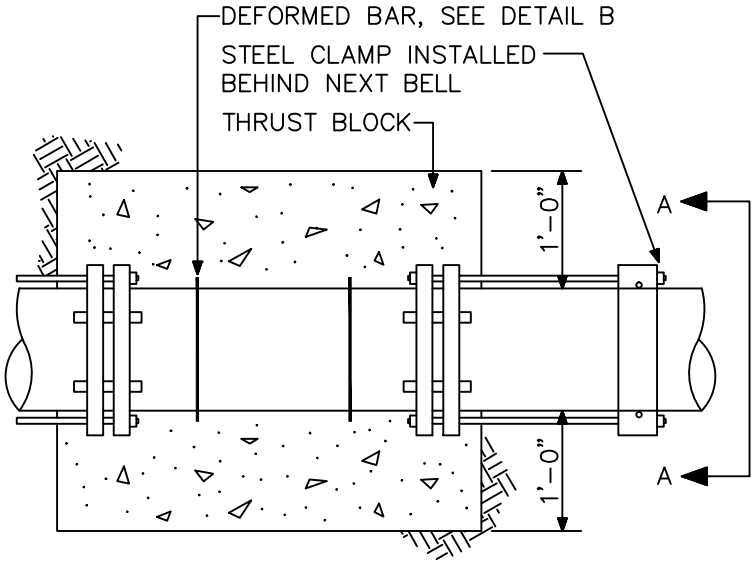
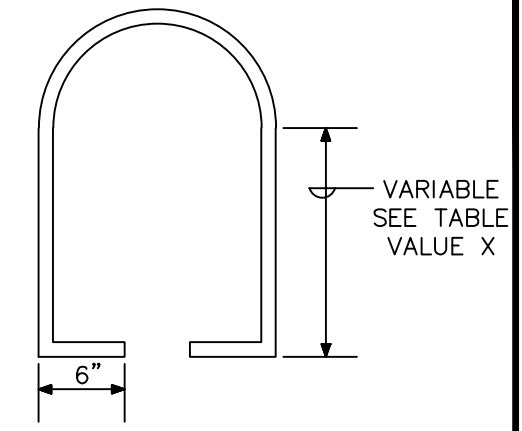
DRAWING NO.
200-3A

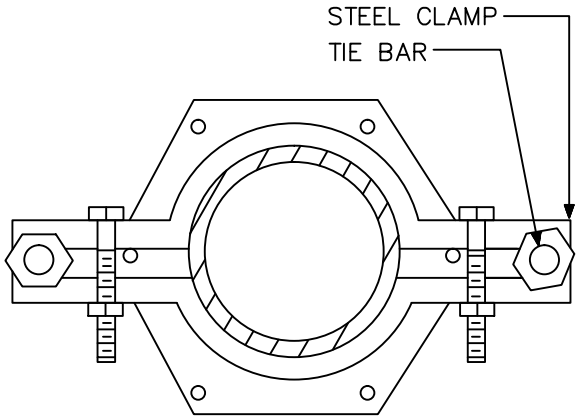


PLAN VIEW A



DETAIL B

MAIN SIZE	DEFORMED BAR		TIE BAR	
	DIA.	X	DIA.	AMOUNT
8"	–	–	.375	2
12"	.500	18"	.500	2
16"	.750	20"	.750	2
24"	1.000	24"	1.000	2



SECTION A–A

NOTES:
1. PIPE USED IN LOWERING SHALL BE DUCTILE IRON PIPE WITH EIGHT (8) MIL POLYWRAP.
2. FITTINGS, PIPES & TIE BARS TO BE WRAPPED SEPARATELY IN POLYETHYLENE.
3. 45° FITTINGS SHALL BE USED.
4. FITTINGS SHALL BE RODDED TO NEXT BELL & NO JOINTS ARE ALLOWED BETWEEN FITTINGS OR UTILIZE MEGALUG CONNECTIONS.
5. FITTINGS SHALL BE M.J.
6. MEGALUG CONNECTIONS OR PIGEARS SHALL BE USED ON RODDING FOR FITTINGS UNLESS OTHERWISE APPROVED BY THE DEVELOPMENT ENGINEERING MANAGER.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

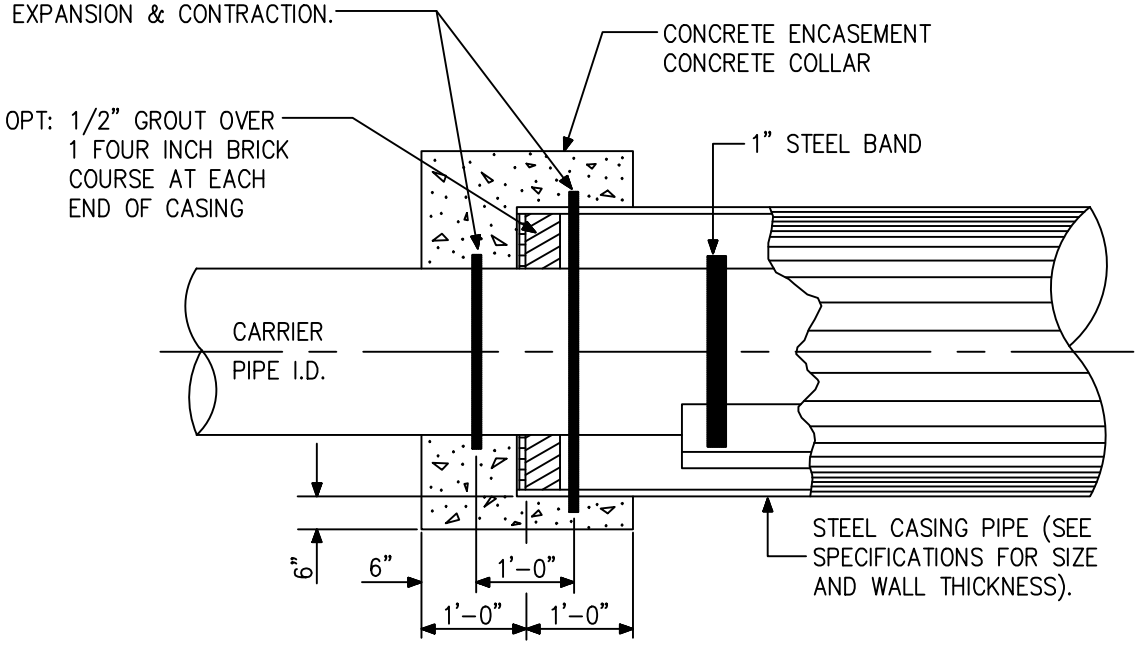
WATERMAIN LOWERING CROSS–SECTION DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

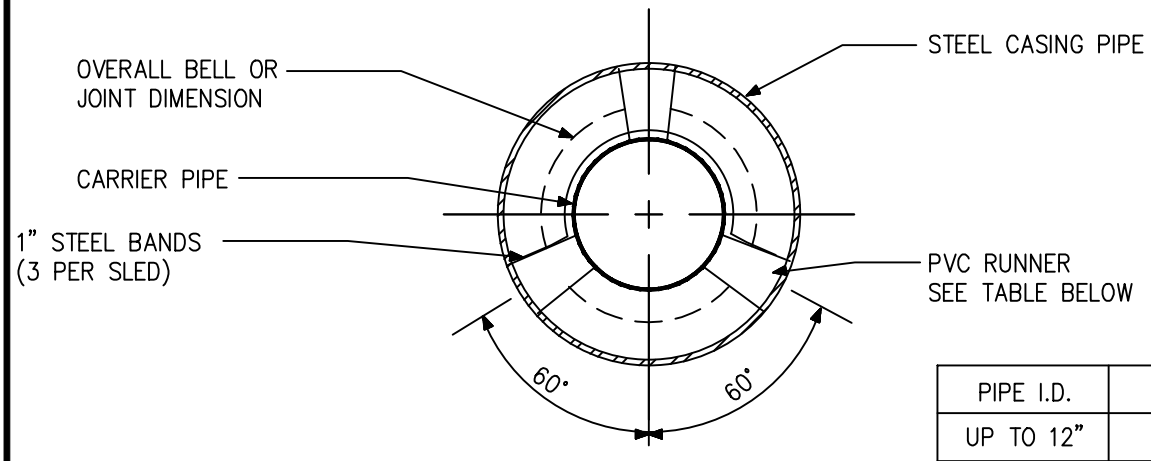
DRAWING NO.
200–3B

SEALING–INSTALL RUBBER O–RINGS OR GASKETS AROUND EACH PIPE (CASING CARRIER) TO PROVIDE CONTINUOUS WATERTIGHT SEAL, TO PREVENT EXPANSION & CONTRACTION.

NOTE:
SLED LENGTHS TO BE 75% OF PIPE LENGTHS.



SLED



PIPE I.D.	RUNNER SIZE
UP TO 12"	4"x 4"
15" – 21"	4"x 4"
24" – 30"	4"x 6"

PIPE CASING DETAIL

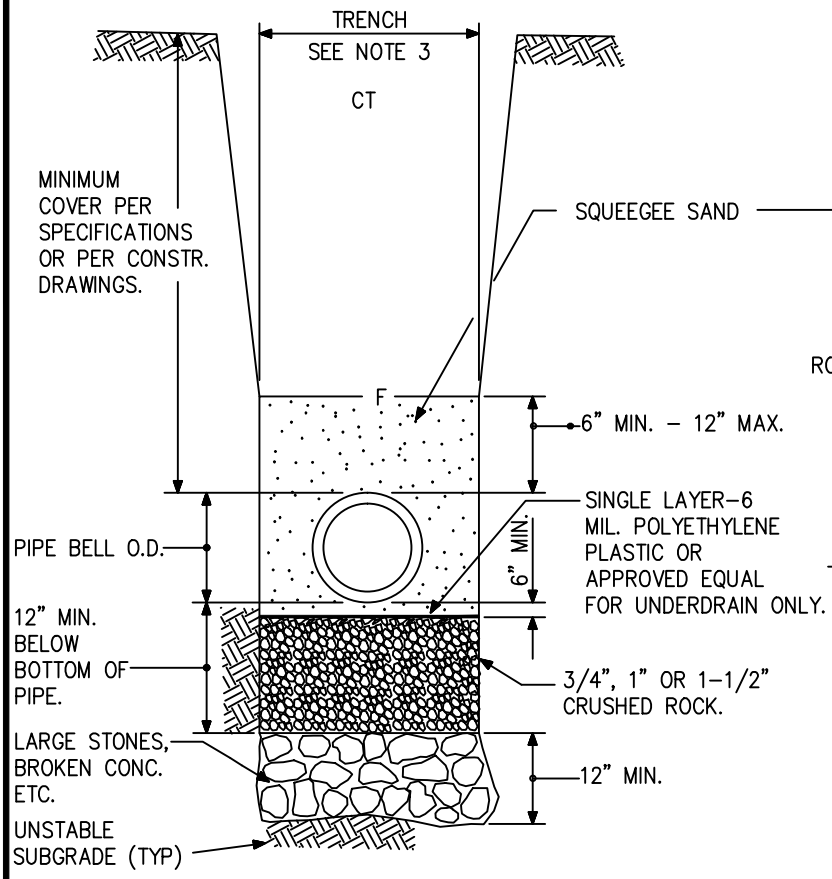
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

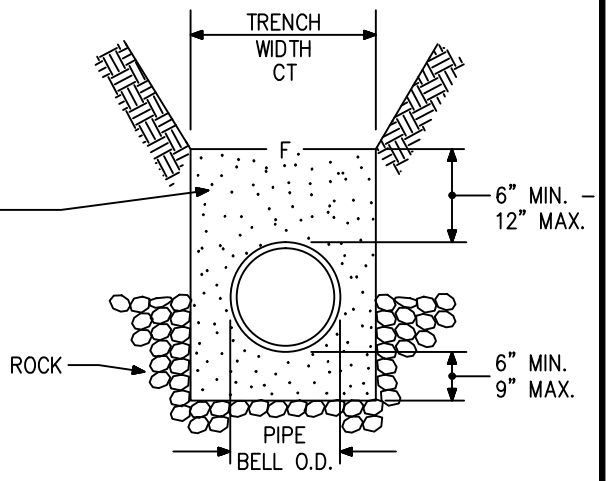
PIPE CASING AND SLED DETAIL

ISSUED:
MARCH 1996
REVISED:
APRIL 2010

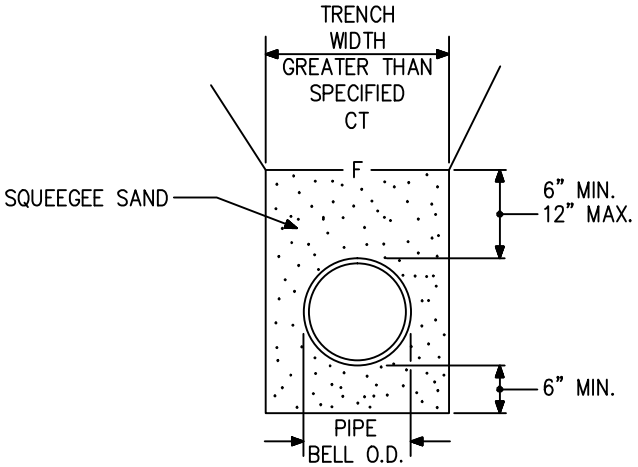
DRAWING NO.
200–4



UNSTABLE SUBGRADE



PIPE BEDDING IN ROCK



TRENCH OVERWIDTH

CT MACHINE COMPACTED TRENCH BACKFILL.

F LIMIT OF SLOPING OR BENCHING OF TRENCH WALLS.

UNDISTURBED GROUND

NOTES:

1. MIN. COVER TO BE BELOW FINAL STREET GRADE WHEN AVAILABLE.
2. TRENCH TO BE BRACED OR SHEETED AS NECESSARY FOR THE PROTECTION OF OTHER UTILITIES AND TO MEET LOCAL, STATE & FEDERAL REQUIREMENTS.
3. TRENCH WIDTH SHALL NOT BE MORE THAN 16 INCHES NOR LESS THAN 12 INCHES WIDER THAN THE LARGEST OUTSIDE DIAMETER OF THE PIPE LAID THEREIN. (BELL OR COUPLING O.D., IF APPLICABLE).

N.T.S.

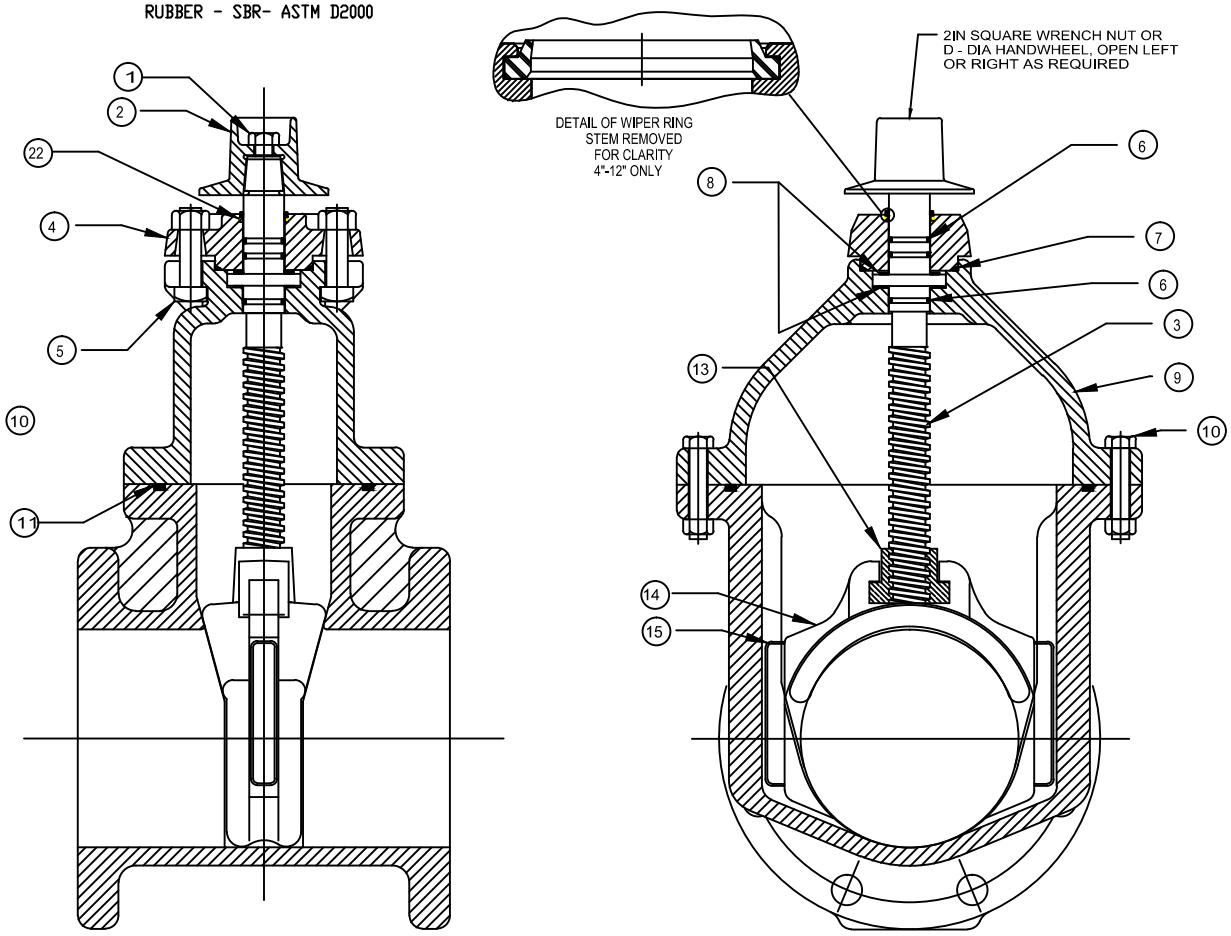
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SPECIAL BEDDING DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200–5

NOTES:
1. RUBBER ENCAPSULATED CAST IRON DISC
   CAST IRON - ASTM A126 CLASS B
   RUBBER - SBR- ASTM D2000



PART LIST					
ITEM	DESCRIPTION	REQ'D	MATERIAL	ASTM	
1	CAP SCREW	1	304 STAINLESS STEEL	A193	GRADE B8
2	WRENCH NUT	1	CAST IRON	A126	CLASS B
3	STEM	1	BRONZE	B138	ALLOY C67600
4	STUFFING BOX	1	CAST IRON	A126	CLASS B
5	STUFFING BOX BOLTS STUFFING BOX NUTS	2	304 STAINLESS STEEL 304 STAINLESS STEEL	A193 F594	GRADE B8 GROUP 1
6	O-RING	3	RUBBER	D2000	NITRILE
7	O-RING	1	RUBBER	D2000	NITRILE
8	ANTI-FRICTION WASHER	2	CELCON		
9	BONNET	1	CAST IRON	A126	CLASS B
10	BONNET BOLTS BONNET NUTS	"Z"	304 STAINLESS STEEL 304 STAINLESS STEEL	A193 F594	GRADE B8 GROUP 1
11	BONNET GASKET (O-RING)	1	RUBBER	D2000	NITRILE
13	DISC NUT	1	BRONZE	B62	ALLOY C83600
14	DISC	1	SEE NOTE 1		
15	GUIDE CAP	2	CELCON		
16	BODY - FLANGE ENDS	1	CAST IRON		CLASS B
17	HANDWHEEL	1	CAST IRON	A126	CLASS B
18	BODY - MJ ENDS	1	CAST IRON	A126	CLASS B
19	BODY - SLIP-ON ENDS	1	CAST IRON	A126	CLASS B
20	BODY - FLANGE x MJ END	1	CAST IRON	A126	CLASS B
21	BODY - FLANGE x SLIP-ON END	1	CAST IRON	A126	CLASS B
22	WIPER RING	1	RUBBER		

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

GATE VALVE DETAIL

ISSUED:
APRIL 2010
REVISED:

DRAWING NO.
200-6A

GATE VALVES

VALVES SHALL BE MANUFACTURED AND TESTED IN ACCORDANCE WITH AWWA STANDARD C-500, "METAL-SEATED GATE VALVES FOR WATER", OR AWWA C-509 "RESILIENT-SEATED GATE VALVES, 3 THROUGH 12 NPS, FOR WATER AND SEWAGE SYSTEMS" WITH THE FOLLOWING ADDITIONAL REQUIREMENTS OR EXCEPTIONS:

VALVES MEETING AWWA STANDARD C-500 SHALL BE OF A MODIFIED WEDGE DISC CONSTRUCTION, COATED BOTH INSIDE AND OUT WITH A TOUGH, DURABLE EPOXY TO PREVENT CORROSION, CAST IRON BODY, FULLY BRONZE MOUNTED WITH NON-RISING STEMS.

VALVES SHALL BE SUITABLE FOR FREQUENT OPERATION, AS WELL AS SERVICE INVOLVING LONG PERIODS OF INACTIVITY. THE OPERATING PRESSURE FOR VALVES SIX (6) INCHES THROUGH TWELVE (12) INCHES SHALL BE 200 PSI.

VALVE STEMS SHALL BE MADE OF BRONZE AND THREADED SO THAT VALVES SHALL OPEN BY TURNING TO THE LEFT (COUNTERCLOCKWISE). EACH VALVE SHALL BE FURNISHED WITH A TWO (2) INCH SQUARE OPERATING NUT. THE OPERATING NUT SHALL HAVE AN ARROW SHOWING THE DIRECTION OF OPENING AND THE WORD "OPEN" CAST ON THE NUT. THE STEM SEAL SHALL CONSIST OF TWO (2) O-RINGS; ONE OR BOTH POSITIONED ABOVE THE THRUST COLLAR WITH THE VALVE UNDER PRESSURE IN THE FULL OPEN POSITION.

BOLTS AND HEX NUTS USED ON THE BONNET OF THE VALVE SHALL BE THE MANUFACTURER'S STANDARD FABRICATED FROM A LOW ALLOY STEEL FOR CORROSION RESISTANCE.

FLANGES SHALL BE SIZED AND DRILLED IN ACCORDANCE WITH ANSI B-16.1 CLASS 125 SPECIFICATIONS. FLANGES SHALL BE MACHINED IN A FLAT FACE OR MACHINED TO A FLAT SURFACE WITH A SERRATED FINISH IN ACCORDANCE WITH AWWA STANDARD C-207 "STEEL PIPE FLANGES."

THE COMPONENTS OF THE MECHANICAL JOINT SHALL CONFORM TO ANSI A-21.11 (AWWA STANDARD C-111). THE TEE-HEAD BOLTS AND HEXAGON NUTS SHALL BE FABRICATED FROM A HIGH STRENGTH, STAINLESS STEEL, OR AN APPROVED EQUAL.

AFTER APPROVED FACTORY ASSEMBLY, EACH VALVE SHALL BE GIVEN THE OPERATION AND HYDROSTATIC TESTS IN ACCORDANCE WITH THE REFERENCED SPECIFICATIONS.

WEDGE DISC VALVES SHALL BE LIMITED TO THE FOLLOWING MANUFACTURERS OR APPROVED EQUIVALENT: WATEROUS SERIES-500, MUELLER-A-2360, KENSEAL, CLOW R/N. RESILIENT-SEATED GATE VALVES SHALL BE LIMITED TO THE AMERICAN-80 "CRS" GATE VALVE OR THE U.S. PIPE "METROSEAL" GATE VALVE.

THE MANUFACTURER SHALL FURNISH A CERTIFIED STATEMENT THAT THE INSPECTION AND SPECIFIED TESTS HAVE BEEN MADE AND THE RESULTS THEREOF COMPLY WITH THE REQUIREMENTS OF THE APPLICABLE STANDARD(S) HEREIN SPECIFIED. A COPY OF THE CERTIFICATION SHALL BE SENT TO THE DEVELOPMENT ENGINEERING MANAGER UPON REQUEST.

CORROSION PROTECTION SHALL BE COVERED IN SUBSECTION 204.2 OF THESE STANDARDS AND SPECIFICATIONS.

VALVES SHALL BE HANDLED IN SUCH A MANNER AS TO PREVENT ANY INJURY OR DAMAGE AND SHALL BE THOROUGHLY CLEANED BEFORE INSTALLATION. VALVES SHALL BE SET IN SUCH A MANNER THAT THE VALVE STEMS ARE PLUMB. VALVES SHALL BE LOCATED AT POINTS AS SPECIFIED IN SUBSECTION 203.8 OF THESE STANDARDS AND SPECIFICATIONS.

VALVE BOXES

VALVE BOX PARTS SHALL BE MANUFACTURED BY TYLER, SERIES 6860 OR AN APPROVED EQUIVALENT MANUFACTURER AND MADE OF GRAY CAST IRON, BUFFALO TYPE WITH NO. 160 OVAL BASE. A FIVE AND ONE-QUARTER (5 ¼) INCH SCREW-TYPE SHAFT SHALL BE ADJUSTABLE FROM 45 INCHES TO 66 INCHES. VALVE BOX LIDS SHALL BE MARKED WITH THE WORD "WATER" AND SHALL HAVE A LIP OR FLANGE EXTENDING INTO THE VALVE BOX SHAFT. NO SLIP-TYPE BOXES SHALL BE ALLOWED. THE VALVE BOX SHALL BE OF A DESIGN WHICH SHALL NOT TRANSMIT SHOCK OR STRESS TO THE VALVE AND SHALL BE CENTERED AND PLUMB OVER THE OPERATING NUT OF THE VALVE WITH THE BOX COVER FLUSH WITH THE SURFACE OF THE PAVEMENT. IN NON-PAVED AREAS, A 24 INCH SQUARE CONCRETE COLLAR IS REQUIRED AROUND VALVE BOX COVER AS PER THE STANDARD DETAIL IN SECTION 200 OF THESE STANDARDS AND SPECIFICATIONS. IN UNIMPROVED ROADWAYS THE VALVE BOX COVER SHALL BE SET SIX (6) INCHES BELOW FINAL GRADE WITH A MARKER POST INDICATING THE LOCATION AS PER THE STANDARD DETAIL DRAWING.

THE MANUFACTURER SHALL FURNISH A CERTIFIED STATEMENT THAT THE INSPECTION AND SPECIFIED TESTS HAVE BEEN MADE AND THE RESULTS THEREOF COMPLY WITH THE REQUIREMENTS OF THE APPLICABLE STANDARD(S) HEREIN SPECIFIED. A COPY OF THE CERTIFICATION SHALL BE SENT TO THE DEVELOPMENT ENGINEERING MANAGER UPON REQUEST.

FOR VALVE BOXES ALONG FIRE SPRINKLER LINES THE LID SHALL BE LABELED “FIRE”.

CORROSION PROTECTION SHALL BE COVERED IN SUBSECTION 204.2 OF THESE STANDARDS AND SPECIFICATIONS.

FINAL ELEVATION OF VALVE BOXES SHALL BE LEFT TO THE DISCRETION OF THE DEVELOPMENT ENGINEERING MANAGER.

VALVE BOXES SHALL BE INSTALLED PLUMB.

VALVE BOXES WHICH HAVE SHIFTED DURING BACKFILL OPERATIONS AND ARE NO LONGER PLUMB, SHALL BE RE-EXCAVATED AND RE-ALIGNED TO THE SATISFACTION OF THE DEVELOPMENT ENGINEERING MANAGER.

FOR GREENBELT AREA APPLICATION, REFER TO DETAIL 200-7

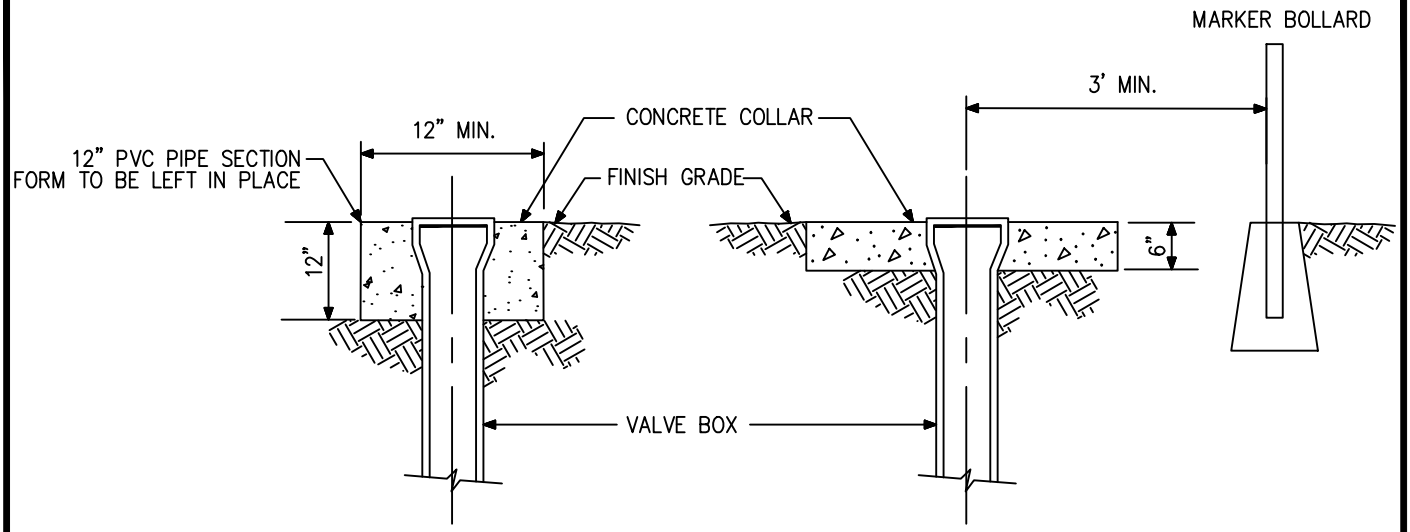
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

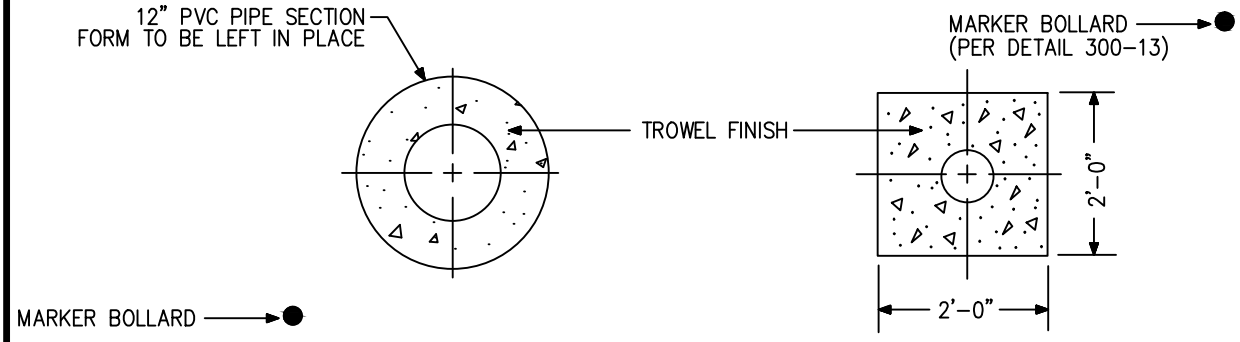
GATE VALVE AND VALVE BOX NOTES

ISSUED:
APRIL 2010
REVISED:

DRAWING NO.
200–6B



SECTION



PLAN

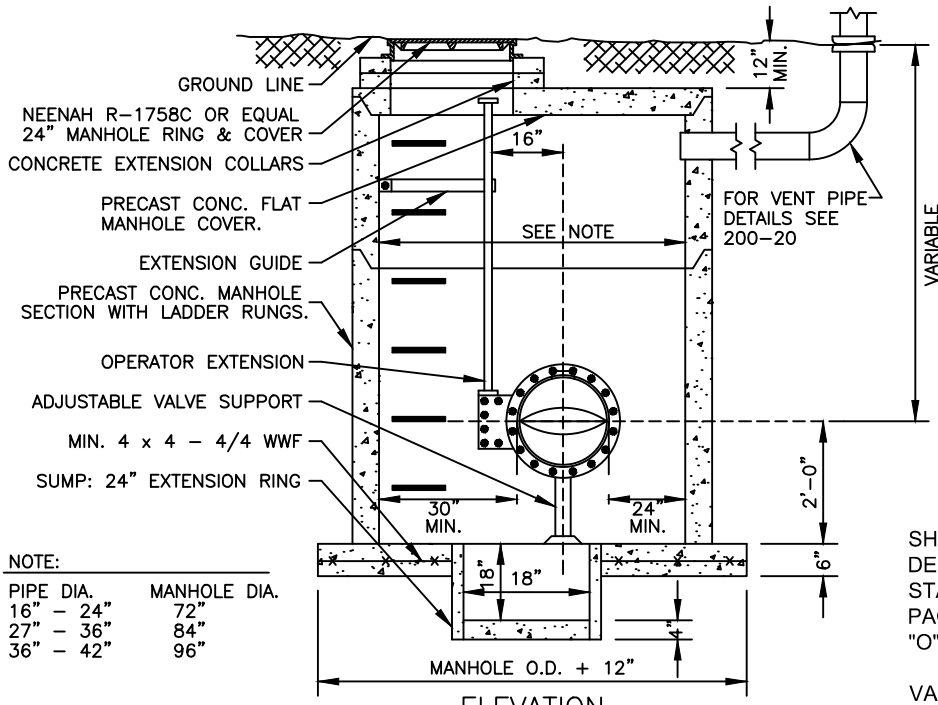
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

VALVE BOX COLLAR FOR GREENBELT AREA DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-7



NOTE:

PIPE DIA.	MANHOLE DIA.
16" - 24"	72"
27" - 36"	84"
36" - 42"	96"

ELEVATION

1.) VALVE OPERATOR SHALL BE ACCESSIBLE THRU MANHOLE OPENING.

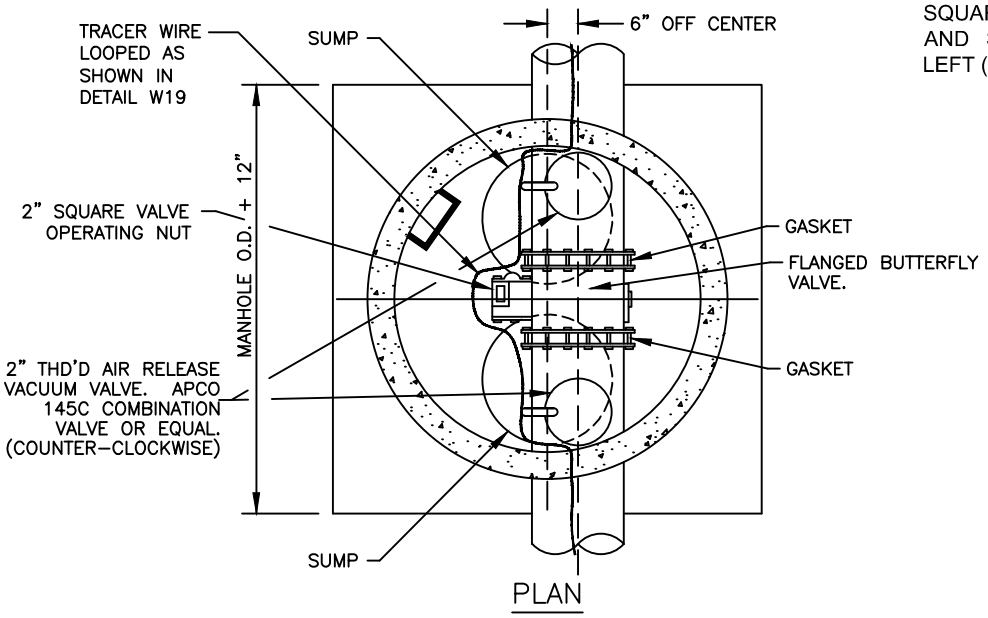
2.) PAD TO REST ON UNDISTURBED SOIL OR 18" OF 1-1/2" FRACTURED ROCK.

3.) SHAFTS SHALL BE A ONE-PIECE UNIT CONSTRUCTED OF STAINLESS STEEL AND SHALL EXTEND COMPLETELY THROUGH THE VALVE DISC BODY.

4.) BUTTERFLY VALVES SHALL BE FURNISHED WITH FLANGED END OR MECHANICAL JOINT CONNECTIONS.

SHAFT SEALS MAY BE DESIGNED FOR THE USE OF STANDARD SPLIT-V TYPE PACKING OR FOR STANDARD "O" RING SEALS.

VALVES SHALL BE FITTED WITH A TWO (2) INCH SQUARE OPERATING NUT AND SHALL OPEN TO THE LEFT (COUNTERCLOCKWISE).



PLAN

NOTE: BUTTERFLY VALVES SHALL BE CLASS 150-B AND CONFORM TO AWWA SPECIFICATION C-504

THE MANUFACTURER SHALL FURNISH A CERTIFIED STATEMENT THAT THE INSPECTION AND SPECIFIED TESTS HAVE BEEN MADE AND THE RESULTS THEREOF COMPLY WITH THE REQUIREMENTS OF THE APPLICABLE STANDARD(S). A COPY OF THE CERTIFICATION SHALL BE SENT TO THE DEVELOPMENT ENGINEERING MANAGER UPON REQUEST.

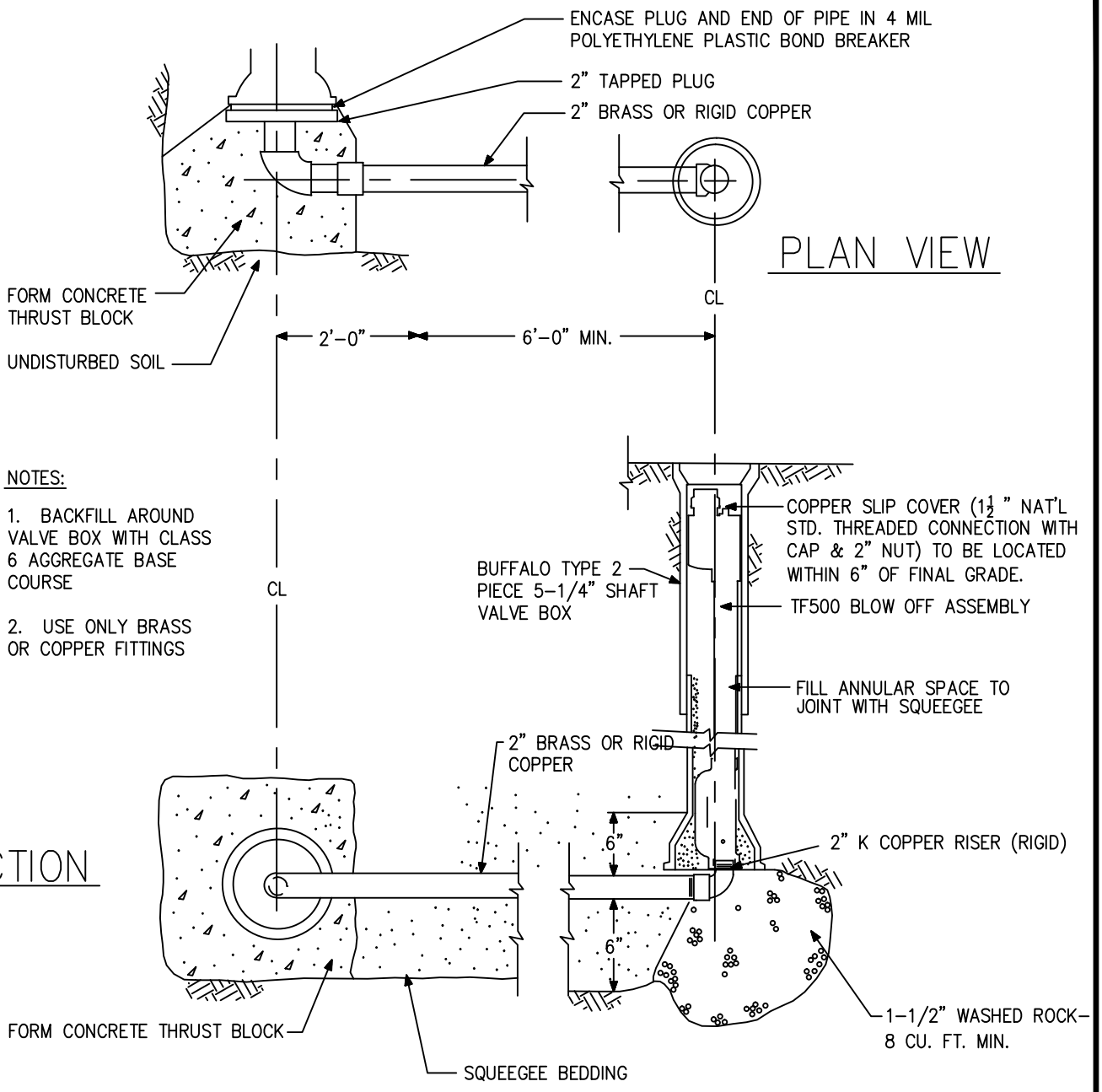
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

16" TO 42" VALVE AND VAULT DETAIL

ISSUED:
JANUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
200-8



VALVES SHALL BE HANDLED IN SUCH A MANNER AS TO PREVENT ANY INJURY OR DAMAGE AND SHALL BE THOROUGHLY CLEANED BEFORE INSTALLATION. VALVES SHALL BE SET IN SUCH A MANNER THAT THE VALVE STEMS ARE PLUMB. VALVE BOXES SHALL BE INSTALLED PLUMB. FINAL ELEVATION OF THE VALVE BOXES SHALL BE LEFT TO THE DISCRETION OF THE DEVELOPMENT ENGINEERING MANAGER.

NOTE: FOR LINES 12" AND LARGER, A HYDRANT SHALL BE USED FOR THE BLOWOFF

N.T.S.

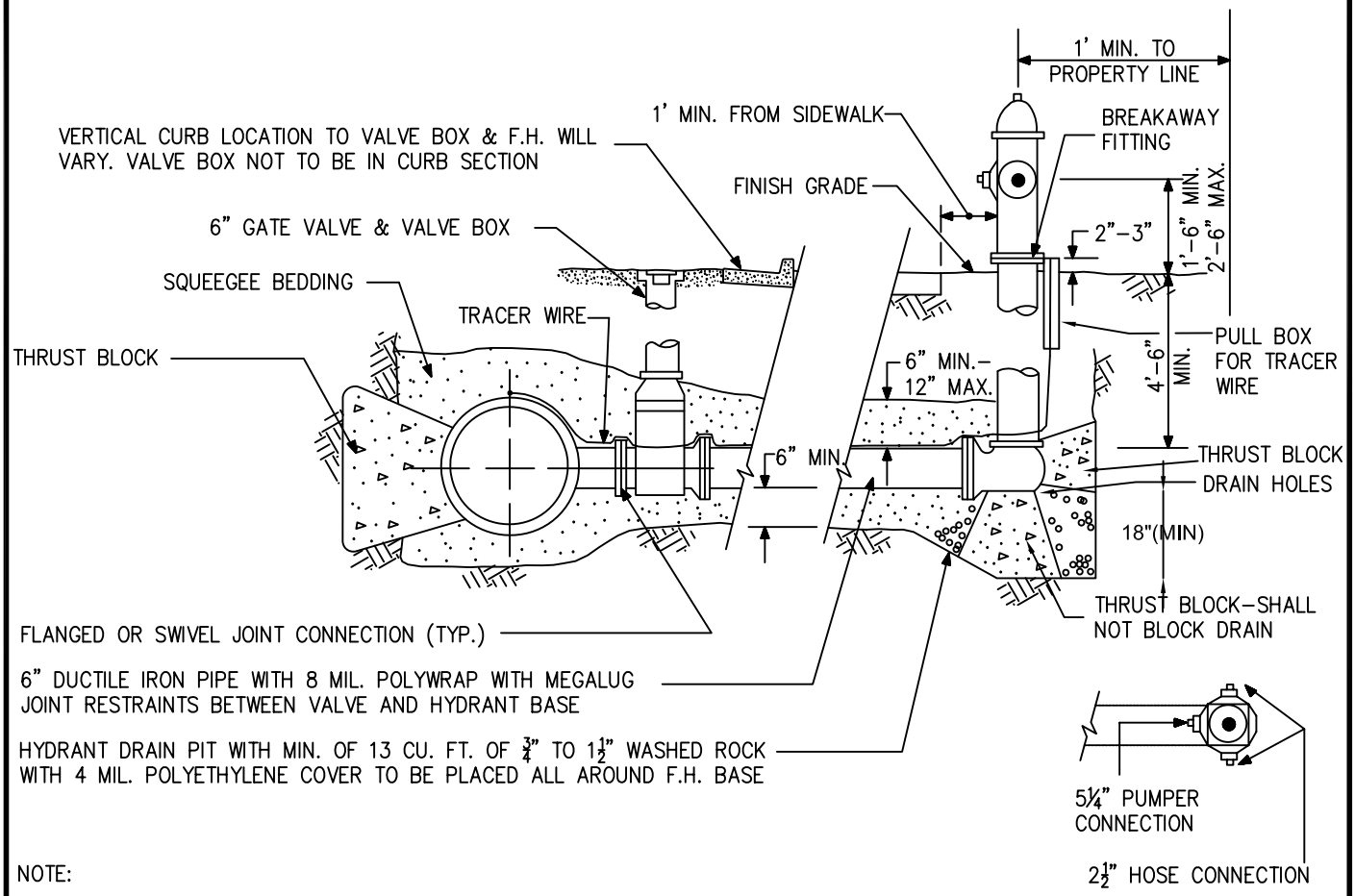
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

2" BLOWOFF DETAIL (FOR MAINS LESS THAN 12" DIA.)

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-9

FIRE HYDRANT ASSEMBLY



NOTE:

FIRE HYDRANTS SHALL BE LIMITED TO THE FOLLOWING MANUFACTURERS ONLY:
1) MUELLER COMPANY 5-1/4 SUPER CENTURION
2) WATEROUS COMPANY (1) MODEL WB-250-PACER

SHOE AND BARREL SHALL BE CONNECTED WITH HIGH STRENGTH STAINLESS BOLTS AND NUTS
HYDRANT SHALL HAVE A FIVE (5') FOOT CLEAR ZONE ON EACH SIDE OF HYDRANT (TEN (10') FOOT EASEMENT AROUND).
MINIMUM DISTANCE FROM DRIVEWAYS SHALL BE SIX (6) FEET.
HYDRANTS SHALL CONFORM TO AND BE TESTED IN ACCORDANCE WITH AWWA SPECIFICATION C-502.
HYDRANTS SHALL BE MADE OF CAST IRON WITH FULL BRONZE MOUNTINGS.
INLET SHALL FIT SIX (6) INCH PIPE WITH BARREL LENGTH SUFFICIENT FOR A FIVE (5) FOOT TRENCH.
ONLY TWO (2) HEIGHT EXTENSIONS MAY BE USED PER HYDRANT.
HYDRANT BASES SHOULD NOT BE ANY DEEPER THAN SIX (6) FEET FROM THE TOP OF FINISHED GRADE.
MAIN VALVE OPENING IN THE HYDRANT SHALL BE NO LESS THAN FIVE (5) INCHES IN DIAMETER.
THREADS ON NOZZLES SHALL BE NATIONAL STANDARD.
OPERATING NUT & NOZZLE COVERS SHALL BE NATIONAL STANDARD PENTAGON MEASURING ONE AND ONE-HALF (1½) INCHES FROM POINT TO OPPOSITE FLAT AND SHALL OPEN CLOCKWISE.
HYDRANTS SHALL BE PLUMBED VERTICALLY WITH PUMPER NOZZLE FACING STREET.
NO WATER SERVICE MAIN TAPS SHALL BE MADE TO A DISTRIBUTION MAIN WITHIN FIVE (5) FEET OF A FIRE HYDRANT BRANCH MAIN.
NO HORIZONTAL BENDS OR OFFSETS SHALL BE USED IN INSTALLING FIRE HYDRANT BRANCH MAINS.

EACH HYDRANT SHALL BE PAINTED WITH OSHA ENAMEL, SAFETY YELLOW, OR AN APPROVED EQUIVALENT.
FIRE HYDRANT ASSEMBLIES SHALL BE MEGALUGGED IN ACCORDANCE WITH SUBSECTION 204.1 (N)

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

FIRE HYDRANT ASSEMBLY DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-10

THRUST BLOCKS SHALL BE CONSTRUCTED AT BENDS AND FITTINGS WHICH RESULT IN UNBALANCED LINE THRUST. CARE SHALL BE TAKEN NOT TO BLOCK OUTLETS OR TO COVER BOLTS, NUTS, CLAMPS OR OTHER FITTINGS OR TO MAKE THEM INACCESSIBLE.

A BOND BREAKER SHALL BE PLACED BETWEEN THE FITTING AND THE THRUST BLOCK TO AID IN EASE OF FUTURE REMOVAL.

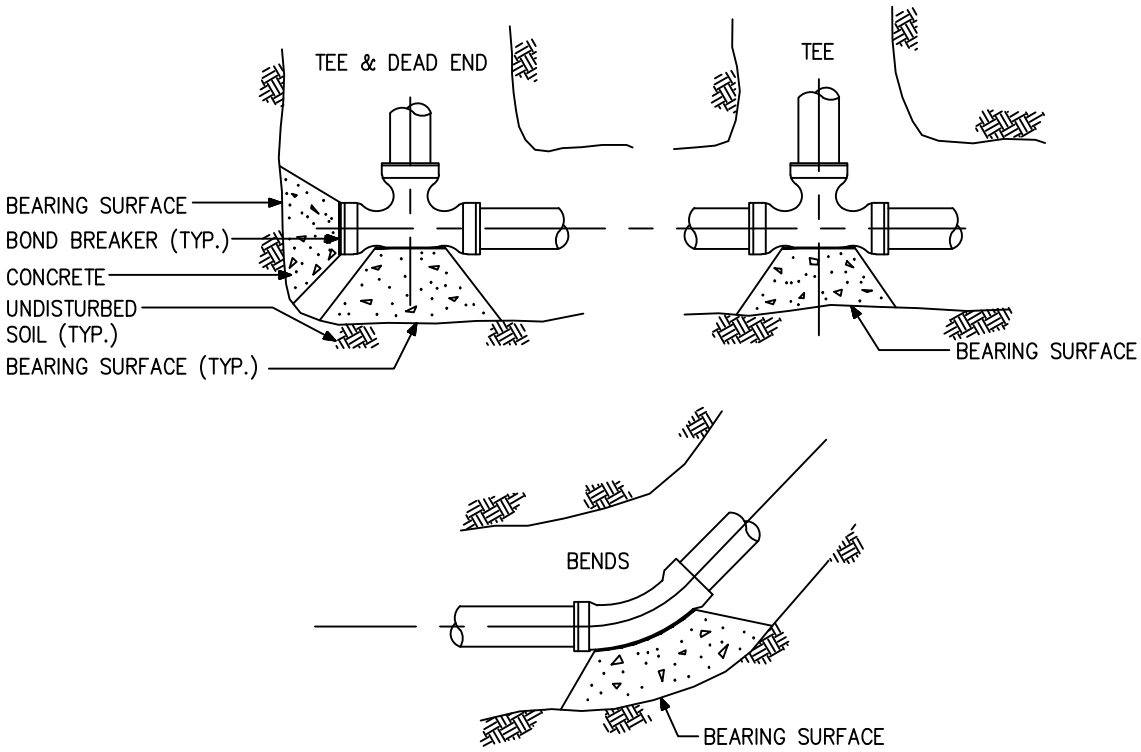
THE VERTICAL SIDES OF THE CONCRETE THRUST BLOCKS SHALL BE FORMED TO ALLOW FOR SYMMETRICAL THRUST.

WHEN IT IS IMPOSSIBLE THROUGH OVER EXCAVATION OR OTHER CAUSES TO POUR A THRUST BLOCK AGAINST UNDISTURBED EARTH, HARNESS RODS SHALL BE REQUIRED TO ANCHOR THE FITTINGS TO THE MAIN UPON APPROVAL OF THE DEVELOPMENT ENGINEERING MANAGER.

BACKFILL MAY BE PLACED OVER THE THRUST BLOCK ONCE THE SURFACE HAS SET SUFFICIENTLY TO RESIST THE WEIGHT OF THE BACKFILL.

NO DRY KICKERS SHALL BE ALLOWED.

NO HAND MIXED CONCRETE SHALL BE ALLOWED.



PLAN VIEW

NOTES:
1. THRUST BLOCKS MUST BE CAST IN PLACE CONCRETE.
2. NO TAMPING OR COMPACTING SHALL BE ALLOWED ABOVE THRUST BLOCK FOR A MINIMUM OF TWENTY–FOUR (24) HOURS AFTER PLACEMENT.
3. CONCRETE MUST SET A MINIMUM OF FORTY–EIGHT (48) HOURS PRIOR TO THE PERFORMANCE OF A HYDROSTATIC TEST.
4. BEARING SURFACE BASED ON BEARING STRENGTH OF 3000 P.S.F. AND MAIN PRESSURE OF 200 P.S.I.. FOR MAINS GREATER THAN 16" OR VERICAL THRUSTS, SHOW AREA REQUIREMENT ON STANDARD DETAILS.
5. BOND BREAKER TO BE MINIMUM OF 8 MIL. POLYETHYLENE PLASTIC.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

THRUST BLOCK DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200–11

THE PRESSURE REDUCING VAULT SHALL BE MANUFACTURED BY ENGINEERED FLUID, INC., DAKOTA PUMP INC. OR OTHER APPROVED BY DEVELOPMENT ENGINEERING MANAGER.

THE VAULT SHALL ALSO BE EQUIPPED WITH FOLLOWING:

A. SUMP PUMPS SHALL BE HYDRO-MATIC OSP50AB, OR AN APPROVED EQUIVALENT. A PIPE UNION SHALL BE INSTALLED IN THE DISCHARGE LINE BETWEEN THE PUMP AND THE CHECK VALVE. DISCHARGE LINE SHALL BE MADE OF IRON AND SHALL DIRECT FLOWS TO A LOCATION APPROVED BY CITY OF THORNTON INSPECTOR.

B. VENTILATION FANS SHALL BE AS MANUFACTURED BY ILG, OR AN APPROVED EQUIVALENT, MODEL PTD DIRECT-DRIVE TUBEAXIAL DUCT FAN SIZE PTD 123 (811 CFM @ 3/8" S.P.) WITH A ONE-SIXTH (1/6) HP, 120-VOLT CONSTANT SPEED, SINGLE PHASE, 60HZ ELECTRIC MOTOR. CONTROL SWITCH FOR THE FAN SHALL BE MOUNTED NEXT TO THE ENTRYWAY SO THAT IT CAN BE OPERATED WITHOUT COMPLETELY ENTERING THE VAULT. THE DISCHARGE OF THE VENT FAN SHALL BE TOTALLY ENCLOSED AND ATTACHED TO THE OPENING OF THE EXHAUST VENT PIPE.

C. DEHUMIDIFIERS SHALL BE DAYTON MODEL# 5EAJ7, OR AN APPROVED EQUIVALENT. PROVIDE CONDENSATE DRAIN PIPE FROM DRIP TRAY TO WITHIN SIX (6) INCHES OF THE FINISHED FLOOR.

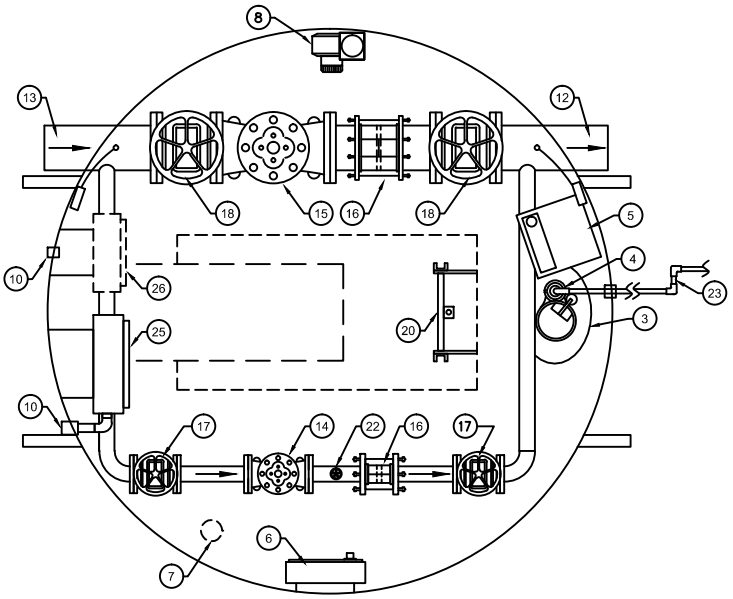
ALL CONTROL LINES AND FITTINGS SHALL BE STAINLESS STEEL AND INCLUDE ISOLATION TO ALL PRV CONTROL LINES

SEE SECTION 204.1(G) AND 204.1(J) OF THE CITY OF THORNTON STANDARDS AND SPECIFICATIONS.

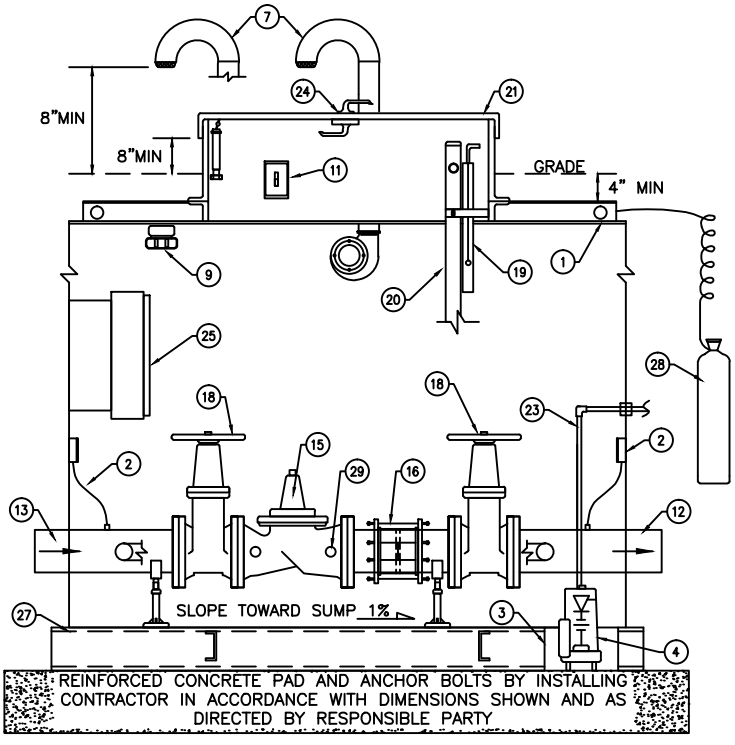
LOW FLOW BYPASS SIZES

PRV	MIN. BYPASS SIZE
8"	2-1/2"
12"	4"
16"	6" w/2" BYPASS

Legend	
1	Lifting Hooks (Add to any equipment in excess of 60 lbs)
2	Pressure Gauges (stainless steel w/ isolation vlv & purge line)
3	Sump Well (18" deep 12" wide)
4	Sump Pump with grate
5	Dehumidifier
6	Station Heater
7	Air Ducts
8	Ventilation Blower
9	Station Light
10	1.5" Conduit (provide a minimum of two conduits)
11	Light and Fan Switch (accessible from outside the vault)
12	Main Outlet
13	Main Inlet
14	Low Flow Bypass
15	Pressure Reducing Valve (With rising stem indicator)
16	Coupling
17	GATE Valves
18	BUTTERFLY valves
19	Safety Post
20	Entrance Ladder
21	Entrance Hatch (weather tight cover with overhang skirt)
22	3/4" Hose Bib
23	Sump discharge (IRON pipe with swivel joint for settlement)
24	Lock with AH1 keys or "BEST" locking assembly
25	Power Panel Enclosure
26	Telemetry Panel (as required by Dev. Eng. Manager)
27	Capsule reinforcement as directed by responsible party
28	Cathotic Protection as directed by responsible party
29	Control lines (stainless steel w/ stainless steel isolation valves)



PLAN VIEW



PROFILE VIEW

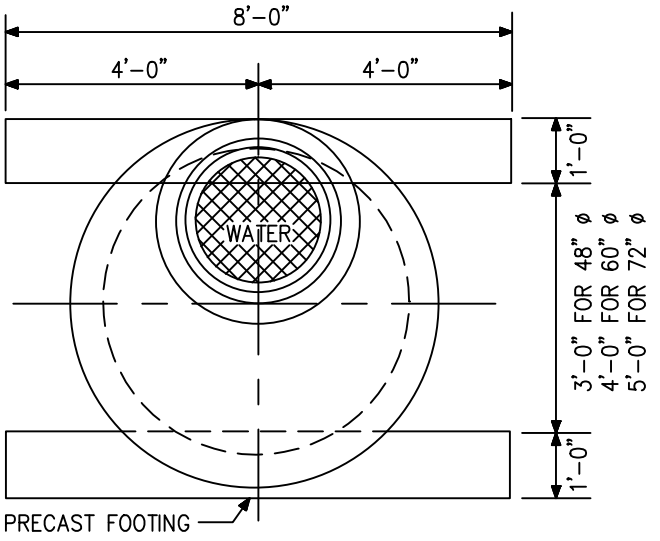
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

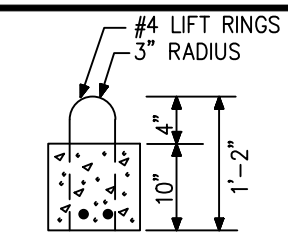
PRESSURE REDUCING VAULT DETAIL

ISSUED:
APRIL 2010
REVISED:

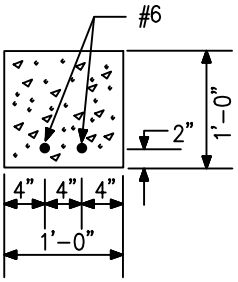
DRAWING NO.
200-12



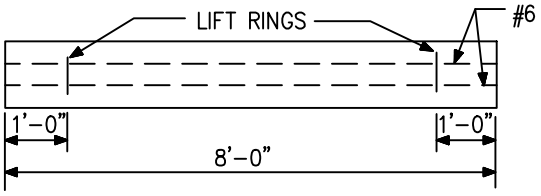
MH PLAN



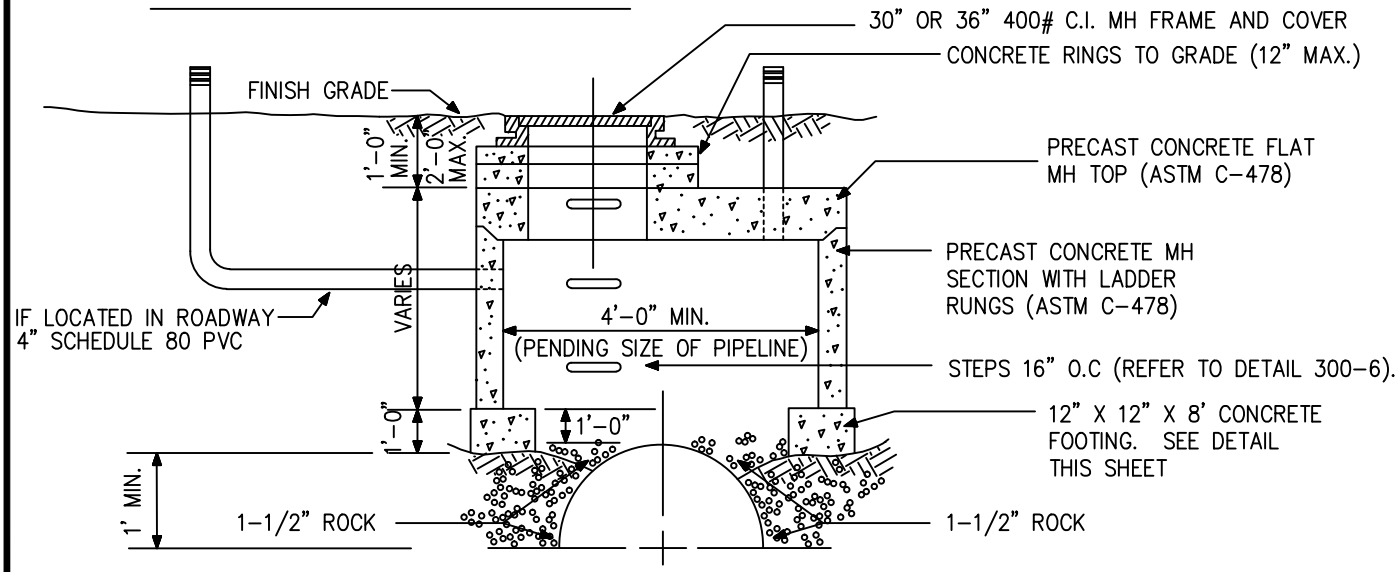
LIFT RING



SECTION
CONCRETE FOOTING



PLAN
CONCRETE FOOTING



ELEVATION

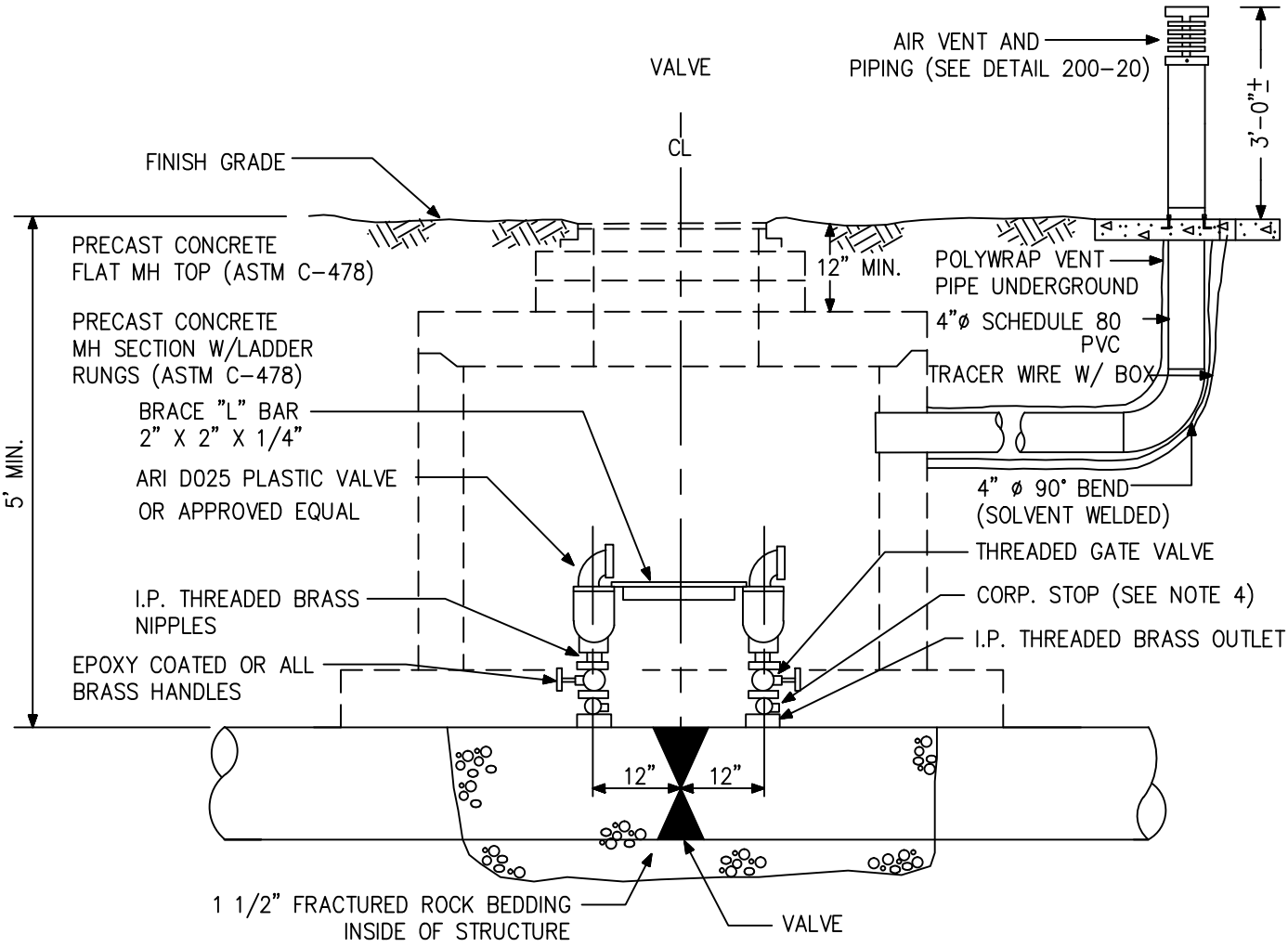
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

AIR RELIEF VALVE ASSEMBLY MANHOLE DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-13A



NOTES:

1. 1-1/2" FRACTURED ROCK SHALL BE PLACED IN BOTTOM OF MH TO CROWN OF PIPE ONLY.
2. PIPE AND FITTINGS SHALL BE BRASS.
3. PIPELINES 24" IN DIAMETER AND LARGER SHALL HAVE MH DIAMETERS OF 60" MINIMUM. MH DIAMETER SHALL BE DETERMINED BY ENGINEER.
4. WITH I.P. THREADED OUTLET, CORP. STOP SHALL BE I.P. THREADED BOTH ENDS (MUELLER H-10012 OR APPROVED EQUAL). FOR DIRECT TAP ON PIPE, CORP. STOP SHALL BE MUELLER (CC) THREADED ONE END, I.P. THREADED OTHER (H-10003 OR OTHER APPROVED BY THE DEVELOPMENT ENGINEERING MANAGER).

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

AIR RELIEF VALVE ASSEMBLY DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-13B

SERVICE PIPE TWO (2) INCHES OR LESS IN DIAMETER SHALL BE CONNECTED TO THE MAIN BY MEANS OF A BRONZE CORPORATION STOP OF THE SAME SIZE. NO UNDERGROUND JOINTS ARE PERMITTED IN THE COPPER SERVICE PIPE BETWEEN THE CORPORATION STOP AND THE CURB STOP AND/OR METER EXCEPT AT REDUCERS. OVERSIZING OF SERVICE LINES IS PERMITTED, AND SHOULD BE OUTSIDE OF THE PIT OR VAULT.

ALL JOINTS MUST BE OF A SWEAT COPPER DESIGN. SOLDER USED IN CONNECTION OF THE JOINTS SHALL BE OF A LEAD CONTENT OF 0.20 OR LESS.

CORPORATION STOPS SHALL BE AWWA TAPER THREAD TO COPPER CONNECTION OF PACK JOINT AND SHALL BE A FORD TYPE F600 OR AN APPROVED EQUAL. TAPS SHALL BE MADE BY THE RESPONSIBLE PARTY.

NO TAPS SHALL BE MADE UNTIL AFTER THE SERVICE PIPE IS SET IN PLACE AND THE COPPER SETTER (ON RESIDENTIALS) OR CURB STOP (ON COMMERCIALS) HAS BEEN INSTALLED.

UNDER NO CIRCUMSTANCES IS A WATER MAIN TO BE TAPPED DIRECTLY. ONLY SADDLES UTILIZING A CAST BRONZE CASTING WITH DOUBLE SILICONE BRONZE STRAPS SHALL BE PERMITTED.

WHEN TAPPING EXISTING ASBESTOS CEMENT PIPE, THE SIZE OF TAPS MUST BE ONE (1) PIPELINE SIZE SMALLER THAN THE SIZE OF THE PIPE BEING TAPPED.

TAPS SHALL NOT BE MADE ON A WATER MAIN UNTIL THE MAIN HAS PASSED THE CHLORINE AND HYDROSTATIC PRESSURE TESTS AND CLEARWATER TESTS.

CARE SHALL BE TAKEN TO PROPERLY INSTALL WATER SERVICE SO THAT ENOUGH SLACK IS IN THE SERVICE TO PROTECT AGAINST PULLOUT PROBLEMS.

WATER MAINS SHALL BE TAPPED AT A 45 DEGREE ANGLE FROM THE HORIZONTAL CENTER LINE OF THE WATER MAIN ON THE SAME SIDE OF THE PIPE AS THE WATER METER.

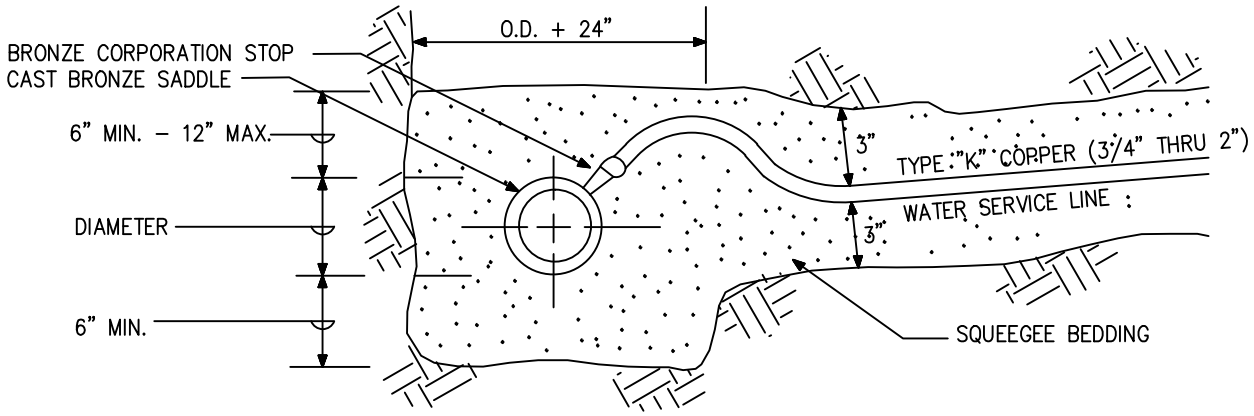
TAPPING MAINS MAY REQUIRE DIGGING OUT BEDDING MATERIAL AND CUTTING OR REMOVING PART OF THE CORROSION PROTECTIVE WRAPPING. AFTER THE TAPS ARE MADE, THE WRAP SHALL BE REPAIRED OR REPLACED BY THE INSTALLING RESPONSIBLE PARTY IN SUCH A MANNER AS TO PROTECT BOTH THE PIPE AND THE MAIN.

SERVICE TAPS SHALL HAVE A MINIMUM SEPARATION OF TWENTY FOUR (24) INCHES AND BE NO CLOSER THAN TWENTY-FOUR (24) INCHES TO A COUPLING OR PIPE JOINT OR FITTING. NO MORE THAN FOUR (4) SERVICE TAPS SHALL BE PERMITTED ON ANY ONE (1) JOINT OF PIPE.

ALL SERVICE PIPE MUST BE LAID AT LEAST FOUR AND ONE-HALF (4½) FEET BELOW THE ESTABLISHED GRADE OF THE STREET IN WHICH THEY WILL BE LAID AND ALL OTHER PLACES AT LEAST FOUR AND ONE-HALF (4½) FEET BELOW THE SURFACE OF THE GROUND.

IF AFTER A SERVICE PIPE HAS BEEN INSTALLED, THE GRADE OF THE SURFACE OF THE GROUND IS LOWERED, THE SERVICE PIPE MUST BE LOWERED TO PROVIDE AT LEAST FOUR AND ONE-HALF (4½) FEET OF COVER.

WATER SERVICE LOCATIONS SHALL BE MARKED WITH A "V" ON THE CURB. SANITARY SEWER SERVICE LOCATIONS SHALL BE MARKED WITH AN "X" ON THE CURB. MARKINGS SHALL BE NEATLY STAMPED, CHISELED, OR SAWCUT, NOT PAINTED.



NOTE: BEDDING MATERIAL SHALL BE SQUEEGEE NON-FRACTURED ROUNDED AND SHALL CONFORM TO THE FOLLOWING LIMITS WHEN TESTED BY MEANS OF LABORATORY SIEVES:

SIEVE SIZE	TOTAL % PASSING BY WEIGHT
3/8- INCH	100
NO. 200	0-5

N.T.S.

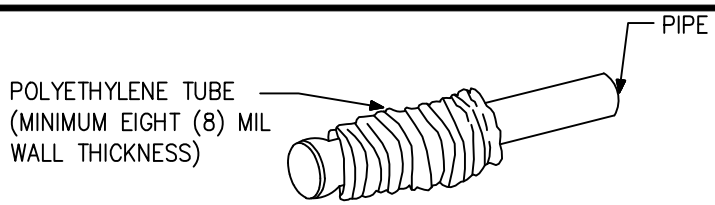
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

3/4" THRU 2" SERVICE CONNECTION DETAIL

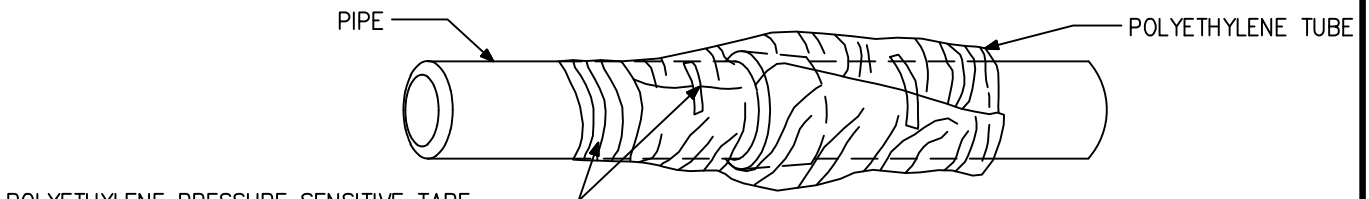
ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-14

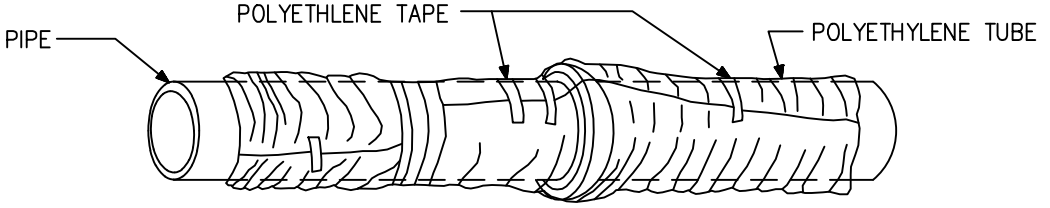
FOR D.I.P.:



STEP 1



STEP 2



STEP 3

NOTE: POLYETHYLENE ENCASEMENT MATERIAL SHALL BE MANUFACTURED IN ACCORDANCE WITH CURRENT ASTM STANDARD. THE RAW MATERIAL USED TO MANUFACTURE POLYETHYLENE FILM SHALL BE TYPE I, CLASS A, GRADE E-1 IN ACCORDANCE WITH CURRENT ASTM STANDARD.

STEP 1 – PLACE TUBE OF POLYETHYLENE MATERIAL ON PIPE PRIOR TO LOWERING IT INTO TRENCH.

STEP 2 – PULL THE TUBE OVER THE LENGTH OF THE PIPE. TAPE TUBE TO PIPE AT JOINT. FOLD MATERIAL AROUND THE ADJACENT SPIGOT END AND WRAP WITH TAPE TO HOLD THE PLASTIC TUBE IN PLACE.

STEP 3 – OVERLAP FIRST TUBE WITH ADJACENT TUBE AND SECURE WITH PLASTIC ADHESIVE TAPE. THE POLYETHYLENE TUBE MATERIAL COVERING THE PIPE SHALL BE LOOSE. EXCESS MATERIAL SHALL BE NEATLY DRAWN UP AROUND THE PIPE BARREL, FOLDED ON TOP OF PIPE AND TAPED IN PLACE.

FOR STEEL:

BITUMINOUS MATERIAL IS TO BE USED FOR CORROSION PROTECTION ON ALL STEEL PIPES.

SOIL RESISTIVITY TESTS:

SOIL RESISTIVITY TESTS AND/OR ANY OTHER SOIL TESTS ARE REQUIRED WITH THE UTILIZATION OF METAL PIPING OR AT THE SOLE DISCRETION OF THE DEVELOPMENT ENGINEERING MANAGER. OTHER MEANS OF CORROSION PROTECTION MUST BE SPECIFICALLY APPROVED BY THE DEVELOPMENT ENGINEERING MANAGER. THE RESPONSIBLE PARTY SHALL INCUR THE COSTS OF ALL SOIL TESTING AS REQUIRED.

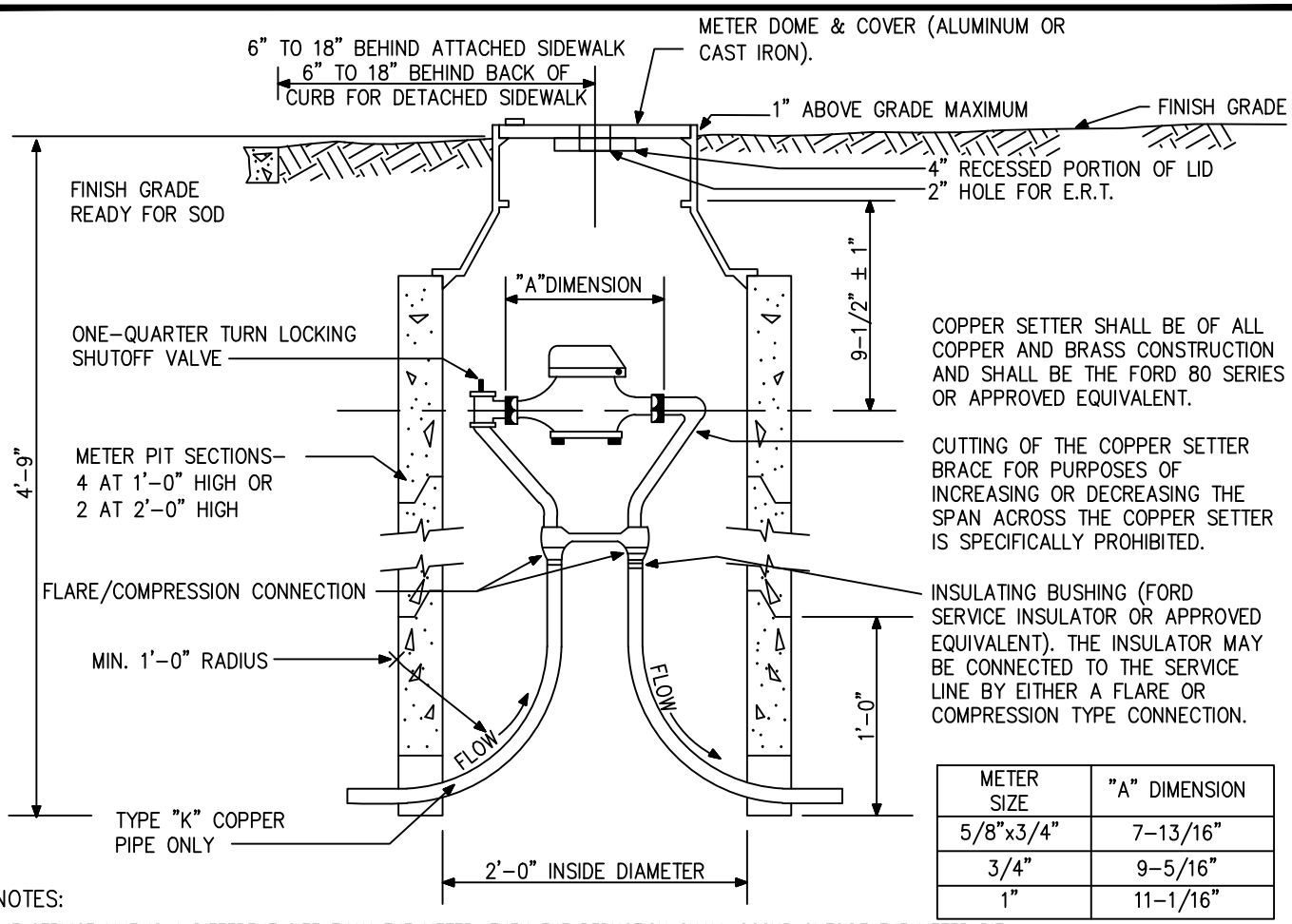
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CORROSION PROTECTION DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-15



METER SIZE	"A" DIMENSION
5/8"x3/4"	7-13/16"
3/4"	9-5/16"
1"	11-1/16"

NOTES:

1. IF SERVICE LINE IS A DIFFERENT SIZE THAN THE METER, THEN THE REDUCTION SHALL OCCUR OUTSIDE THE METER PIT.
2. WATER METER PITS, COPPER SETTERS, DOMES, AND COVERS SHALL BE INSTALLED BY THE RESPONSIBLE PARTY. THE WATER METER SHALL BE INSTALLED BY THE CITY. METER PITS MAY NOT BE INSTALLED IN ANY TYPE OF VEHICULAR OR PEDESTRIAN TRAFFIC ZONE WITHOUT THE APPROVAL OF THE DEVELOPMENT ENGINEERING MANAGER. IN THE EVENT A METER PIT IS INSTALLED WITHIN A VEHICULAR OR PEDESTRIAN TRAFFIC ZONE, A TRAFFIC RATED DOME SHALL BE INSTALLED BY THE RESPONSIBLE PARTY AT THE SOLE EXPENSE OF THE RESPONSIBLE PARTY.
3. IF INSTALLATION IN A RESIDENTIAL DRIVE IS PERMITTED, THE CONCRETE JOINT PATTERN SHALL CONSIST OF JOINTS ALLOWING THE LEAST AMOUNT OF DAMAGE TO THE SURROUNDING CONCRETE AS POSSIBLE.
4. METER PITS SHALL BE CONSTRUCTED OF CONCRETE OR PLASTIC. PLASTIC METER PITS SHALL BE MID-STATES PLASTIC, MODEL NO. MS202448B OF DFW PLASTICS, MODEL NO. 2048 B OR EQUAL AS APPROVED BY THE DEVELOPMENT ENGINEERING MANAGER. PLASTIC METER PITS SHALL MEET SAME DIMENSION REQUIREMENTS AS THE CONCRETE PITS. THE INTERIOR OF THE PLASTIC METER PITS SHALL ALSO BE WHITE.
5. METER PITS GRADE ADJUSTMENT SHALL BE MADE UTILIZING CONCRETE RINGS. THE TRENCH FLOOR UNDER THE CONCRETE RINGS SHALL BE COMPACTED EARTH. COPPER SERVICE PIPE ENTERING AND LEAVING THE PIT BENEATH THE BOTTOM CONCRETE RING SHALL BE OF SUFFICIENT LENGTH SO AS TO MEET THE DEPTH SPECIFICATIONS WHEN THE COPPER SETTER IS INSTALLED. THE PIT SHALL NOT BEAR ON THE SERVICE PIPE. UNDER NO CIRCUMSTANCES SHALL THE SERVICE PIPE ENTER AND EXIT ON THE SAME SIDE OF THE PIT.
6. WATER METER PIT INSTALLATIONS SHALL NOT BE GIVEN FINAL INSPECTION OR THE WATER METER INSTALLED UNTIL FINAL GRADING HAS BEEN COMPLETED. AFTER THE CITY HAS MADE THE FINAL INSPECTION, ANY NECESSARY GRADE ADJUSTMENTS TO THE PIT SHALL BE THE RESPONSIBILITY OF THE RESPONSIBLE PARTY.
7. THE USE OF CONCRETE RISER RINGS FOR THE PURPOSE OF DOME HEIGHT ADJUSTMENT IS PERMITTED PROVIDED SPECIFICATIONS ARE MET AFTER THE INSTALLATION IS COMPLETED (FOR PLASTIC METER PITS RISERS SHOULD BE PER MANUFACTURER'S RECOMMENDATION). THE USE OF BROKEN RINGS OR WOOD SHIMS UNDER THE DOME IS SPECIFICALLY PROHIBITED.
8. GALVANIZED PIPE AND FITTINGS ARE SPECIFICALLY PROHIBITED.
9. WATER SERVICE LOCATIONS SHALL BE MARKED WITH A "V" ON THE CURB. SANITARY SEWER SERVICE LOCATIONS SHALL BE MARKED WITH AN "X" ON THE CURB. MARKINGS SHALL BE NEATLY STAMPED, CHISELED, OR SAWCUT, NOT PAINTED.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD METER PIT DETAIL 5/8" X 3/4", 3/4" AND 1" METERS ONLY

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-16

SIZE	LAYING LENGTH
1–1/2"	13–1/2"
2" COMPOUND	15–1/2"
2" TURBINE	10–3/4"

WATER SERVICE SADDLES SHALL BE CAST BRONZE CASTING WITH DOUBLE SILICONE BRONZE STRAPS, SERIES 183–0 AS MANUFACTURED BY R. H. BAKER AND COMPANY; TYPE 323 BY SMITH–BLAIR INC., OR AN APPROVED EQUIVALENT.

CORPORATION STOPS SHALL BE AWWA TAPER THREAD TO COPPER CONNECTION OF PACK JOINT AND SHALL BE A FORD TYPE F600 OR AN APPROVED EQUAL. TAPS SHALL BE MADE BY THE RESPONSIBLE PARTY.

A CURB STOP OR VALVE CONFORMING TO THE FOLLOWING STANDARDS SHALL BE INSTALLED ON EVERY COMMERCIAL SERVICE LARGER THAN ONE (1) INCH BETWEEN THE WATER MAIN AND THE METER WHICH IS AT A POINT AT OR NEAR THE PROPERTY LINE.

CURB STOPS SHALL BE COMPRESSION TO COMPRESSION CONNECTIONS AND SHALL BE FORD BALL VALVES, B44–666M (ONE AND ONE–HALF (1–1/2) INCHES) OR B44–777M (TWO (2) INCHES) OR APPROVED EQUAL.

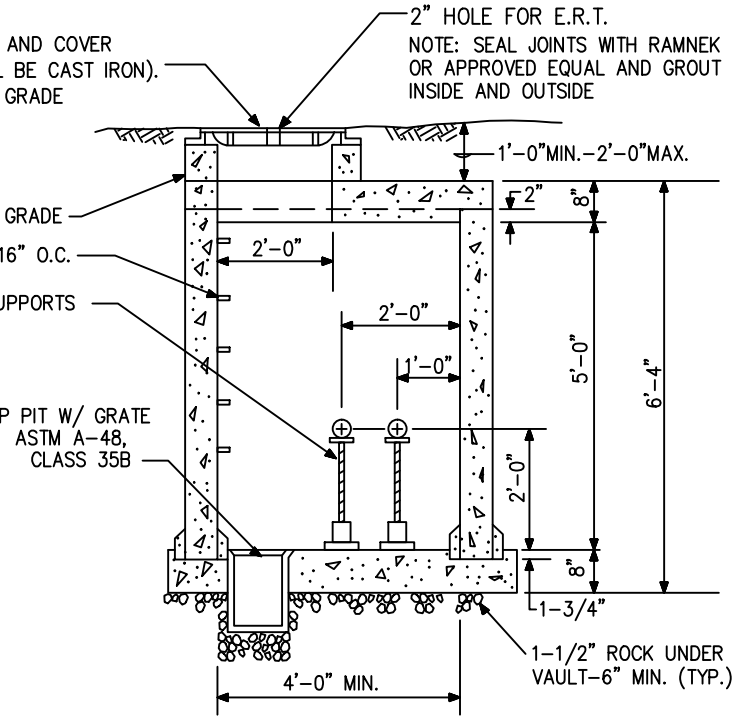
CURB STOP SERVICE BOXES SHALL BE A CAST IRON BOX, MINNEAPOLIS PATTERN, EXTENSION TYPE. THE CURB STOP BOX SHALL BE CENTERED OVER THE CURB STOP VALVE AND IN A VERTICAL POSITION. THE TOP LID OF THE CURB STOP BOX SHALL BE INSTALLED A MAXIMUM OF ONE (1) INCH ABOVE THE FINAL GRADE.

PIPE SHALL BE TYPE K CLASS, RIGID COPPER PIPE. THE METER VAULT PIPING SHALL BE OF THE SAME INSIDE DIAMETER AS THE METER ORIFICE. ANY SERVICE PIPE MATERIAL CHANGES SHOULD OCCUR OUTSIDE THE METER VAULT ON THE OUTLET SIDE.

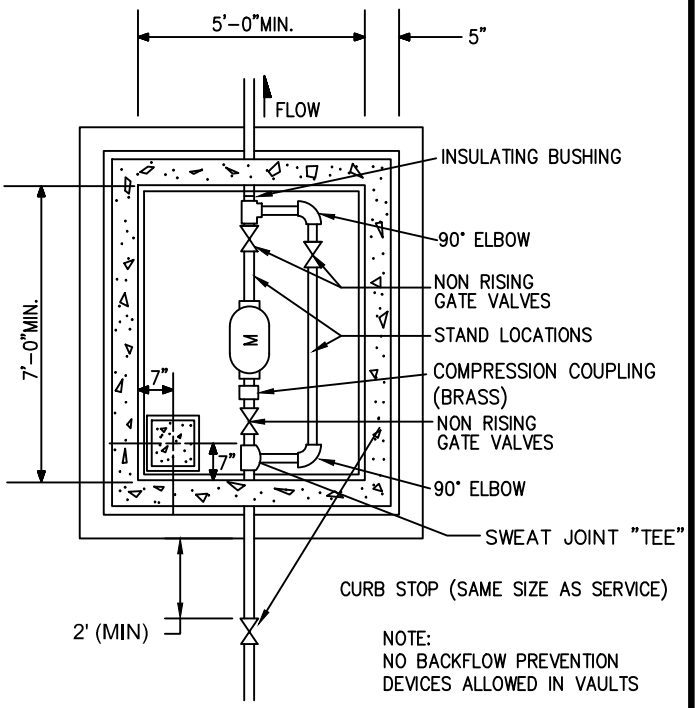
JOINTS SHALL BE OF A SWEAT COPPER DESIGN. SOLDER USED IN CONNECTION OF THE JOINTS SHALL BE OF A LEAD CONTENT OF 0.20 OR LESS.

GATE VALVES SHALL BE AWWA APPROVED GATE VALVES OF BRASS CONSTRUCTION. THE VALVES SHALL BE COUNTERCLOCKWISE OPEN. REFER TO SUBSECTION 204.1(D) OF THESE STANDARDS AND SPECIFICATIONS. VALVES LOCATED IN VAULTS SHALL HAVE HANDWHEELS IN LIEU OF A TWO (2) INCH SQUARE OPERATING NUT.

WATER SERVICE LOCATIONS SHALL BE MARKED WITH A "V" ON THE CURB, AND SEWER SERVICE SHALL BE MARKED WITH AN "X". MARKINGS SHALL BE NEATLY STAMPED, CHISELED, OR SAWCUT, AND SHALL NOT BE PAINTED.



VAULT PROFILE



VAULT PLAN

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD 1–1/2" AND 2" METER SETTING DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200–17A

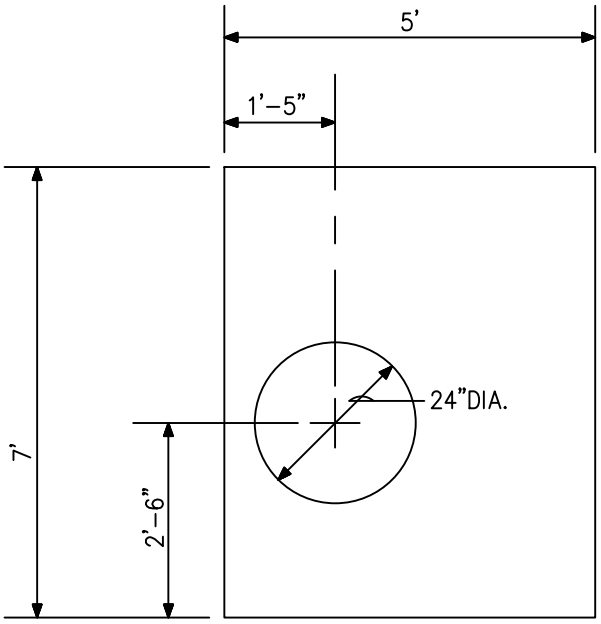
1. METER VAULT LIDS AND COVER SHALL BE CAST IRON.

2. PIPE SHALL BE TYPE K CLASS, RIGID COPPER PIPE. THE METER VAULT PIPING SHALL BE OF THE SAME INSIDE DIAMETER AS THE METER ORIFICE. ANY SERVICE PIPE MATERIAL CHANGES MUST OCCUR OUTSIDE THE METER VAULT ON THE OUTLET SIDE. JOINTS SHALL BE OF SWEAT COPPER DESIGN. SOLDER USED IN CONNECTION OF THE JOINTS SHALL BE OF A LEAD CONTENT OF 0.20 OR LESS. THE OUTLET SIDE OF THE COPPER SETTERS SHALL BE ISOLATED FROM TE SERVICE LINE WITH A FORD SERVICE INSULATOR OR APPROVED EQUIVALENT.

3. GATE VALVES SHALL BE AWWA APPROVED GATE VALVES OF BRASS CONSTRUCTION. THE VALVE STEMS SHALL BE OF NON-RISING DESIGN. VALVES SHALL BE COUNTERCLOCKWISE OPEN, AND SHALL HAVE HANDWHEELS IN LIEU OF A TWO (2) INCH SQUARE OPERATING NUT. VALVES SHALL BE INSTALLED BOTH UPSTREAM AND DOWNSTREAM OF THE WATER METER WITHIN THE VAULT.

4. BYPASS PIPING SHALL BE INSTALLED ON THESE SERVICES TO FACILITATE REMOVAL OF THE WATER METER WITHOUT DISCONTINUATION OF SERVICE. A GATE VALVE SHALL BE INSTALLED ON THE BYPASS LINE. THE CONNECTION TO THE METER SERVICE LINE SHALL BE MADE BY MEANS OF A SWEAT JOINT "TEE" INSIDE THE VAULT. CONNECTIONS SHALL BE UPSTREAM OF THE VALVE ON THE INLET SIDE OF THE WATER METER AND DOWNSTREAM ON THE OUTLET SIDE.

5. BRASS UNIONS OF A COMPRESSION TYPE SEALING DESIGN SHALL BE INSTALLED BETWEEN THE GATE VALVE AND THE WATER METER, EITHER UPSTREAM OR DOWNSTREAM OF THE METER TO FACILITATE REMOVAL OF THE WATER METER FROM THE SERVICE LINE.



ROOF SLAB

N.T.S.

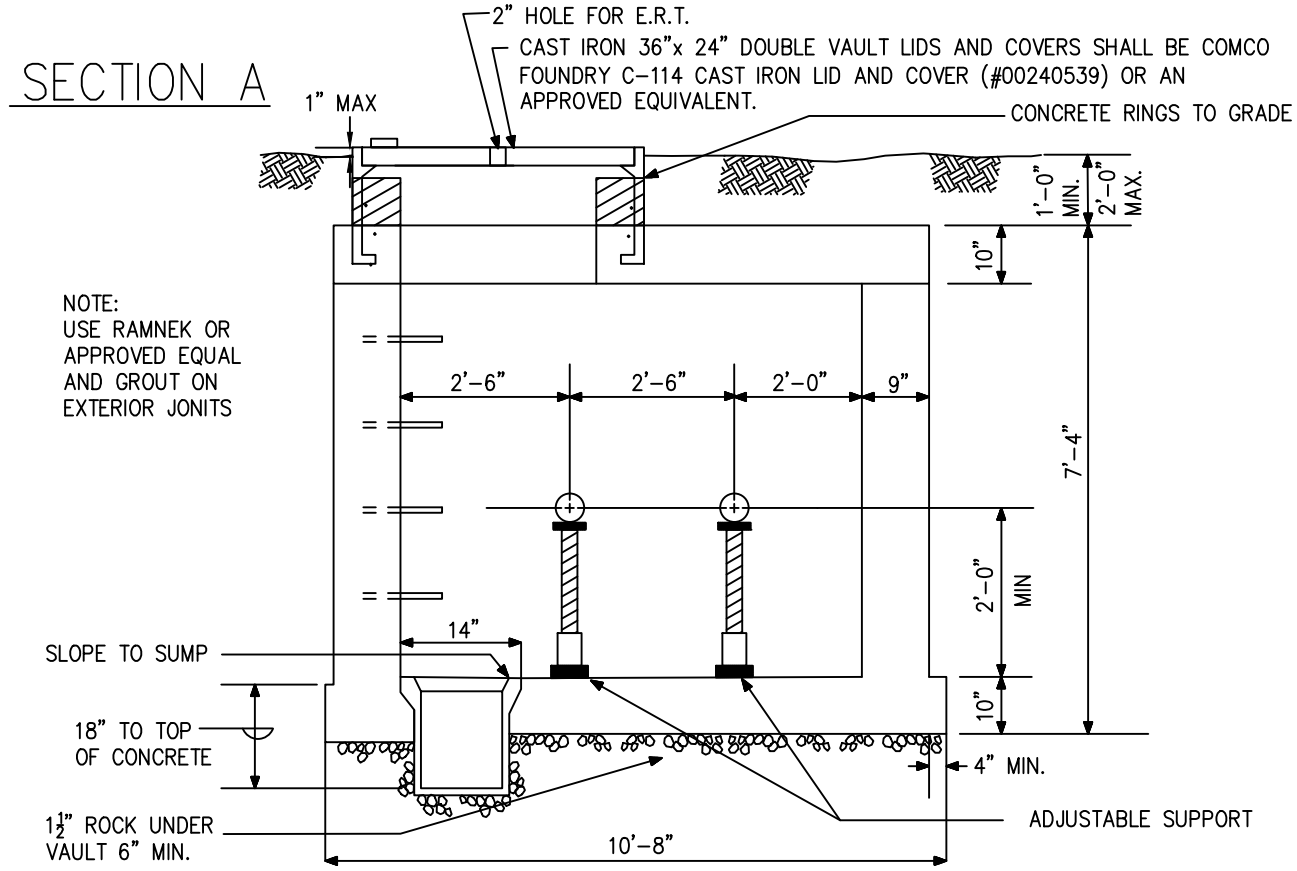
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD 1-1/2" & 2" METER SETTING ROOF SLAB DETAIL

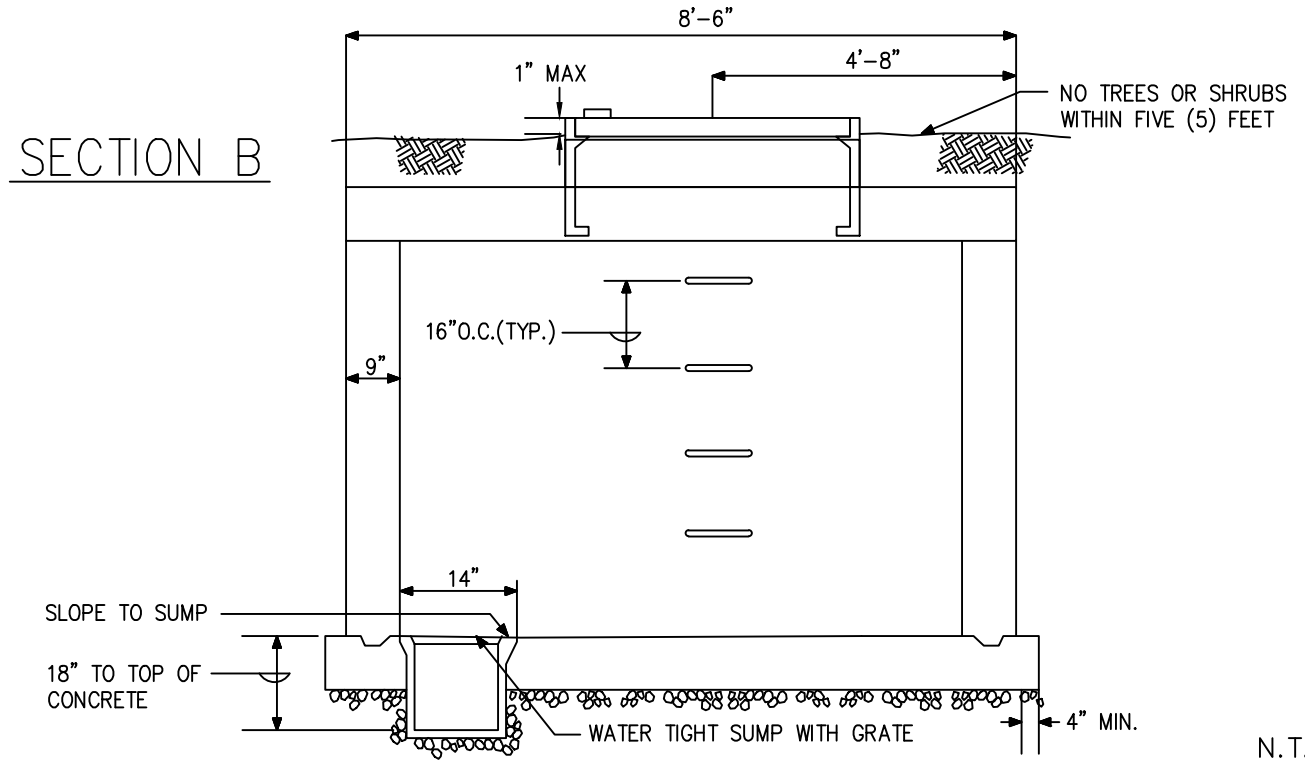
ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-17B

SECTION A



SECTION B



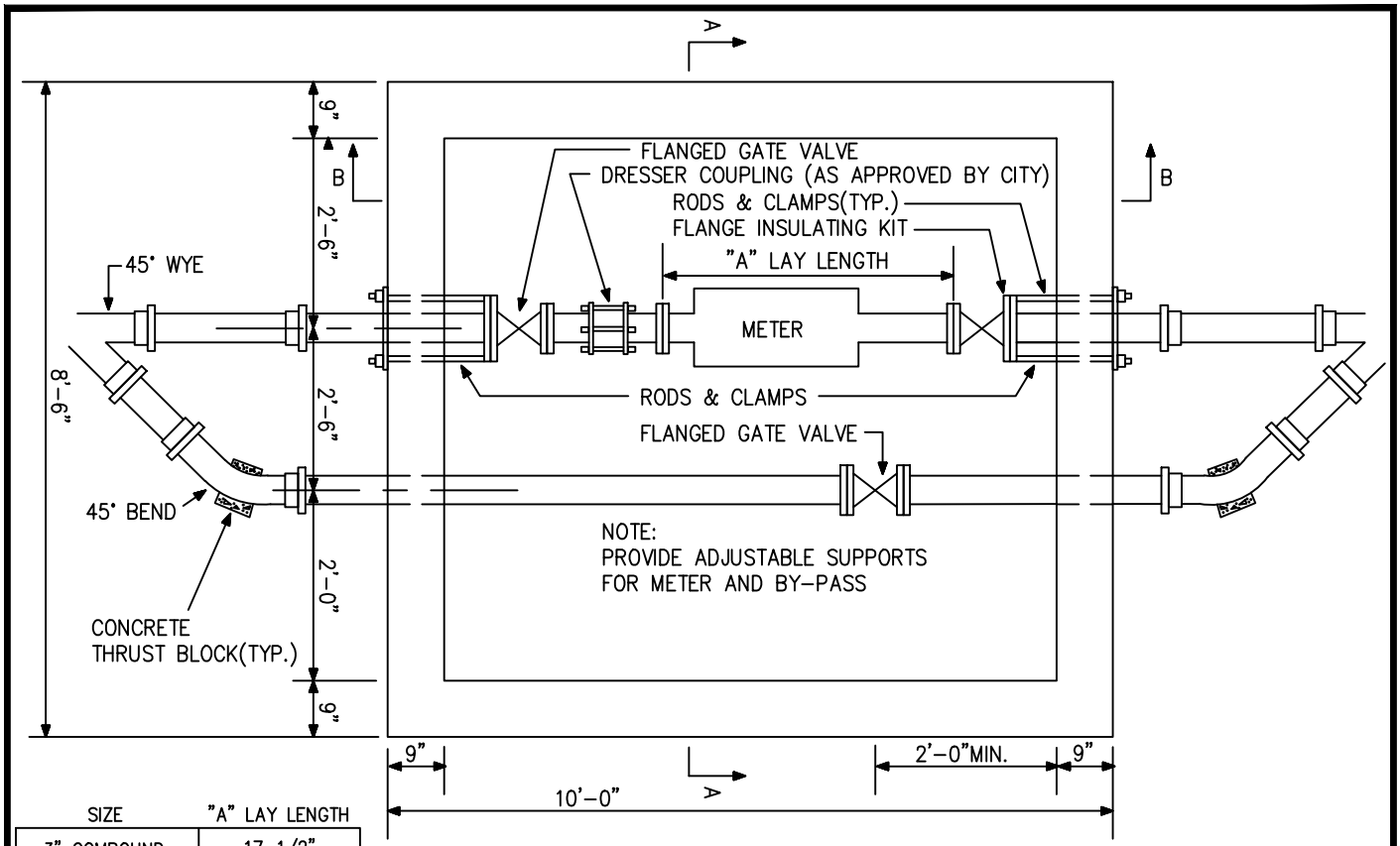
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD 3" AND 4" METER SETTING DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-18A



SIZE	"A" LAY LENGTH
3" COMPOUND	17-1/2"
3" TURBINE	12-1/4"
4" COMPOUND	20-1/4"
4" TURBINE	14-1/4"

1. WATER SERVICE SADDLES SHALL BE CAST BRONZE CASTING WITH DOUBLE SILICONE BRONZE STRAPS, SERIES 183-0 AS MANUFACTURED BY R. H. BAKER AND COMPANY; TYPE 323 BY SMITH-BLAIR INC., OR AN APPROVED EQUIVALENT.

2. CURB STOP GATE VALVES SHALL MEET AWWA SPECIFICATIONS AND BE CAPABLE OF WITHSTANDING 200 PSI WORKING PRESSURE. THEY SHALL BE OF BRONZE MOUNTED, ALL CAST IRON BODY CONSTRUCTION. THE VALVES AND OPERATING STEMS SHALL BE OF A NON-CORROSIVE CONSTRUCTION, COUNTERCLOCKWISE OPEN. GATE VALVES LARGER THAN THREE (3) INCHES IN SIZE SHALL BE WEDGE DISC TYPE. THE VALVE SHALL BE INSTALLED IN THE SERVICE PIPE A MAXIMUM OF TWO (2) FEET UPSTREAM OF THE METER VAULT WALL THROUGH WHICH THE INCOMING SERVICE PIPE ENTERS.

3. CURB STOP SERVICE BOXES SHALL BE A CAST IRON BOX, MINNEAPOLIS PATTERN, EXTENSION TYPE. THE CURB STOP BOX SHALL BE CENTERED OVER THE CURB STOP VALVE AND IN A VERTICAL POSITION. THE TOP LID OF THE CURB STOP BOX SHALL BE INSTALLED A MAXIMUM OF ONE (1) INCH ABOVE THE FINAL GRADE.

4. PIPING INSIDE THE VAULT FOR THREE (3) INCH AND FOUR (4) INCH METER SERVICES SHALL BE OF DUCTILE IRON, FLANGE JOINT DESIGN ONLY. THE METER VAULT PIPING SHALL BE OF THE SAME SIZE AS THE WATER METER ORIFICE, BOTH ENTERING AND LEAVING THE VAULT.

5. GATE VALVES INSTALLED SHALL MEET ALL AWWA SPECIFICATIONS AND BE CAPABLE OF WITHSTANDING 200 PSI WORKING PRESSURE. THE VALVES SHALL BE COUNTERCLOCKWISE OPEN AND OF A NON-RISING STEM TYPE CONSTRUCTION WITH HAND WHEELS IN LIEU OF SQUARE OPERATING NUTS. REFER TO SUBSECTION 204.1(D) OF THESE STANDARDS AND SPECIFICATIONS.

6. CONNECTION TO THE METER SERVICE FOR THE BYPASS MAY BE MADE BY MEANS OF A "WYE" CONNECTION OUTSIDE THE VAULT, IF NECESSARY, ALTHOUGH THE GATE VALVE MUST BE INSTALLED INSIDE THE METER VAULT.

7. INSTALLATION OF METER SHALL BE PERFORMED BY A LICENSED PLUMBER.

8. WATER SERVICE LOCATIONS SHALL BE MARKED WITH A "V" ON THE CURB, AND SEWER SERVICE SHALL BE MARKED WITH AN "X". MARKINGS SHALL BE NEATLY STAMPED, CHISELED, OR SAWCUT, AND SHALL NOT BE PAINTED.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD 3" AND 4" METER SETTING DETAIL

ISSUED:
APRIL 1992
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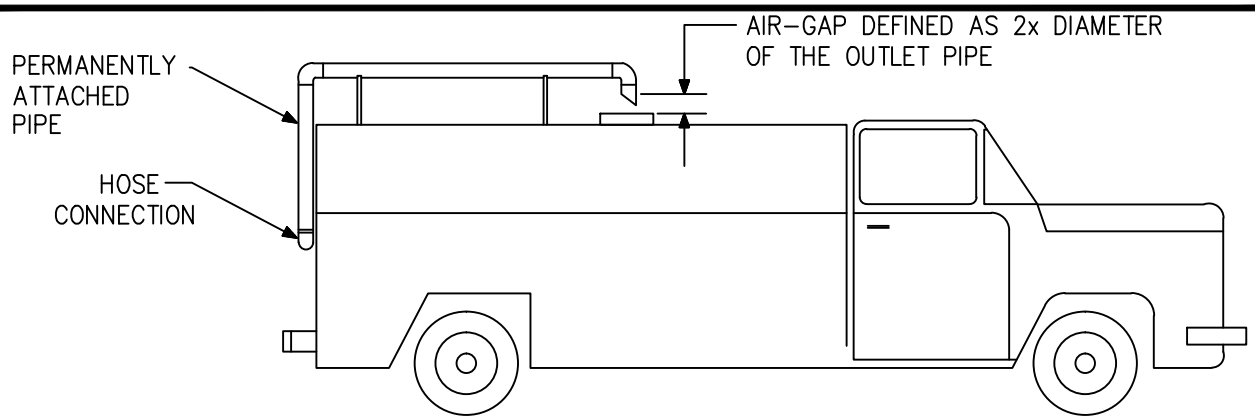
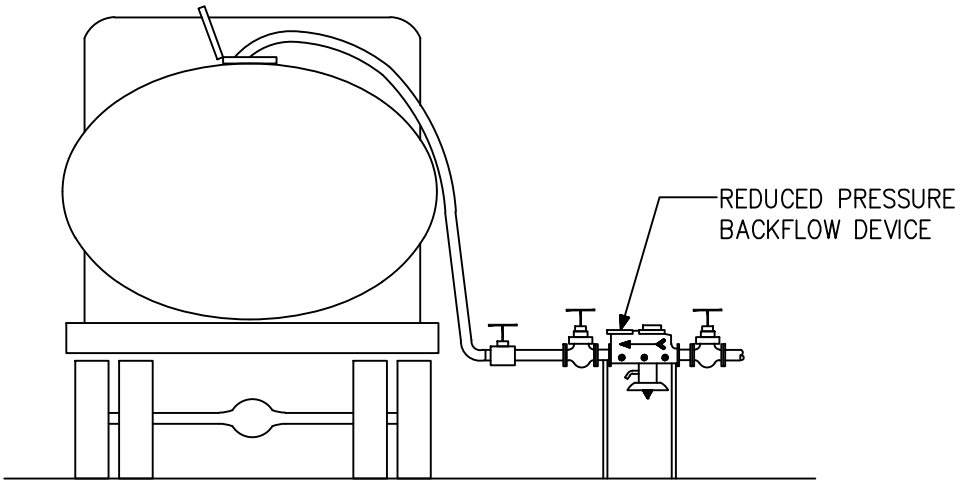
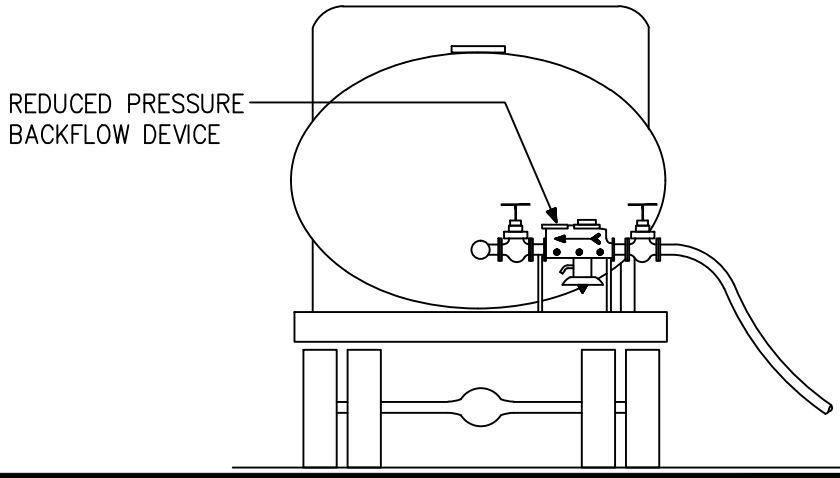
APRIL 2010

DRAWING NO.
200-18B







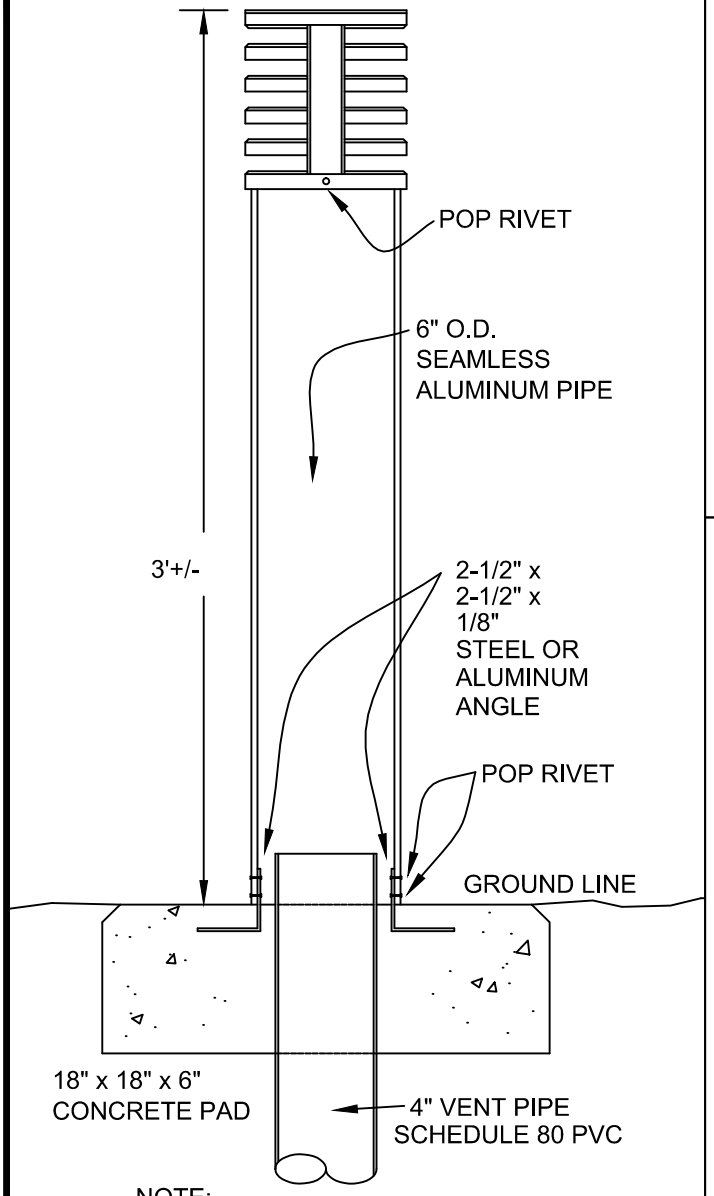
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

APPROVED METHODS OF FILLING PORTABLE SPRAY AND CLEANING EQUIPMENT

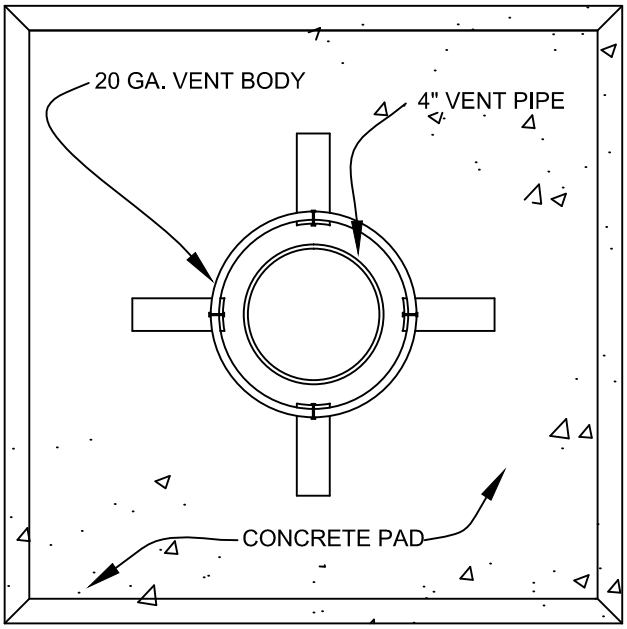
ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
200-19

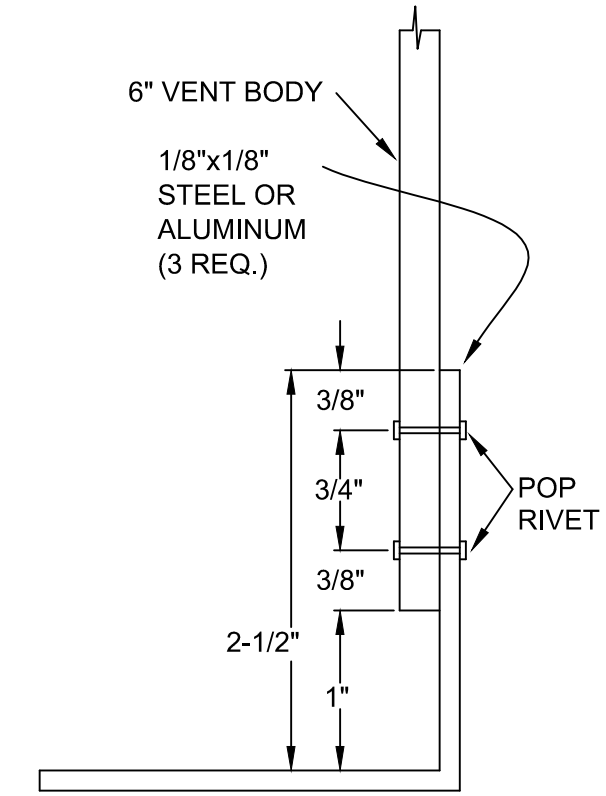


NOTE:
COLOR SHALL BE FLAT BLACK

ROUND VENT SCREEN



BASE DETAIL



STEEL OR ALUMINUM ANGLE DETAIL

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL AIR VENT DETAIL

ISSUED:
JANUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
200–20

SECTION 300 - SANITARY SEWER SYSTEM STANDARDS
TABLE OF CONTENTS

DETAIL DRAWINGS

SECTION 300 - SANITARY SEWER SYSTEM STANDARDS

301 GENERAL PROVISIONS

These standards are promulgated by the Utilities Director of the City in accordance with the authority contained in the Thornton City Code. Improvements shall also be in conformance with Chapter 74 of the Thornton City Code.

302 GENERAL SPECIFICATIONS

302.1 Granting of Service

Sanitary sewer shall be extended at the requestor's expense, when it has been determined that the City has the capability and capacity to serve the area, provided that the area to be served is located within the Thornton sanitary sewer service area and provided that the Responsible Party can show evidence of fee ownership of the property to be serviced. The request for service must be in compliance with stipulations contained in all utilities agreements entered into by the City and said applicant as well as in compliance with all applicable City ordinances, codes and charter principles.

302.2 Application, Permit, Construction, and Acceptance Procedure

Refer to Section 100 for City application, permitting, construction, and acceptance procedures.

303 SANITARY SEWERS DESIGN CRITERIA

303.1 General

A. The purpose of these Standards and Specifications is to ensure that only proven high quality materials are installed with first class workmanship. Determination of the best materials and construction methods are based upon lowest life cycle costs, not necessarily upon lowest initial costs. The sizing and layout of the system are part of the total consideration of design, operations, and maintenance of a sanitary sewer system that yields optimum quality service at the lowest total cost to the consumer.

B. Sanitary sewer mains and appurtenances shall be constructed in conformance with these Standards and Specifications and shall be designed by or under the direct supervision of a registered PE licensed to practice in the State of Colorado. Refer to the checklist in section 100 for construction drawing requirements related to sanitary sewer.

303.2 Design Criteria

A. Sanitary sewers must be designed to carry the peak discharge with the pipe being no more than 50 % of maximum flow capacity (q/Q) for mains smaller than 15 inches in diameter or 80 % of maximum flow capacity (q/Q) for mains 15 inches in diameter and larger. In manholes, sewers shall be designed so that the crown of the invert sewers match, and the manhole shall be filleted as shown on Detail 300-3. The mains shall also be able to transport suspended material such that deposits in the sewer are precluded. It is essential that the sewer have capacity for peak hourly sewage flow and adequate velocity at minimum sewage flows.

B. The Manning formula, with an "n" value of 0.013, shall be utilized for the sizing of sanitary sewer mains. The minimum diameter for sanitary sewer mains shall be eight (8) inches.

C. The following are the minimum and maximum slopes generally permissible for sewer collection and outfall mains:

SEWER SIZE (inches)	MINIMUM SLOPE	MAXIMUM SLOPE
Sanitary Sewer Services		
4	2.00%	8.00%
6	1.00%	8.00%
Sanitary sewer collection and outfall mains		
8	0.40%	5.00%
10	0.28%	4.00%
12	0.22%	3.00%
15	0.15%	2.50%
18	0.12%	2.00%
21	0.10%	1.50%
24	0.08%	1.20%
30	0.06%	0.90%

The maximum slope on an eight (8) inch sewer line may be increased to seven (7) % where necessary to match approved street slope and is not economically feasible to place sewer on a lesser slope. Increasing the pipe diameter exclusively to utilize a lesser slope is not permitted.

303.3 Flow Calculations

A. Flow calculations shall be submitted to the Development Engineering Division for review along with the engineering plans.

B. Calculations shall include:

1. The average and hourly peak quantity of sewage flow projected to be generated by the project.

2. The velocity of flow in the proposed sewer.

3. The % of pipe capacity utilized (q/Q), including anticipated peak flows from all upstream properties.

4. The impact on downstream sewer systems from the proposed development to the nearest transmission main.

5. The quantity and type of discharge of an unusual nature such as swimming pool drainage, cooling water, etc.

C. The following design criteria shall be used for projecting wastewater flows, unless more site specific criteria are available:

1. Residential:

a. 80 gallons per person per day (gpd)

i. low density (less than 5 DU/Ac.) = 3.45 people/unit
ii. mid density (5 to 12 DU/Ac.) = 2.45 people/unit
iii. high density (more than 12 DU/Ac.) = 2.20 people/unit

2. Commercial and Industrial:

600 gallons per acre per day

Peaking Factor - Peak hourly factor shall be calculated utilizing the following equation:

$$PF = \frac{1.72}{F^{0.295}} \qquad \text{[3.5 max., 2.6 min.]}$$

where PF = Peaking Factor
F = Average Flow in MGD

D. If flow monitoring is determined to be needed in order to check existing sewers for available capacity, the Responsible Party is required to hire a contractor to perform the work. The contractor will need to contact Development Engineering to coordinate the location and scheduling of the flow monitoring. All flow monitoring equipment shall be utilized for a minimum of one (1) week, and shall be securely fastened so that if the equipment does become loose, it will not be conveyed into the downstream pipes.

303.4 Lift Stations

A. Where lift stations are proposed, a basin study shall be completed by the Responsible Party's engineer. The basin shall include properties other than the proposed development, and costs for sizing of facilities within the basin shall be allocated as documented in Chapter 74 of the City Code.

B. Lift stations shall be equipped with an odor control device, and no lift station shall be permitted within 100 feet of a residential lot. The Responsible Party's engineer shall submit a pretreatment plan for review and approval by the Development Engineering Manager. The pretreatment shall provide effective control of odors in the downstream sewerage system.

C. Lift stations and force mains shall be sized for peak hour wastewater flows. Force mains shall be sized for a maximum velocity of six (6) fps, minimum velocity of two (2) fps.

D. Air relief valves shall be installed on the high point of all sanitary sewer force mains in accordance with Details 300-8A, 8B, and 8C.

E. Lift stations shall be Gorman-Rupp package system with submersible pump and Smith-Loveless package system design for high lift applications (wet well and dry well) when pump cannot provide the required head pressure, or equivalent subject to approval of the Development Engineering Manager.

F. Controls and electrical components shall be housed in a weatherproof enclosure above ground and adjacent to the wet well. The force main leaving the lift station shall be constructed of C-900 DR-14 pressure pipe

G. Emergency power shall be provided for the lift station and sized to run the entire lift station at capacity. A diesel generator shall be provided in a walk-in above-ground enclosure on a concrete pad. The fuel tank shall be sized to permit 24 hours of run time. The Responsible Party shall install a generator silencer or masonry wall as determined by the Development Engineering Manager to decrease the level of noise created by the emergency generator when adjacent to residential property.

H. Shop drawings for the lift station and related equipment shall be submitted to the Development Engineering Manager for approval. Construction shall not begin on lift station until shop drawings have been approved by the Development Engineering Manager and the Colorado Department of Public Health and Environment.

303.5 Oversizing of Mains

Oversizing of mains may be required by the City, as documented in Chapter 74 of the City Code.

303.6 Materials

A. Only sanitary sewer mains constructed of the following materials are permitted:

1. PVC Pipe ASTM 3034, SDR 35/SDR 26, and C-900 DR-14

B. These materials shall be consistent from manhole to manhole.

303.7 Ground Cover

A. Sewer mains and services shall be designed so that a minimum of four (4) feet of cover exists over the pipe after final grade has been established.

B. Sewer mains and services which have less than four (4) feet of cover or more than 20 feet of cover shall be installed using SDR 26 or C-900 DR-14. When a sewer main crosses underneath a stream, irrigation ditch, or storm drainage ditch, casing of the facility is required.

303.8 Location

A. Sewers shall be installed in dedicated street rights of way or exclusive easements. City sanitary sewer mains shall not cross through residential lots. Location for these sewers shall be 10 feet from the center line on the south or west side of the street. Streets with asphalt widths less than 32 feet shall have sewers located five (5) feet from the center line on the south or west side. In addition, a minimum separation of five (5) feet from the lip of pan or edge of pavement is required for sanitary sewer.

B. Sewer mains shall be installed in exclusive easements, when, as determined by the Development Engineering Manager, it is not practical to make such installation in a dedicated street ROW. Under no circumstances shall any structures be constructed within these easements or ROW without prior approval, including terms and conditions, as set by the City. The minimum width requirements for sanitary sewer easements are 20 feet or twice the depth of the pipe, whichever is greater. The pipeline shall be centered in the easement, and offset a minimum of five (5) feet from any property line. In the event two (2) utilities share the same easement, the minimum width for the easement shall be 30 feet, and for three (3) public utilities, the width shall be 40 feet, etc. All easements in residential areas shall be in a dedicated tract with a minimum width of 40 feet.

C. Sanitary sewer mains shall be located so that they are accessible.

D. Sanitary sewer mains shall not be installed within five (5) feet of any concrete, such as sidewalks, curb, gutter, or cross pans except for 90 degree crossings

E. No curvilinear sewers shall be permitted.

F. Sanitary sewers shall not be installed in drainage ditches (except at 90 degree crossings) or detention ponds.

G. The minimum vertical separation between pipes shall be 18 inches, and the minimum horizontal separation between pipes shall be 10 feet. Distances shall be measured edge to edge.

303.9 Manholes

A. Manholes shall be installed at both ends of each section of sewer, at changes in grade, size, or alignment, at intersections and at distances not greater than 450 feet for all sewers.

B. Manholes shall be combined when they are located at the apex of a sewer main, and are within 50 feet of another manhole

C. A drop manhole shall be provided for a sewer entering a manhole at an invert elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer invert and the manhole invert is less than 24 inches, the invert shall be shaped in a filleted fashion to prevent solids deposition, as shown in Detail 300-3. Drops should be avoided whenever possible.

D. The internal diameter of the manhole barrel shall be as follows, whichever is greater:

Pipe Size (inches)	Minimum Manhole Diameter (inches)
18 and less	48
21-27	60
36 and larger	72

E. The flow channel through the manhole shall be made to conform to shape and slope to that of the sewers. A minimum three-tenths (3/10) fall across manholes shall be maintained.

F. Manholes shall not be located in concrete areas, such as sidewalks, cross pans, aprons, curbs, and gutters.

G. All manholes shall be accessible by a maintenance vehicle. Any necessary access roads shall be designed to carry an H-20 loading, with a maximum grade of seven (7) % and maximum cross slope of four (4) %.

H. Manholes shall be located at the end of sewers being stubbed out for future connection.

303.10 Grease and Sand/Oil Interceptors

Developments that are required to install a grease or sand/oil interceptor shall meet all requirements of the City of Thornton Building Division.

303.11 Sewer Services

A. Separate services are required for each single family dwelling (attached/detached), multifamily foundation, townhome and townhome-style condominium, and commercial/office foundation.

B. Separate services are also required for each bottom unit for condo-style condominiums.

C. For strip retail centers, a sanitary sewer service is required to be installed the entire length of the facility to prevent more than one (1) unit from releasing grease into the service, and to allow for the outside installation of grease interceptors.

303.12 Prohibited Connections to Sewer

No person shall make connection of roof downspouts, sump pumps, foundation drains, areaway drains, or other sources of surface runoff or groundwater to a building sewer or building drain which in turn is connected directly or indirectly to a public sanitary sewer.

303.13 General Discharge Prohibitions

The Responsible Party shall include a description of the nature of all waste not ordinary to domestic sewage. No user shall contribute or cause to be contributed, directly or indirectly, any pollutant or wastewater which will interfere with the operation or performance of the publicly-owned treatment works, and shall follow the guidelines as set forth in Chapter 74 of the City Code.

304 SANITARY SEWERS - CONSTRUCTION SPECIFICATIONS

304.1 Materials

A. Materials furnished shall be new and undamaged. Everything necessary to complete installations shall be furnished and installed whether shown on approved drawings or not and installations shall be completed as fully operational.

B. Acceptance of materials or the waiving of inspection thereof shall in no way relieve the Responsible Party of the responsibility for furnishing materials meeting the requirements of the specifications. The City reserves the right to direct or deny use of certain types of materials in specific circumstances.

C. Materials delivered to the job site shall be adequately housed and protected so as to ensure the preservation of their quality and fitness for the work.

1. Polyvinyl Chloride Pipe

a. Pipe materials and fittings shall meet the extra strength minimum requirements of ASTM D-3034, SDR-35, or latest revision thereof.

b. Pipe shall be subjected to drop impact tests in accordance with ASTM D-2444.

c. Fittings and accessories shall be as manufactured and furnished by the pipe supplier or approved equal, as determined by the Development Engineering Manager, and have bell and/or spigot configurations compatible with that of the pipe.

d. Pipe stiffness for pipe shall be tested in accordance with ASTM D-2412, while joint tightness shall be tested in accordance with ASTM D-3212.

e. Installation shall be in accordance with Ring-Tite PVC Gravity Sewer Pipe Installation Guide TR-614A published by John-Mansville, except as modified by these Standards and Specifications.

f. If deflection limits exceed five (5) %, the Responsible Party shall be responsible for removing the existing pipe and installing a new pipe material under the direction of the Development Engineering Manager.

g. The manufacturer shall furnish a certified statement that the inspection and the specified tests have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the Development Engineering Manager upon request.

h. Solvent cement joints are not permitted.

2. Polyvinyl Chloride Pressure Pipe

Refer to Subsection 204.1(B) of these Standards and Specifications.

304.2. Manholes – Detail 300-3

A. Manhole Construction

1. Whenever the manhole is left unattended, including prior to any connection, the manhole cover or a temporary cover shall be installed at the opening. Temporary covers shall be of such design as to prevent ground/storm water, children, or animals from entering sewer. Temporary covers shall be subject to approval by the Development Engineering Manager.

2. Sewer connections to existing manholes where there is no existing pipe stubbed out shall be made in such a manner that the finished work shall conform as nearly as practical to the essential requirements specified for new manholes. The Responsible Party shall break out as small an opening in the existing manhole as necessary to insert the new sewer. The existing concrete foundation bench shall be chipped to the cross section of the new pipe in order to form a smooth, continuous invert similar to what would be formed in a new concrete base. Portland cement grout shall be used as necessary to smoothly finish the new invert and to seal the new sewers so the junction is watertight.

3. Steel pipe manhole marking poles will be required as depicted on Detail 300-5. In cultivated areas, manholes shall be left below grade; considering the type of equipment being used for the cultivated area, the ring and cover elevations shall be lower in order to protect structure from damage, and properly marked by a marker post (Detail 300-5), located at the nearest possible fence line. Final elevation of manholes is to be at the discretion of the Development Engineering Manager.

4. Refer to Detail 300-3 for additional manhole requirements.

B. Waterproofing

Manholes shall be waterproofed where ground water or other water sources are present, as determined by the Development Engineering Manager, that could be detrimental to the function of the structure. Method of waterproofing shall be submitted by the Responsible Party for review and approval by the Development Engineering Manager.

C. Lining and Rehabilitation

1. All new manholes installed downstream of a lift station along the sewer mainline shall be lined in accordance with these specifications. In addition, all manholes within 1500 feet installed on a distribution line connected to a sewer mainline downstream from a lift station shall be lined in accordance with Detail 300-1.

2. If a lift station is installed as part of a development project, the developer shall line all new manholes as specified above and rehabilitate all existing downstream manholes as specified above. Existing manholes that have been previously lined or rehabilitated will not be required to be rehabilitated.

D. Drop Manholes – Detail 300-4A & 300-4B

A drop manhole shall be constructed at manhole locations where the incoming pipe invert is two (2) feet or more above the manhole invert.

E. Semi-Drop Manholes – Detail 300-3

A semi-drop manhole shall be constructed at manholes where the incoming pipe invert is up to two (2) feet above the manhole invert pipe outlet. Refer to Detail 300-3 for semi-drop manholes.

304.3 Installation of Pipe

A. Refer to Section 100 for excavation, dewatering, pipe bedding, testing, backfill, and compaction requirements.

B. Pipe and fittings shall be loaded and unloaded by lifting so as to avoid shock or damage. Under no circumstances shall such material be dropped. Before the placing of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of foreign material, kept clean and examined for cracks or defects before installation. The Development Engineering Manager may reject any pipe which shows discoloration due to the sun.

C. Joint lubricant shall be as supplied by the pipe manufacturer.

D. The pipe shall be laid upstream with spigot ends pointing downstream. The pipe shall be placed true to line and grade with ends abutting, carefully centered and with a smooth invert at the joint. The joint shall be made in a workmanlike manner so as to be watertight. New installations shall be complete and flushed prior to connecting to existing pipes.

E. Whenever the pipe is left unattended, including prior to any connection, temporary plugs shall be installed at openings. Temporary plugs shall be watertight, standard cast iron and of such design as to prevent ground/storm water, children, or animals from entering the pipe. Temporary plugs shall be subject to approval by the Development Engineering Manager.

F. No pipe or appurtenant structure shall be installed upon a foundation into which frost has penetrated or at any time when the Development Engineering Manager deems there is a danger of ice formation or frost penetration at the bottom of the excavation. No pipe or appurtenant structure shall be installed unless backfilling can be completed before the formation of ice and frost.

G. Immediately before joining two (2) lengths of pipe, the inside of the bell, the outside of the spigot end, and the gasket shall be thoroughly cleaned. Caution shall be exercised to ensure that the correct type of gasket is used. A thin film of gasket lubricant shall be applied to either the inside face of the gasket or the spigot end of the pipe or both, according to the pipe manufacturer's installation procedure.

H. The spigot end of the pipe shall be placed in the socket with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow, steady pressure. Stabbing shall not be permitted.

I. Repaired couplings shall not be permitted.

J. Sewer lines installed at minimum grade shall have final grade field verified by a Professional Surveyor, registered in the State of Colorado, and a television inspection, prior to backfill, at the Responsible Party's

expense. This shall also be performed after the backfill and compaction of trench area is complete in place above the pipe.

K. Under no circumstances shall sewer lines be installed beneath any concrete, such as sidewalks, curbs, or gutters.

L. In-line "Y" shall be installed at all service line locations in new mains.

304.4 Testing

A. Sanitary sewer pipe and appurtenances shall be cleaned and tested after backfill operations have been completed and acceptable compaction test results have been submitted to the Development Engineering Manager.

B. New sanitary sewer installations shall be televised and as-built shots taken to verify design slope requirements by the responsible party after backfill operations have been completed. The results of the inspection and video shall be submitted to the Development Engineering Manager for approval. Water line installation may not begin until acceptable televised testing video and as-built shots have been submitted and reviewed by the City.

C. The Responsible Party shall have sewers jet washed on new installation prior to the initial television inspection completed by the City. Debris resulting from the cleaning shall be removed before entering the City's existing sewer, by either some type of plug or elbow to catch debris. Material shall be removed from the site and disposed of by the Responsible Party. If on the initial television inspection the cleaning is unsatisfactory and prevents the television inspection from being completed, the Responsible Party shall reclean the sewer and shall be responsible for costs incurred by a second television inspection. The low pressure air test shall be required on the entire length of pipe installations.

D. Any damages to the pipe caused by cleaning or testing operations shall be repaired or replaced by the Responsible Party at his own expense. Should the pipe fail to meet the requirements of the low pressure air test or infiltration of ground water is noted, the Responsible Party shall determine the source or sources of the leakage and shall replace defective materials or workmanship. Replacement of defective materials or workmanship as above noted shall be the financial responsibility of the Responsible Party. Pipe which fails to meet these requirements shall be repaired or replaced and retested in accordance with these requirements.

E. New sanitary sewer installations will be televised by the City for initial acceptance after the installation, cleaning, testing, and final lift of asphalt are complete. Inspection reports and videos shall be available for review by the Responsible Party. The Responsible Party shall be responsible for any repairs or replacement of any portions of the pipeline that are determined defective by the television inspections.

F. Prior to the final acceptance there shall be another television inspection performed by the City. If there are any discrepancies, a punch list shall be formulated and sent to the Responsible Party. Any discrepancies must be repaired prior to final acceptance being granted.

G. Low Pressure Air Test

1. Pipe outlets shall be plugged with suitable test plugs. Pipe may be tested without pre-wetting. If the pipeline to be tested is submerged in groundwater, the Responsible Party shall determine the groundwater elevation at the test location and provide it to the Development Engineering Manager. The backpressure on the pipe due to groundwater shall be determined and the internal pipeline test pressure shall be established at 4.0 psi (gauge) in excess thereof. Add air slowly to the portions of the pipe being tested. After the pipe has been filled to the required pressure, allow at least two (2) minutes for the air-temperature to stabilize, adding only the amount of air necessary to maintain the test pressure. After the two (2) minute period, disconnect the air supply and allow the initial pressure to drop to 3.5 psi (gauge) in excess of the groundwater back pressure.

2. The time interval required for the sewer internal pressure to drop from 3.5 psi (gauge) to 2.5 psi (gauge) above the excess of ground water backpressure shall be measured and recorded.

3. The basis for acceptance of the air test shall be the minimum time required for the internal pressure to drop 1.0 psi (gauge). The minimum allowable time in seconds shall be in accordance with the following tables. The minimum allowable pressure drop time is computed based upon an allowable leakage rate not to exceed 0.003 cfm per square foot of internal pipe surface. Sewers 15 inches in diameter and smaller shall be tested from manhole to manhole. Sewers 18 inches in diameter and larger shall be tested in lengths such that the total loss is no less than two (2) cfm when computed using an allowable rate of 0.003 cfm per square foot of internal surface.

Minimum allowable pressure drop times for pipe 15 inches in diameter and smaller (in seconds):

Pipe Diameter (Inches)	Length of Pipe Being Tested (Feet)			
	100	200	300	400
8	38	76	114	152
10	47	94	141	188
12	56	113	170	226
15	71	141	212	283

Minimum allowable pressure drop times for pipe 18 inches in diameter and larger (in seconds):

Pipe Diameter (inches)	Length of Pipe Being Tested (feet)					Maximum Testing Length (feet)
	25	50	75	100	126	
18	21	42	64	85	106	140
21	25	50	74	99		120
24	28	56	85	113		106
27	32	64	95			94
30	35	71	106			84
36	42	85				70

The minimum allowable pressure drop time when using the maximum testing length is 120 seconds.

4. Sewers 36 inches in diameter shall be tested one (1) joint at a time.

5. If it appears that excessive infiltration is present after the air tests have been completed, the Development Engineering Manager may require an infiltration test prior to final acceptance. Excessive infiltration may be the cause for rejection. The Development Engineering Manager shall be the sole judge of whether or not the infiltration test is required.

6. The Responsible Party shall follow precautions necessary to perform a safe and successful test. Plugs used to isolate the line for the air test must be securely braced to avoid the unintentional release of the plug. Gauges, air piping manifolds, and control valves shall be located above ground. No one shall be permitted to enter a manhole when a plugged pipe is under pressure. Air testing apparatus shall be equipped with a pressure relief device designed to relieve the pressure when in excess of six (6) psi (gauge).

305 SANITARY SEWER SERVICES AND APPURTENANCES CONSTRUCTION SPECIFICATIONS

305.1 General

Sanitary sewer service construction connecting to the City sanitary sewer system shall be done in accordance with these Standards and Specifications, which cover new sanitary sewer service construction and repairs to existing services from the sewer main to the property line. Refer to Sections 100 and 304 and 305 for installation and testing procedures for sanitary services and appurtenances.

305.2 Materials

A. Materials furnished shall be new and undamaged. Everything necessary to complete installations shall be furnished and installed whether shown on approved drawings or not and installations shall be completed as fully operable.

B. Acceptance of materials or the waiving of inspection thereof shall in no way relieve the Responsible Party of the responsibility for furnishing materials meeting the requirements of the specifications.

C. The City of Thornton reserves the right to direct or deny use of certain types of materials in specific circumstances.

D. Materials delivered to the job site shall be adequately housed and protected so as to ensure the preservation of their quality and fitness for the work.

E. Polyvinyl Chloride Pipe

Refer to Subsection 304.1(C)(1) of these Standards and Specifications.

F. Polyvinyl Chloride Pressure Pipe

Refer to Subsection 204.1(B) of these Standards and Specifications.

G. Manholes

Refer to Subsection 304.2 of these Standards and Specifications.

305.3 Pipe Bedding – Detail 300-2

Section 100 of these Standards and Specifications are applicable except that four (4) inch and six (6) inch services require a minimum bedding depth of eight (8) inches as shown in the detail drawing.

305.4 Location and Alignment of Service

Sanitary sewer services shall be constructed on the shortest and straightest route possible. At no time shall the service be any closer than five (5) feet to the side property, and except when installed in easements in commercial areas, no service may be constructed through or in front of any adjoining property. When possible, the service shall be located five (5) feet toward the low side of the lot from the center of the lot. Services are not to extend beneath driveways. Sewer and water services must be a minimum of 10 feet apart horizontally or concrete encasement of the sewer or special protection shall be required.

305.5 Service Stub-Ins to Property Line – Detail 200-2

Service stub-ins shall be extended at least to property line and shall be plugged with a watertight compression stop. Adjacent to the end of the stub-in, a four (4) foot length of two (2) inch by four (4) inch wood marker (or a four (4) foot length steel fence post) shall be placed in a vertical position prior to backfilling. The responsible party shall place a chiseled "X" in the curb head at the location where the service crosses underneath the curb. This two (2) inch by four (4) inch wooden marker shall remain in place until service locations are chiseled on the curb. If the two (2) inch by four (4) inch wood marker is not present at time of chiseling, the Responsible Party shall bear the expense of reaffirming the location of the service stub-out by re-excavation. The Responsible Party shall take measurements of distances from manholes to service taps and give this information to the City.

305.6 Connections

A. Where wyes have not or could not have been installed in the main sewer, the Responsible Party shall excavate around the main and prepare the main for tapping. The main shall then be tapped by the Responsible Party at the expense of the Responsible Party. The connection shall be watertight and at a 45 degree angle above the pipe horizontal center line. Projection of the sewer service pipe inside the sewer main shall not be permitted. Approved tees or sewer service saddles shall be used to connect the service to the sewer main.

B. No aluminum saddles shall be permitted. Plastic saddles shall be attached to the mains utilizing either epoxies or stainless steel straps. The City shall inspect the main and saddle at every tap prior to backfilling. In the event the tap is covered before it is inspected, it shall be dug out by the Responsible Party and any concrete or mortar around the fitting shall be removed to allow visual inspection of the tap and the main. If the main sewer is cracked or broken during the process of locating and tapping, it shall be repaired immediately either by replacing the broken section or by placing a minimum of nine (9) inches of concrete above, at the sides and below the main pipe parallel for the width of the excavation. The method of repair shall be chosen by the Development Engineering Manager. Lines in service must be machine tapped.

C. A manhole shall be installed instead of a service tap when a six (6) inch connection is to be made on an existing eight (8) inch or 10 inch sewer. Six (6) inch connections may be made without a manhole on new installations with the use of a wye. If a wye cannot be used, a manhole shall be required on eight (8) inch and 10 inch new sewers. Service taps to existing manholes shall not be permitted.

D. Sewer mains shall be laid through manholes at the end of cul-de-sacs. One (1) joint of pipe and plugged wyes shall be installed in order that the end of the cul-de-sac may be serviced without tapping into the manhole. No more than two (2) wyes may be located on that joint of pipe laid through the manhole.

E. No more than three (3) one-fourth (¼) bends shall be permitted in any sanitary sewer service line. Where services are longer than 100 feet, cleanouts shall be required as depicted in Detail 300-7.

F. All sewers connecting to existing main lines shall be plugged at the manhole. The plug shall be a cast iron wing nut type and connected to the top step of the manhole using a stainless steel cable or approved equal. The plug shall remain installed and be maintained until initial acceptance of the work. Once initial acceptance of the work is received, the plug shall be removed and the sewer will be allowed to transmit wastewater into the existing main line.

305.7 Commercial and/or Industrial Manholes

A manhole may be required where so specified by the Development Engineering Manager in order to have samples taken if industrial wastes are suspected. Such a manhole would be located on the commercial service, so samples could be taken before such fluids could reach the sanitary sewer main.

305.8 Abandoning Existing Service Taps

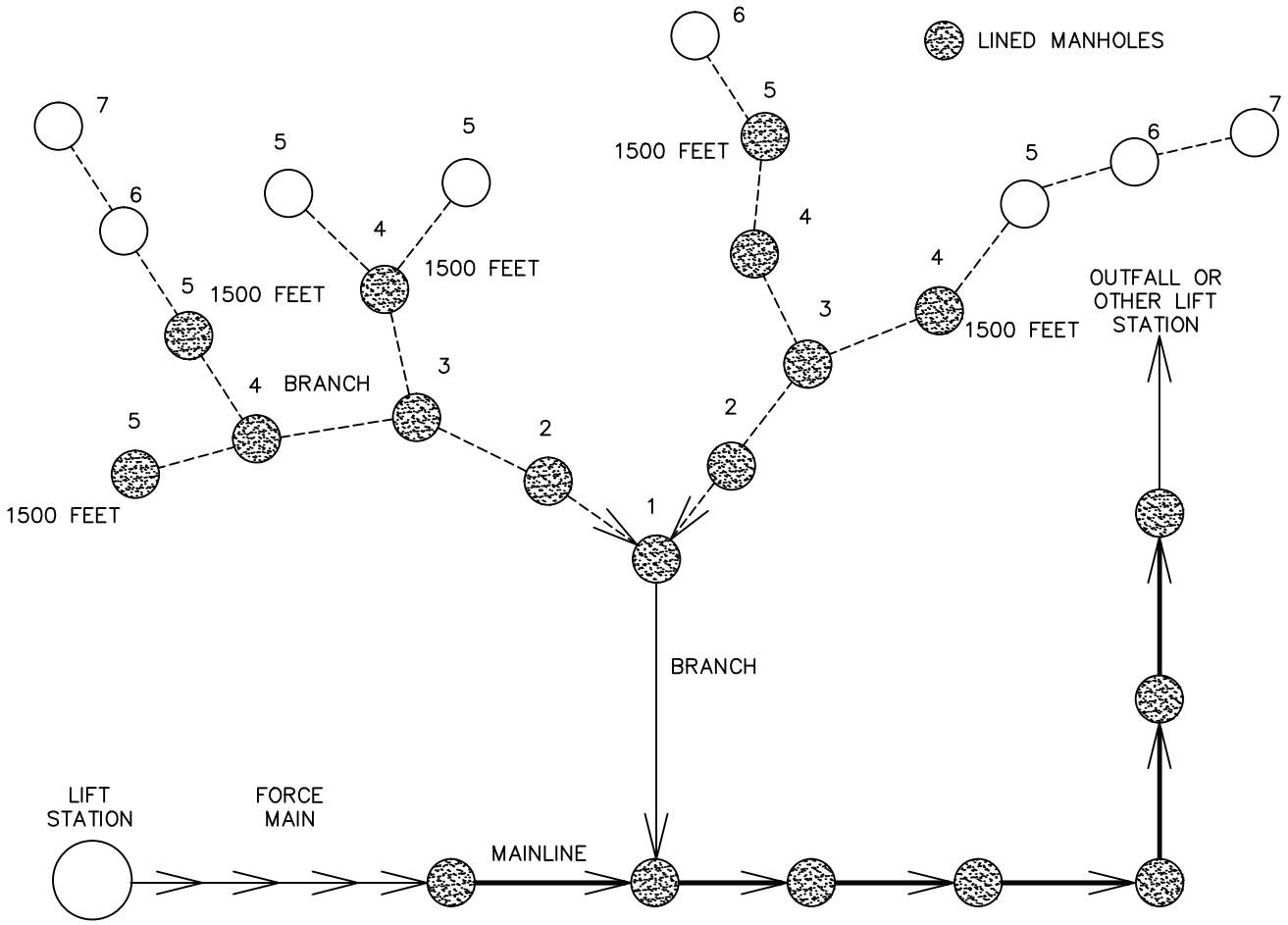
If it has been determined by the Development Engineering Manager that a service line is to be temporarily abandoned in conjunction with a development, it shall be removed to the property line and capped. If the abandonment is permanent, then it shall be disconnected from the main line, a cap or plug shall be installed in the wye and it shall be encased in concrete.

305.9 Abandoning Existing Sewer Main

If it has been determined by the Development Engineering Manager that sanitary sewer shall be abandoned in conjunction with a development, the sewer shall be removed or flash/flow filled in place.

305.10 Sanitary Sewer Service Repair

All sewer service repairs outside of City rights-of-way shall follow the currently adopted International Plumbing Code and any amendments.



ALL NEW MANHOLES INSTALLED ALONG THE SEWER MAINLINE DOWNSTREAM OF AN EXISTING OR PROPOSED FUTURE LIFTSTATION SHALL BE LINED IN ACCORDANCE WITH THESE SPECIFICATIONS. IN ADDITION, A MINIMUM OF 1500 FEET OF MANHOLES INSTALLED ON A DISTRIBUTION LINE CONNECTED TO A SEWER MAINLINE DOWNSTREAM FROM AN EXISTING LIFT STATION SHALL BE LINED IN ACCORDANCE WITH THESE SPECIFICATIONS. IF A LIFT STATION IS INSTALLED AS PART OF A DEVELOPMENT PROJECT, THE DEVELOPER SHALL LINE ALL NEW MANHOLES AS SPECIFIED ABOVE AND REHABILITATE ALL EXISTING DOWNSTREAM MANHOLES AS SPECIFIED ABOVE. EXISTING MANHOLES THAT HAVE BEEN PREVIOUSLY LINED AND REHABILITATED WILL NOT BE REQUIRED TO BE REHABILITATED.

THE CORROSION PROTECTION MATERIAL SHALL BE SPRAYROQ SPRAYWALL® POLYURETHANE COATING. THE APPLICATIONS SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS. THE CONTRACTOR PERFORMING THE WORK SHALL PROVIDE EVIDENCE TO THE CITY THAT THEY HAVE EXPERIENCE WORKING WITH THIS OR SIMILAR PRODUCTS.

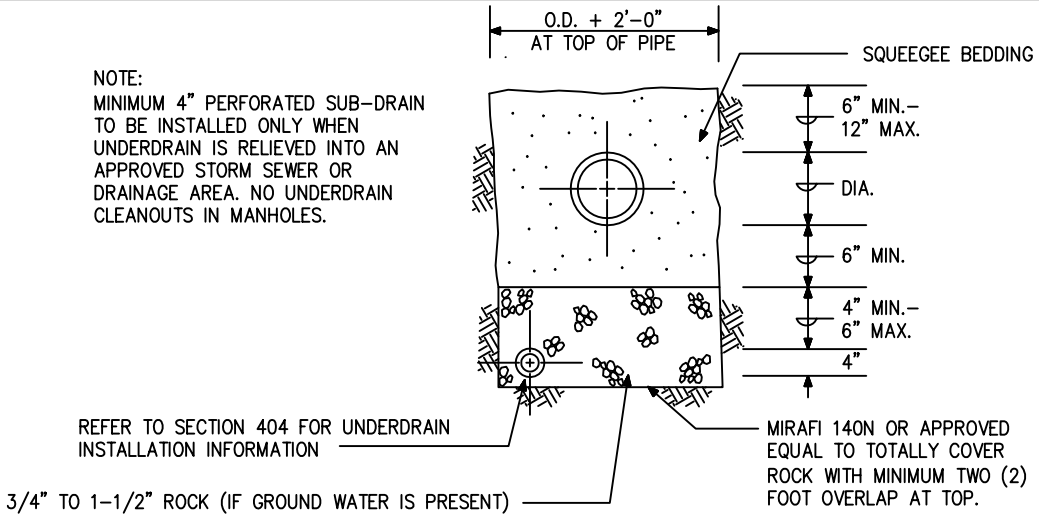
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SEWER MAIN LINING AND REHABILITATION DETAIL

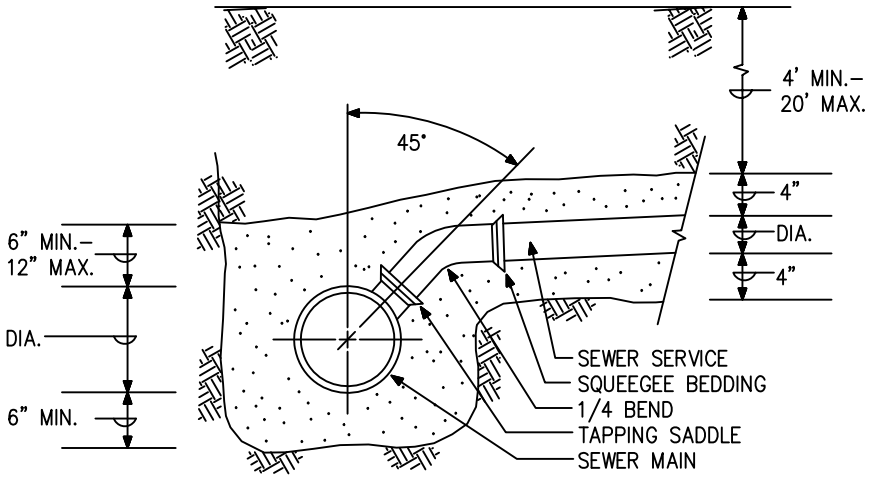
ISSUED:
APRIL 2004
REVISED:
APRIL 2010

DRAWING NO.
300-1



SEWER MAIN BEDDING AND UNDERDRAIN DETAIL

SERVICE STUB-INS SHALL BE EXTENDED AT LEAST TO PROPERTY LINE AND SHALL BE PLUGGED WITH A WATERTIGHT COMPRESSION STOP. ADJACENT TO THE END OF THE STUB IN, A FOUR (4) FOOT LENGTH OF TWO (2)INCH BY FOUR (4) INCH WOOD MARKER (OR A FOUR (4) FOOT LENGTH STEEL FENCE POST) SHALL BE PLACED IN A VERTICAL POSITION PRIOR TO BACKFILLING. THE RESPONSIBLE PARTY SHALL PLACE A CHISELED "X" IN THE CURB HEAD AT THE LOCATION WHERE THE SERVICE CROSSES UNDERNEATH THE CURB. THIS MARKER SHALL REMAIN IN PLACE UNTIL SERVICE LOCATIONS ARE CHISELED ON THE CUR. IF THE MARKER IS NOT PRESENT AT THE TIME OF CHISELING, THE RESPONSIBLE PARTY SHALL BEAR THE EXPENSE OF REAFFIRMING THE LOCATION OF THE SERVICE STUB-OUT BY RE-EXCAVATION. THE RESPONSIBLE PARTY SHALL TAKE MEASUREMENTS OF DISTANCES FROM MANHOLES TO SERVICE TAPS AND GIVE THIS INFORMATION TO THE CITY. SERVICE LOCATIONS FOR SANITARY SEWER SHALL ALSO BE MARKED WITH AN "X" ON THE CURB. MARKINGS SHALL BE NEATLY CHISELED OR SAW-CUT, NOT PAINTED, BY THE RESPONSIBLE PARTY.



TYPICAL SEWER SERVICE CONNECTION DETAIL

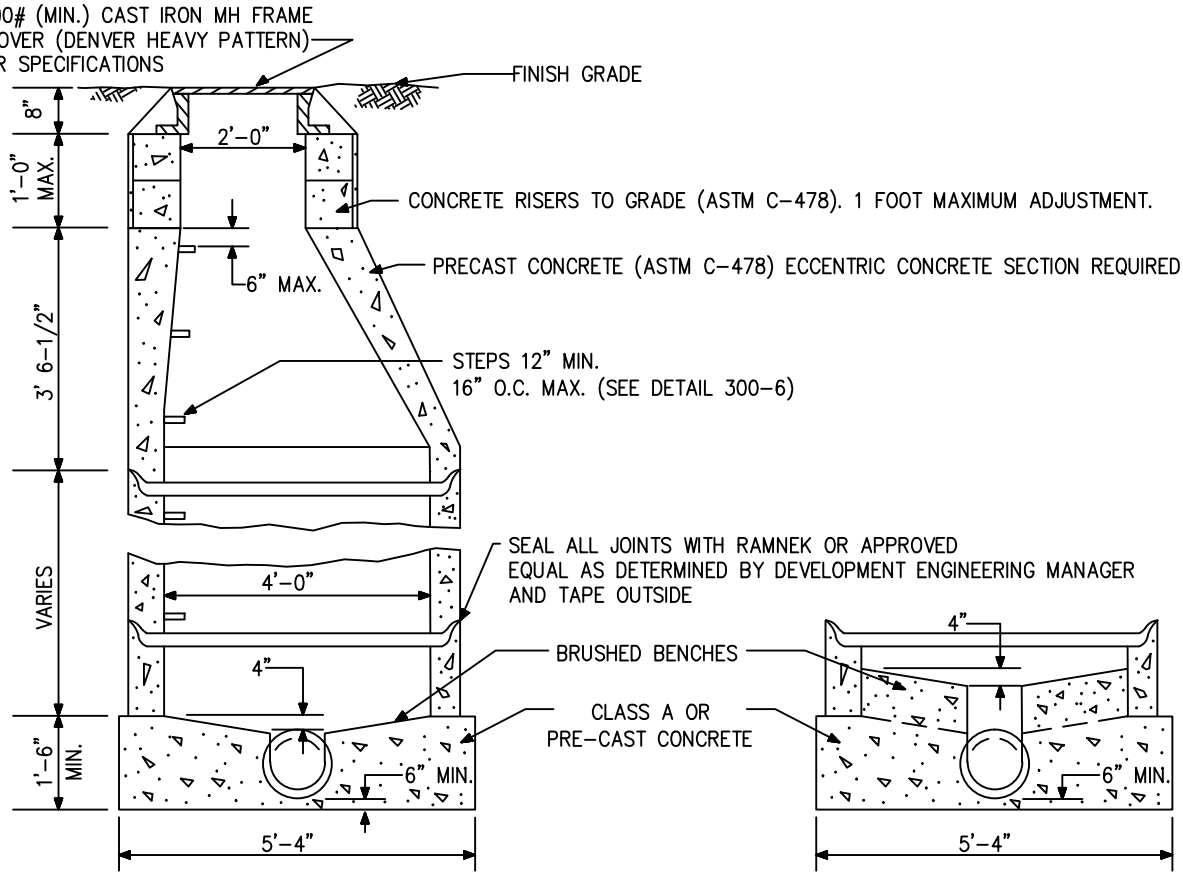
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SEWER MAIN BEDDING, UNDERDRAIN AND SERVICE CONNECTION DETAIL

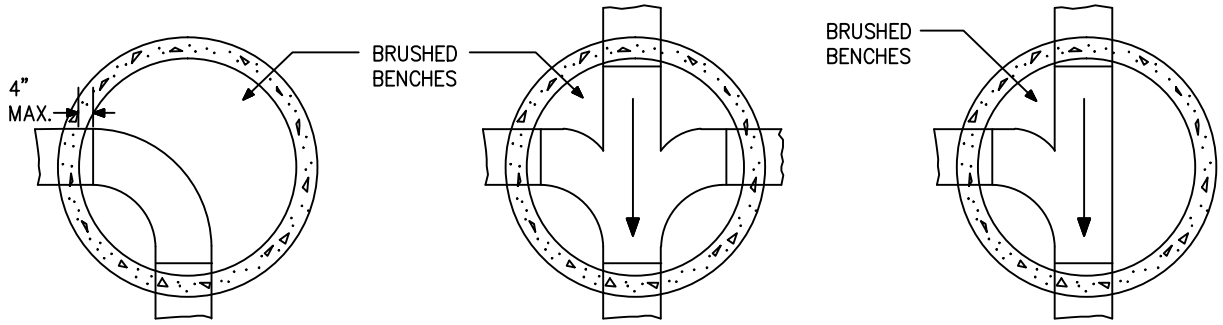
ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
300-2



NOTES:

1. TOP ELEVATION OF THE MANHOLE SHALL BE ADJUSTED TO EXACTLY MATCH FINAL STREET GRADE PRIOR TO THE INITIATION OF THE ONE (1) YEAR WARRANTY PERIOD.
2. IF MANHOLES ARE LOCATED IN OPEN FIELDS, THEY SHALL BE LEFT SIX (6) INCHES TO EIGHT (8) INCHES ABOVE GRADE WHERE PRACTICAL.
3. FLAT TOP SECTIONS MAY BE USED ON SHALLOW LINES WHERE CONE SECTIONS ARE IMPRACTICAL TO USE AS SPECIFIED BY THE DEVELOPMENT ENGINEERING MANAGER.
4. SEMI-DROP MANHOLES SHALL BE USED FOR DROPS OF 2'-0" OR LESS.
5. MANHOLE RINGS SHALL BE 30 INCH DIAMETER, WITH 24 INCH INSERT AND COVER, FOR 60 INCH AND 72 INCH DIAMETER MANHOLE BARRELS.
6. MANHOLE INVERTS SHALL BE FORMED AS INDICATED BELOW TO ENSURE SMOOTH FLOW THROUGH MANHOLE.
7. WHERE MORE THAN ONE SEWER ENTERS A MANHOLE, THE SMALLER OF THE LINES SHALL INSTALLED AT THE CROWN ELEVATION OF THE LARGER SEWER.
8. WATERPROOFING IS REQUIRED WHERE GROUNDWATER IS PRESENT AS REQUIRED BY THE DEVELOPMENT ENGINEERING MANAGER.
9. A LOCKING RING AND COVER SHALL BE INSTALLED ON MANHOLES LOCATED OUTSIDE OF ROADWAYS. THE LOCKING LIDS SHALL HAVE MCGARD INTIMIDATOR MANLOCKS MODEL NUMBER 117011 (2 PER MANHOLE).
10. THE CONCENTRIC CONE OF THE MANHOLE SHALL BE ROTATED SO THAT THE MANHOLE ACCESS IS TOWARDS THE CENTERLINE OF THE STREET.



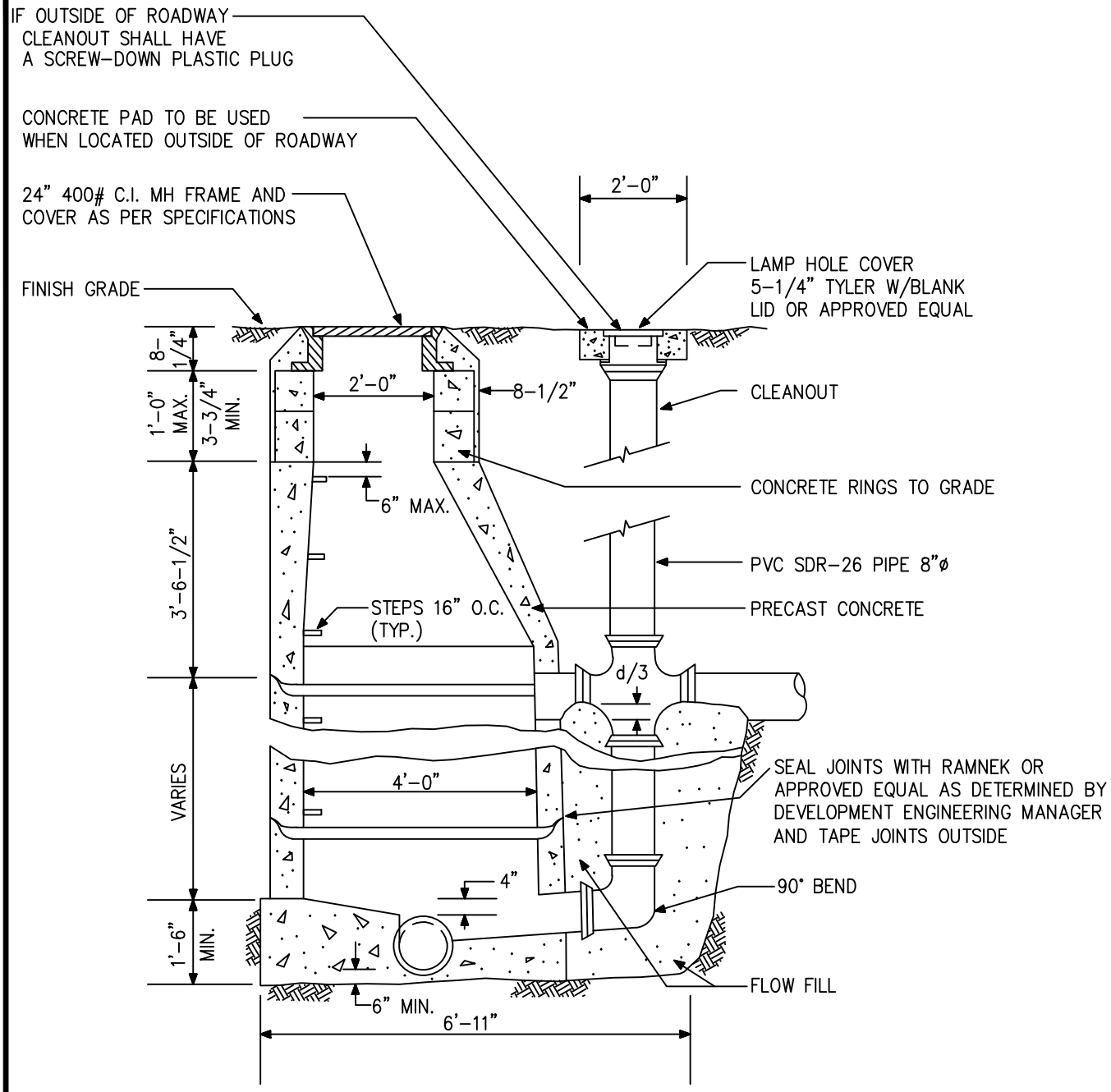
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD AND SEMI-DROP MANHOLE DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
300-3



NOTES:

1. SEE STANDARD MANHOLE DETAIL FOR PLAN OF INVERTS.
2. MINIMUM OF 18" OF CONCRETE REQUIRED BENEATH 90° BEND.
3. LIMITS OF CONCRETE BENEATH CROSS TO BE DETERMINED BY THE CITY INSPECTOR BASED UPON ACTUAL FIELD CONDITIONS.
4. SEAL JOINTS WITH RAMNAK OR APPROVED EQUAL AND TAPE JOINTS OUTSIDE.
5. A LOCKING RING AND COVER SHALL BE INSTALLED ON MANHOLES LOCATED OUTSIDE OF ROADWAYS. THE LOCKING LIDS SHALL HAVE MCGARD INTIMIDATOR MANLOCKS MODEL NUMBER 117011 (2 PER MANHOLE).

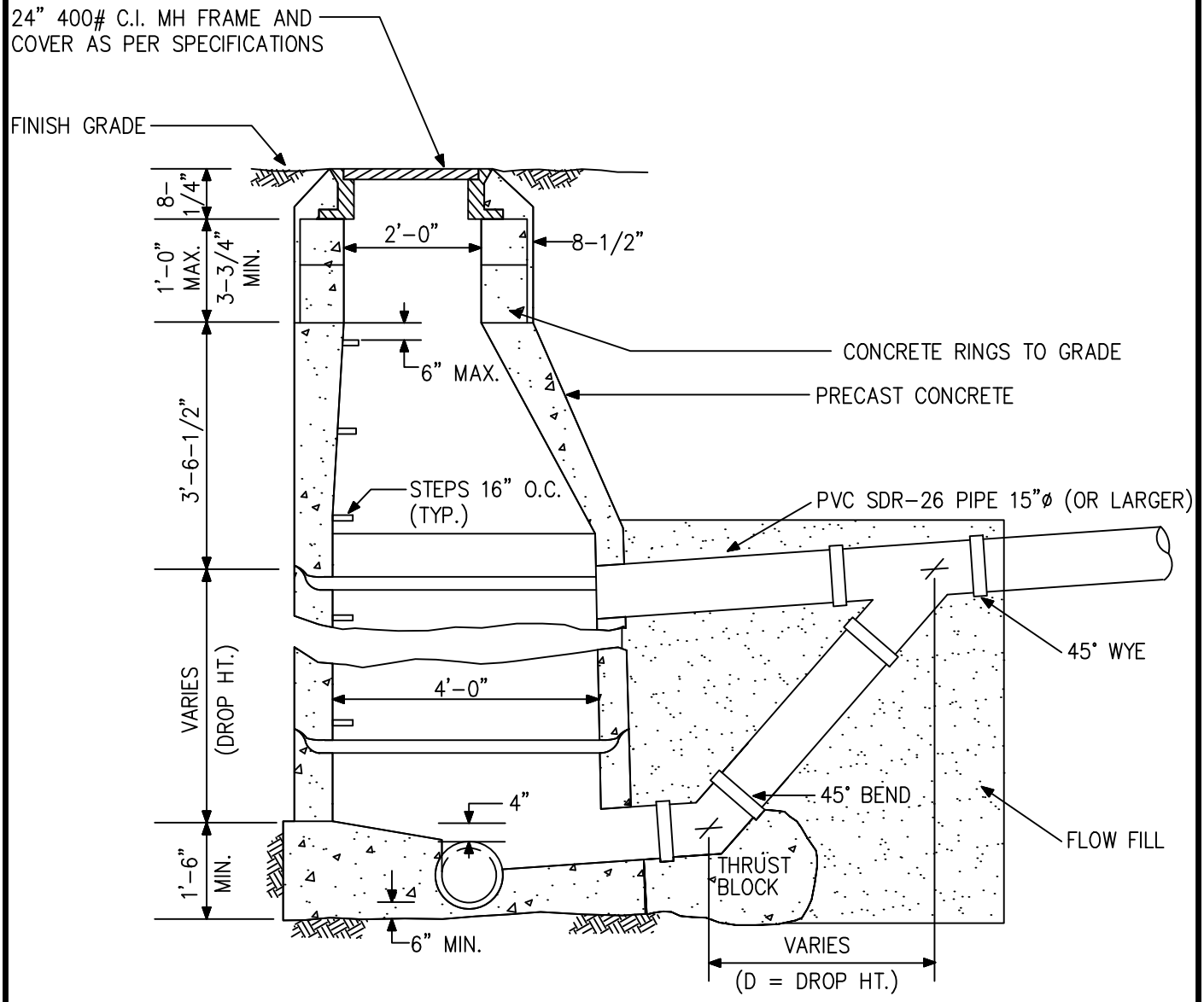
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

DROP MANHOLE – A
8" & 12" LINES DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
300-4A



NOTES:

1. SEE STANDARD MANHOLE DETAIL FOR PLAN OF INVERTS.
2. SEAL JOINTS WITH RAMNEK OR APPROVED EQUAL AS DETERMINED BY THE DEVELOPMENT ENGINEERING MANAGER, AND TAPE JOINTS OUTSIDE.
3. A LOCKING RING AND COVER SHALL BE INSTALLED ON MANHOLES LOCATED OUTSIDE OF ROADWAYS. THE LOCKING LIDS SHALL HAVE MCGARD INTIMIDATOR MANLOCKS MODEL NUMBER 117011 (2 PER MANHOLE).

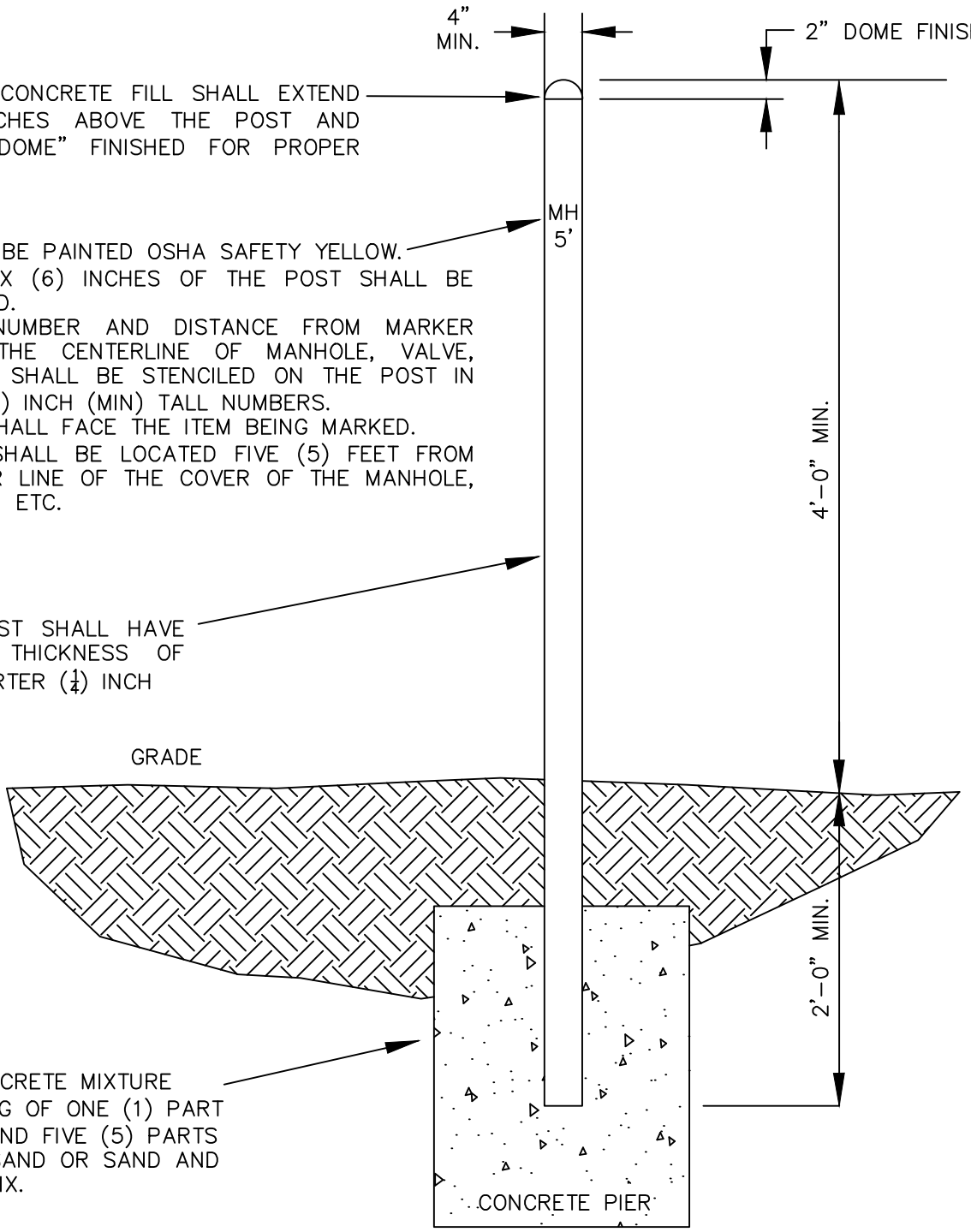
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD DROP MANHOLE – B
15" AND LARGER LINES DETAIL

ISSUED:
MAY 2000
REVISED:
APRIL 2010

DRAWING NO.
300-4B



NOTE: PIPE SHALL BE BLASTED (OR OTHERWISE CLEANED) PRIOR TO PRIMING AND PAINTING. THE PIPE SHALL BE COATED WITH TWO (2) LAYERS OF PRIME COAT AND ONE (1) OIL BASE SEMI-GLOSS FINISHING COAT IN THE COLORS SPECIFIED ABOVE. THE TOTAL PRIME AND PAINT THICKNESS SHALL BE A MIN. OF 4.5 MIL. THICKNESS OR 1.5 MIL. OF EACH LAYER.

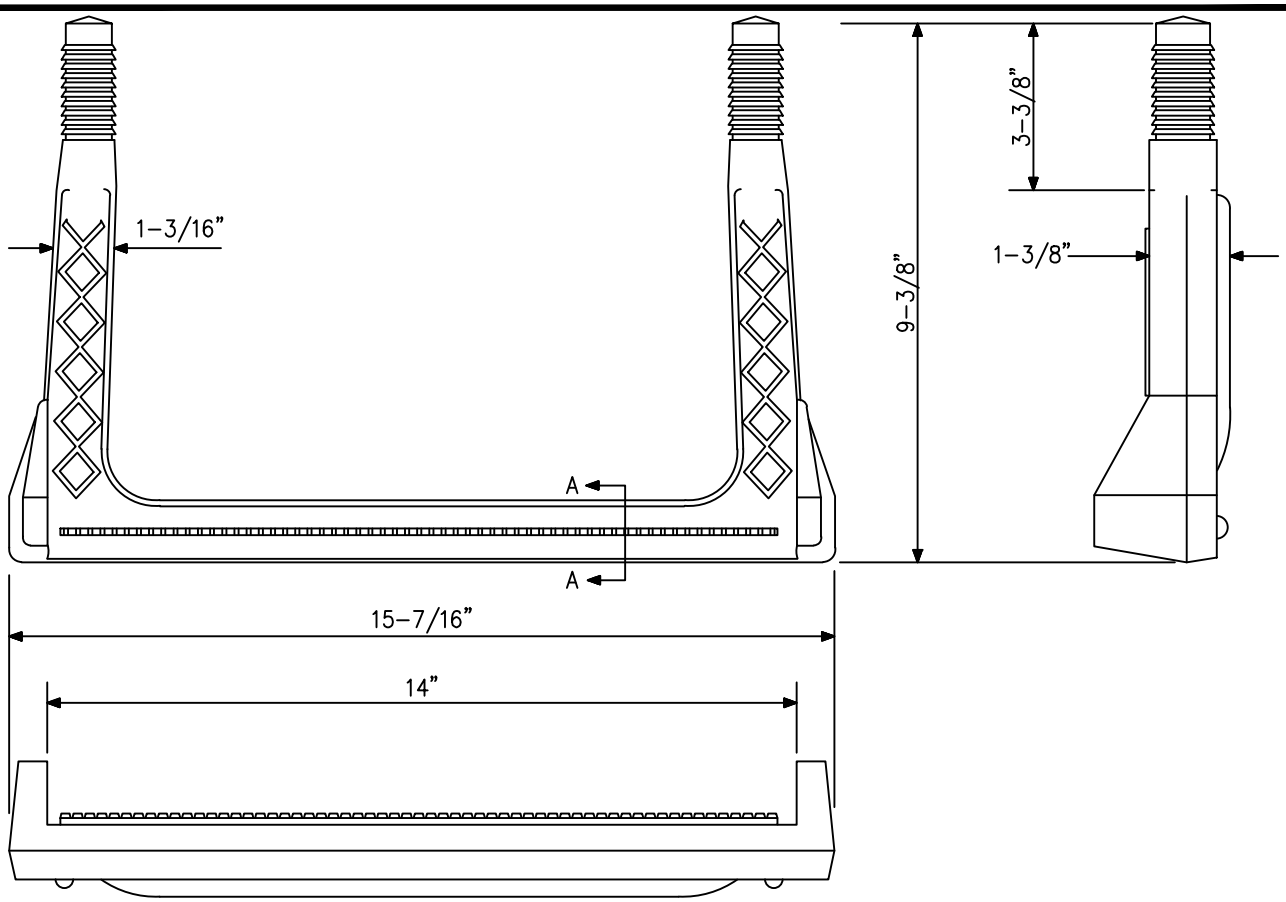
N.T.S.

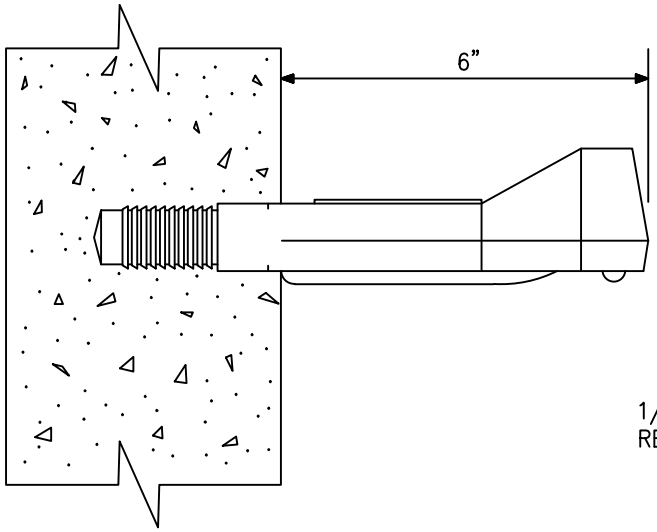
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

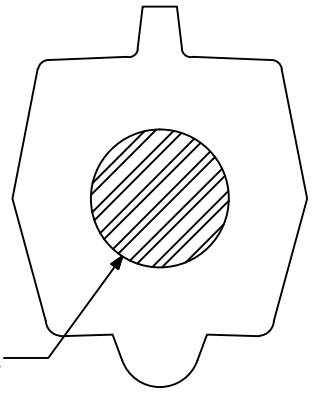
MARKER POST DETAIL

ISSUED: JANUARY 2003
REVISED: APRIL 2010

DRAWING NO. 300-5







SECTION-A

NOTE:
STEPS SHALL BE PLASTIC COATED STEEL STEPS MANUFACTURED BY M.A. INDUSTRIES INC., #PS2-PF, OR APPROVED EQUIVALENT, AS DETERMINED BY THE DEVELOPMENT ENGINEERING MANAGER, SPACED 12 TO 16 INCHES ON CENTER, ALIGNED AWAY FROM THE INVERT OVER LARGEST BENCH.

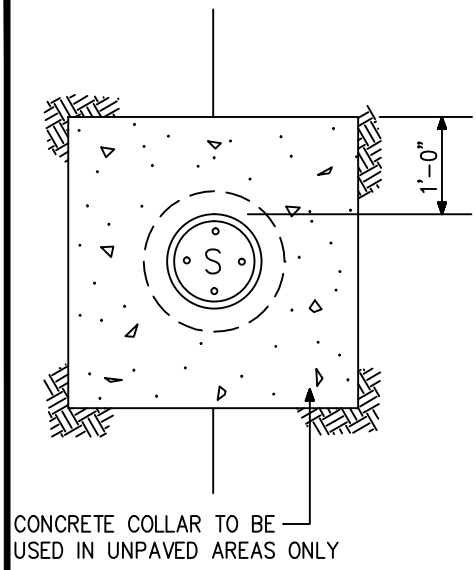
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

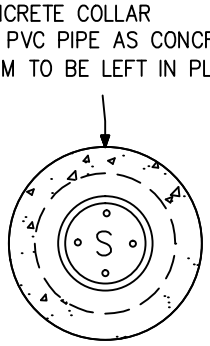
PLASTIC MANHOLE STEP DETAIL

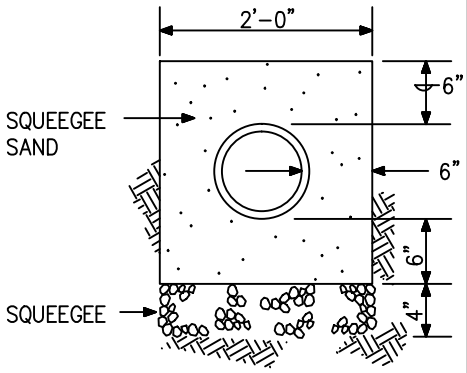
ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
300-6

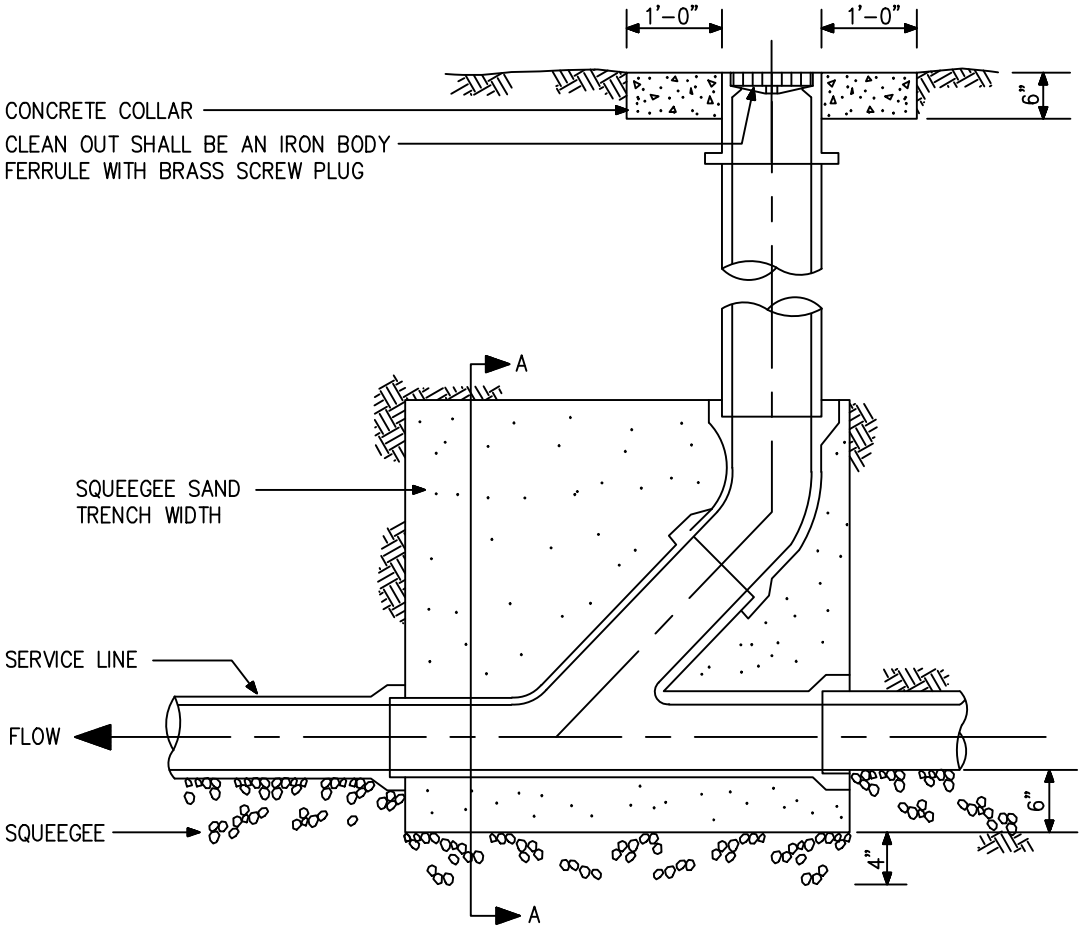


PLAN VIEW





SECTION A-A



ELEVATION

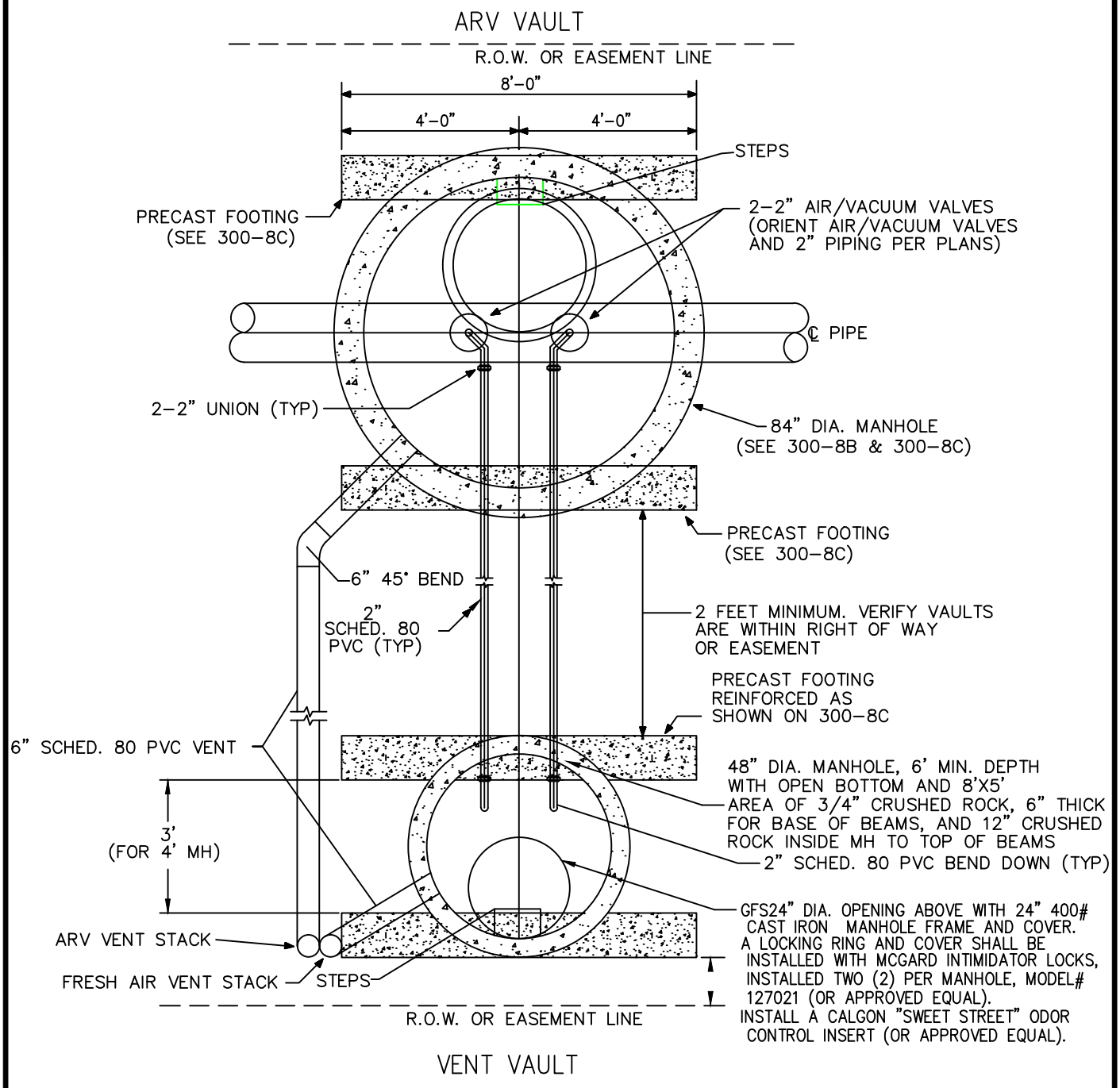
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD CLEAN-OUT DETAIL

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
300-7



NOTES: 1. SEE PLANS FOR LOCATIONS OF VENT STACKS.
2. SEE DETAIL 300-8B & 300-83 FOR ADDITIONAL INFORMATION.

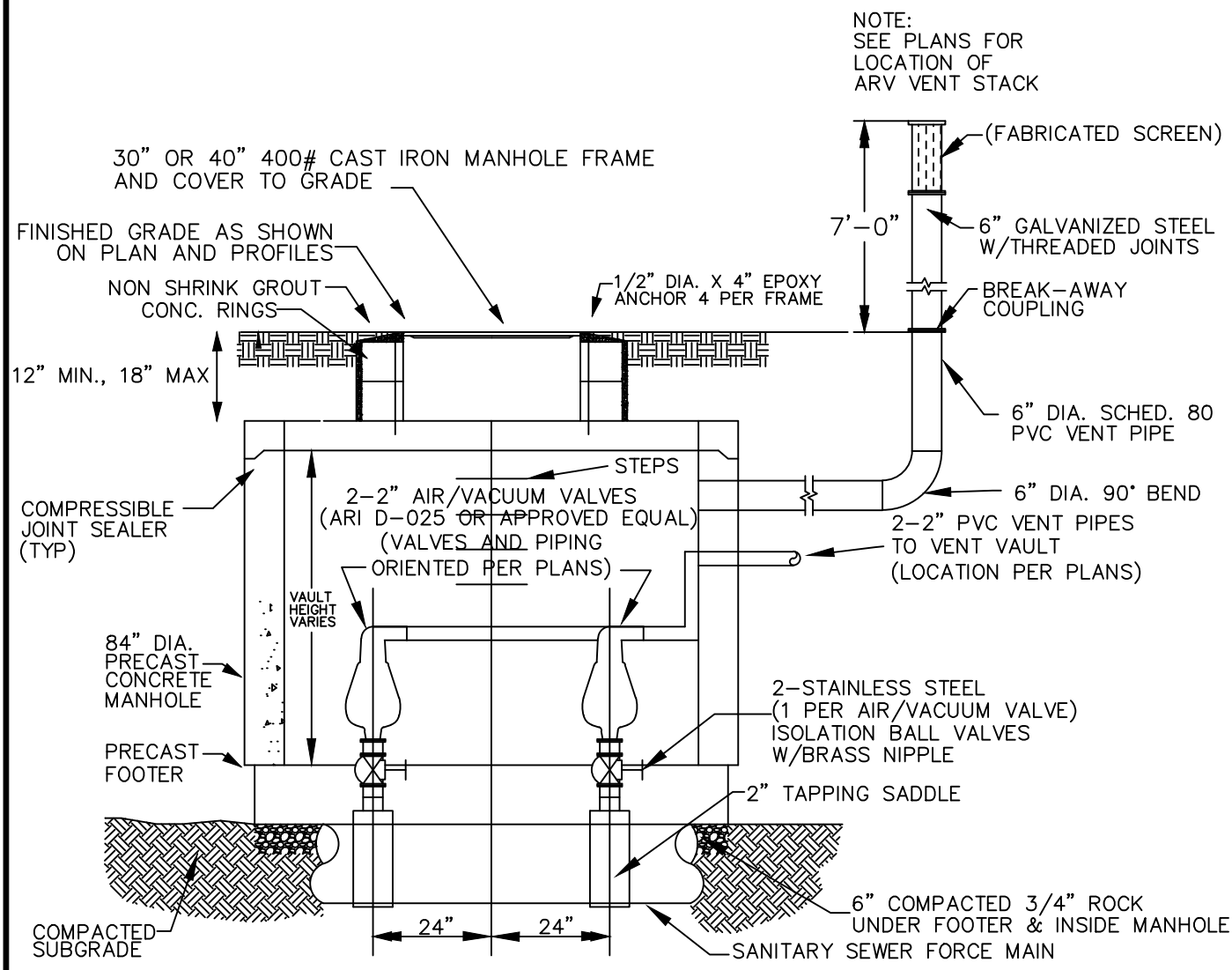
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SANITARY SEWER ARV AND VENT VAULTS DETAIL

ISSUED:
JUNE 2005
REVISED:
APRIL 2010

DRAWING NO.
300-8A



SEE DETAIL 300-8A AND 300-8C FOR ADDITIONAL INFORMATION

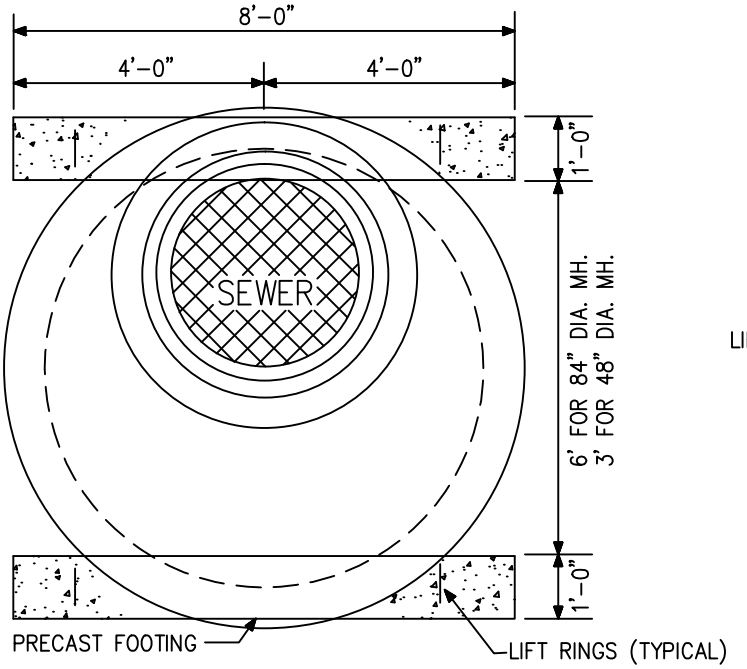
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

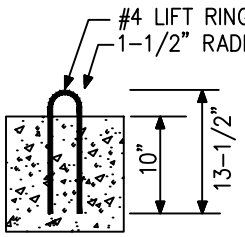
SANITARY SEWER ARV DETAIL

ISSUED:
JUNE 2005
REVISED:
APRIL 2010

DRAWING NO.
300-8B

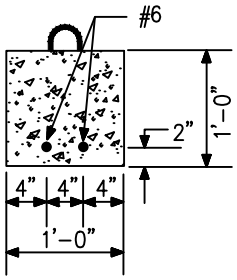


MANHOLE PLAN

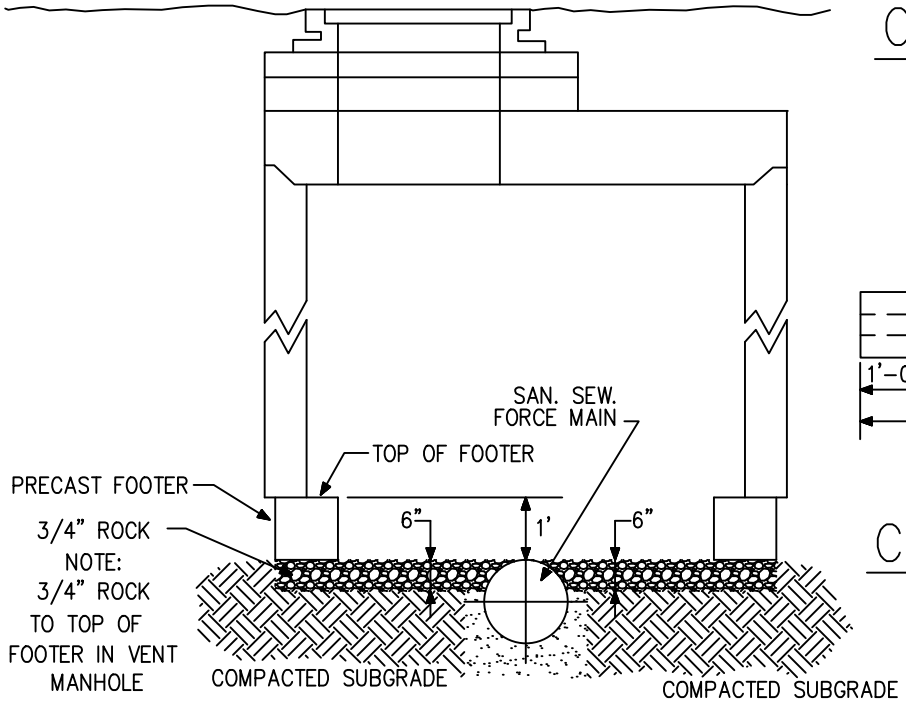


LIFT RING*

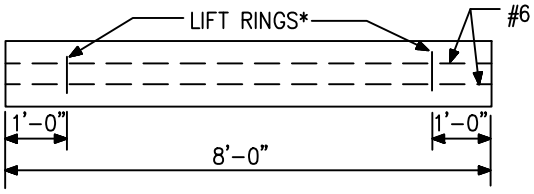
LIFT RINGS* AS SHOWN OR APPROVED EQUAL



SECTION
CONCRETE FOOTING



ELEVATION



PLAN
CONCRETE FOOTING

SEE DETAIL 300-8A AND 300-8B FOR ADDITIONAL INFORMATION N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SANITARY SEWER ARV MANHOLE & VENT MANHOLE BASE FOOTING DETAILS

ISSUED:
JUNE 2005
REVISED:
APRIL 2010

DRAWING NO.
300-8C

SECTION 400 - STORM DRAINAGE DESIGN, GRADING, AND WATER QUALITY TECHNICAL CRITERIA

TABLE OF CONTENTS

TABLES

DETAIL DRAWINGS

SECTION 400 - STORM DRAINAGE DESIGN, GRADING, AND WATER QUALITY TECHNICAL CRITERIA

401 GENERAL PROVISIONS

401.1 Purpose

A. These standards are promulgated by the Public Works Director of the City in accordance with the authority contained in the City Code. Improvements shall also be in conformance with all applicable provisions of the City Code. B. This section presents the minimum design and technical criteria for the analysis and design of storm drainage facilities located within the City. All subdivisions or any other proposed construction, which increase drainage from historic levels or otherwise alters storm runoff shall be subject to these Standards and Specifications. The primary resource for stormwater drainage policy and design is the Urban Drainage and Flood Control District's (UDFCD) Urban Storm Drainage Criteria Manual (UDFCD Manual). The purpose of these Standards and Specifications is to further define the guidelines and/or to identify variations.

C. In addition to the above, these regulations are to establish minimum design criteria for water quality control, flood control, and site grading, which are all closely related to stormwater management.

1. Design Criteria

Storm drainage system analysis and design shall meet or exceed these Standards and Specifications which were developed to support and supplement the policies and standards set forth by the UDFCD. Policies and technical criteria not specifically addressed in this document shall follow the provisions of the UDFCD Manual. The Responsible Party is also referred to the Colorado Department of Transportation's Standard Plans ("M-Standards") for additional design details not covered in these Standards and Specifications or the UDFCD Manual.

2. Review and Approval

a. The Development Engineering Manager shall review submittals as necessary for general compliance with these Standards and Specifications. An approval by the Development Engineering Manager does not relieve the Responsible Party from the responsibility of ensuring that the calculations, plans, specifications, construction, and record drawings are in compliance with these Standards and Specifications.

b. The UDFCD shall approve reports and construction plans for regional detention ponds or Masterplan drainageway improvements as required by this Section or the UDFCD Manual. Where floodplain delineation is involved, UDFCD and FEMA approval is required. All submittals to either UDFCD or FEMA shall be made to the City, who will coordinate the submittal and approval.

402 STORM DRAINAGE DESIGN CRITERIA

402.1 Rainfall

1. Introduction

A. Colorado Urban Hydrograph Procedure (CUHP) or an equivalent method shall be used to generate an inflow hydrographs from watersheds unless a variance is approved by the Development Engineering Manager.

B. Design Storm Distribution

The one (1) hour design point rainfall values obtained from the NOAA Atlas for Thornton are as follows:

TABLE 400-1

ONE (1) HOUR POINT RAINFALL (IN.)

2-YEAR	5-YEAR	100-YEAR
.97	1.38	2.69

402.2 Runoff

A. Introduction

This subsection presents the criteria and methodology for approximating the storm runoff design peaks and volumes to be used in the City in the preparation of storm drainage studies, plans, and facility design.

The details of the rainfall/runoff models are presented in the UDFCD Manual. The specific input data requirements and modifications to the procedures are presented in this subsection.

B. CUHP

The CUHP method or equivalent UDFCD method shall be used to determine stormwater runoff calculations. The procedures for the CUHP, as explained in the Manual, Volume-1 "Runoff," shall be followed in the preparation of drainage reports or plans and storm drainage facility designs in the City.

402.3 Overlot Grading

For residential application (single family detached and duplex), the grading shall be designed so that no more than one lot shall drain through another lot.

402.4 Street Drainage

A. Introduction

The Responsible Party is directed to utilize the UDFCD Manual for allowable use of streets for storm runoff, with the exception that the allowable depth of water at the gutter flowline shall be 12 inches on local and collector roadways and streets shall be designed so that the runoff does not encroach onto residential lots.

402.5 Curb and Gutter

A. The minimum longitudinal slope of a gutter shall be 0.75%.

B. The minimum cross slope of two (2)% for pavement drainage.

C. Concrete cross pans may be used to convey runoff across intersections. However, cross pans will only be permitted at locations where traffic is controlled by a stop sign. The minimum longitudinal slope for cross pans is 0.75%.

402.6 Roadside Ditches

A. Roadside ditches shall not be permitted in lieu of curb and gutter for public right-of-way except in instances where the Responsible Party is only required to construct curb and gutter for one (1) side of the roadway, then roadside ditches are permitted and shall be designed to adequately carry the street runoff caused by the minor storm.

B. Freeboard of six (6) inches is required on all roadside ditches.

C. Roadside ditches shall be designed with maximum side slopes of 4:1 and maximum velocities during the minor storm of five (5) feet per second.

D. Where the requirements of this section cannot be met, curb and gutter and/or storm sewer shall be required.

E. Roadside ditches are not permitted in or adjacent to developed property. Are allowed only on a temporary basis and must be approved by the Development Engineering Manager. The primary function is to convey right-of-way drainage to an approved drainage system or approved drainageway.

402.7 Storm Sewers

A. Introduction

1. Storm sewers must be designed to convey the minor storm without surcharging the pipe. The CUHP method is required to determine the peak flows that the storm sewers must be able to covey. Modeling shall be done using StormCAD or approved equal.

2. All storm sewer infrastructure in public right-of-ways shall be designed for the ultimate cross section of the roadway.

3. The minimum allowable pipe size for all public storm sewer shall be 18 inches.

4. Private owned and maintained detention pond outlet pipes which do not discharge to public right-of-way may be smaller than 18 inches.

B. Vertical Alignment

1. The storm sewer grade shall be such that a minimum cover is maintained to withstand AASHTO HS-20 loading on the pipe. The minimum cover depends upon the pipe size, type and class, and soil bedding condition, but shall be not less than 18 inches for Reinforced Concrete Pipe (RCP) and 24 inches for High Density Polyethylene (HDPE) at any point along the pipe.

2. Refer to Section 200 and 300 for clearance requirements.

3. Uniform slopes shall be maintained between manholes.

C. Horizontal Alignment

The minimum horizontal separation between storm sewers and water mains shall be 10 feet measured from edge of pipe to edge of pipe.

D. Material

Storm sewers within the City shall be constructed using the following material and meet the applicable standard as presented below:

TABLE 400-2

STORM SEWER STANDARDS

Pipe Material	Standard	Application
Reinforced Concrete (ClassIII)	ASTM C-76/C-506/C-507/C-789/C-850 or AASHTO M-170/M-206/M-207/M-259/M-273	Permitted for all public and private storm sewer
High Density Polyethylene Polyvinyl Chloride Pipe	AASHTO M-294/M-252 or ASTM F-667ASTM F-679/F-794/F-1803/D-3212/F-477 or AASHTO M-304	Permitted for all private storm sewer

1. High Density Polyethylene Polyvinyl Chloride Pipe (HDPE)

i. The maximum pipe size for High Density Polyethylene is 48 inch diameter.

ii. The minimum allowable pipe size for all public storm sewer, with the exception of detention pond outlets shall be 18 inches.

iii. The Responsible Party's shall provide calculations for all concrete head and end walls required due to the buoyancy of HDPE.

E. Storm Sewer Hydraulics

All storm sewers shall be designed for the buildout condition of the street as depicted in the current Transportation Plan, and include the five (5) and 100 year HGL. The five (5) year HGL should be completely contained within the pipe and the 100 year HGL must be contained within the overall drainage system but cannot encroach onto any lots.

402.8 Inlets

1. All inlets in sump conditions must provide an emergency overflow that does not encroach upon residential lots. All emergency overflows shall be designed for a major storm and the assumption that the storm sewer system is plugged. In addition, the 100 year ponding shall be shown on grading plans.

2. Care should be taken to not place inlets within areas which will be shadowed during the winter months by structures, landscaping, or fencing along the south side of east-west roadways. This may require additional inlets along north-south roadways to minimize flows to the south side of an east-west street.

A. Types of Inlets

Grate and slotted inlets and are not permitted.

402.9 Manholes

A. Manholes shall be required whenever there is a change in size, direction, elevation, grade, or where there is a junction of two (2) or more pipes.

B. Manhole covers are not permitted within concrete areas (i.e. gutter, sidewalks, crosspans, etc.).

C. Grate or slotted manhole lids are not permitted.

D. A locking ring and cover shall be installed on manholes located below the HGL of the major (100 year) storm. See Section 404 for requirements.

TABLE 400-3

REQUIRED MANHOLE SIZES:

SEWER DIAMETER	MANHOLE DIAMETER
18"	4'
21" to 42"	5'
48" to 54"	6'
60" and larger	CDOT Std. M-604-20 and M-604-21

MAXIMUM SPACING:

VERTICAL DIMENSION OF PIPE (INCHES)	MAXIMUM ALLOWABLE DISTANCE (FEET)
18” to 36”	400’
42” and larger	500’

B. Larger manhole diameters or a junction structure may be required when sewer alignments are not straight through or more than two (2) storm sewers enter the manhole.

D. A locking ring and cover shall be installed on manholes located in open fields. The locking lids shall have McGard Intimidator man locks installed two (2) per manhole, model No. 117011 or approved equal.

402.10 Hyrdaulic Structures

A. Seepage Analysis

Seepage analyses shall be performed on all hydraulic structures (i.e. irrigation ditches, ponds, etc) both existing and proposed which may impact the development. Linings, cut off walls and/or underdrains may be required if seepage is found.

B. Culvert or Storm Sewer Outlet Structures

1. Rip rap or approved equivalent is required at all culvert and storm sewer outfalls as depicted in Detail 400-4. These structures must be designed to minimize or eliminate standing water.

2. Impact Stilling Basins

Reinforced concrete stilling basins are not allowed at culvert outlets unless they are located within a major drainageway which will be maintained by UDFCD. All stilling basins shall be designed to minimize or eliminate standing water.

C. Breach Analysis

A breach analysis is required for all hydraulic structures.

402.11 Post Construction Stormwater Quality

A. Permanent water quality best management practices (BMPs) are required for new or redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale. If water quality detention is required, full spectrum detention pond sizing method shall be utilized per the UDFCD Manual.

B. Acceptable stormwater management practices include those found in the UDFCD Manuals Volume 3 – Water Quality Capture Volume.

C. Consideration for selecting and using stormwater management BMPs for a specific development will include, but not limited to: site applicability, public safety, spatial requirements, soil characteristics, hydrologic benefits, slope, existing land use conditions, maintenance requirements, location within the watershed, buffer requirements, tree protection, and easements. In addition to the items listed above, it is the City's goal to make stormwater features amenities and assets to the overall aesthetics of the City.

402.12 Detention Pond Design

A. Introduction

Detention ponds are used for stormwater runoff quantity control to mitigate the effects of excess runoff due to development. Parking lot and underground detention shall not be permitted in residential subdivisions.

B. Detention Sizing Procedures

1. The method for determining runoff magnitude will be by the CUHP or equivalent methodology. An inflow hydrograph is required for sizing of detention facilities.

2. The Rational Method shall only be used for sites less than 1 acre.

3. Detention ponds that accept stormwater runoff from public right-of-ways shall be designed for the ultimate cross section of the roadway.

4. Water quality detention is required for all development and adjacent rights-of-way if it is not included in the Excess Urban Runoff Volume (EURV) provided by Full Spectrum Detention design method. This is designated as the two (2) year frequency event.

Storage volumes must be calculated using the Full Spectrum Detention Pond sizing method; therefore, the empirical equations and the Modified FAA Procedure may not be used except for preliminary estimating purposes. The 100 year water surface elevation shall be less than residential lots.

C. Forebays

Concrete forebays are not allowed unless it is a regional facility. However, outlet protection to control outfall velocities is required.

D. Outlet Configuration

See Details 400-5A and 400-5B for detention pond outlet structure requirements. Micropools are not allowed except within the outlet structure.

E. Grading Requirements

Side slopes for detention ponds shall not be steeper than four (4) horizontal to one (1) vertical. The minimum bottom slope from storm sewer pipe to outlet box shall be two (2)% measured perpendicular to the trickle channel. In addition, the bottom of the pond shall slope at a minimum of four (4)%. Access is required to all detention ponds, and shall be a minimum of 10 feet wide and a maximum slope of seven (7)%.

F. Trickle Channel or Low flow Channel

Detention ponds may include a low flow trickle channel to convey storm drainage from the culvert outlets to the outlet structure. The trickle channel shall be a "u-style" channel terminating prior to the outlet structure to allow for vegetation to capture sediment and oil.

G. Emergency Overflow Spillways

1. Emergency overflow spillways shall be designed to pass twice the 100 year storm and have one (1) foot of freeboard.

2. The emergency overflow spillway shall be designed to have an overland flow path to convey flows to a designated drainageway or right-of-way, without encroaching onto residential lots.

Emergency overflow spillways shall be constructed of grouted rip-rap buried a minimum of 12 inches.

402.13 Minor and Major Drainage System

Subdivisions shall include the planning, designing, and implementation for both the minor and major drainage systems. The five (5) and 100 year respectively.

A. Downstream Effects

1. The downstream conveyance system shall be evaluated to ensure that it has sufficient capacity to accept design discharges without adverse backwater or downstream impacts such as flooding, erosion, and sediment deposition. Each design must take into consideration travel path to the nearest designated major drainage facility (i.e. creek, river, etc…)

2. Drainage easements may be required from all downstream property owners through which developed stormwater flows are conveyed between the proposed development and an approved drainageway.

3. Runoff from private property should be directed to approved drainageways or public right-of-way. Adverse impacts on adjacent property due to storm or irrigation runoff should be avoided whenever possible. Special procedures such as drainage swales or grading restrictions may be required to minimize impacts.

4. Easement Requirements

The City requires dedicated drainage easements whenever surface or subsurface drainage from public property drains across private property, for detention ponds and for property within the floodplain.

a) Storm sewer shall be installed in dedicated right-of-way or drainage easements, as determined by the Development Engineering Manager. The minimum width requirements for drainage easements are 20 feet or twice the depth of the pipe, whichever is greater. The pipeline shall be centered in the easement and offset a minimum of five (5) feet from any property line. In the event that two (2) or more utilities share the same easement, the minimum width for the easement shall be 30 feet, and for three (3) public utilities, the width shall be 40 feet, etc.

b) Detention ponds both public and private shall be encompassed within a tract with a drainage easement granted over the tract.

c) Floodplains shall be encompassed within a tract with a drainage easement granted over the tract.

403 CONSTRUCTION SPECIFCATIONS

403.1 Pipe Material

A. Storm sewers within the City shall be constructed using the following material and meet the applicable standard as presented below:

TABLE 400-4

STORM SEWER STANDARDS

Pipe Material	Standard
Reinforced Concrete (Class III)	ASTM C-76/C-506/C-507/C-789/C-850 or AASHTO M-170/M-206/M-207/M-259/M-273
High Density Polyethylene Polyvinyl Chloride Pipe	AASHTO M-294/M-252 or ASTM F-667ASTM F-679/F-794/F-1803/D-3212/F-477 or AASHTO M-304

B. Manholes;

1. As depicted on detail 400-3.

2. A locking ring and cover shall be installed on manholes located below the HGL of the major storm.

a. Manholes located outside of the roadway section shall have McGard Fibershield locking lids or approved equal.

b. For manholes located in the roadway section, the locking lids shall have McGard Intimidator man locks installed two (2) per manhole, model No. 11701, or approved equal.

403.2 Pipe Installation

A. Refer to Detail 400-2 for pipe bedding requirements.

D. High Density Polyethylene Pipe (HDPE)

The Responsible Party's shall provide calculations for all concrete head and end walls required due to the buoyancy of HDPE.

403.3 As-Built Certification

The Responsible Party shall provide a final detention pond volume certification, as constructed topographic map of the detention pond, and the final release rates in accordance to drainage criteria.

404 UNDERDRAINS

A. Mains

1. Underdrains are required to be installed in all residential subdivisions. The underdrain main shall connect to the foundation drain system of every residence.

2. Underdrains shall be installed for commercial and industrial subdivisions where they are recommended by the Geotechnical Engineer.

3 The underdrain main shall be the responsibility of the Homeowners' Association or the Business Owners' Association and will not be owned or maintained by the City.

4. Underdrain main shall be installed in accordance with the approved construction plans, prepared under the direction of a registered professional engineer.

5, Underdrain main shall be a minimum of six (6) inches, and constructed of black HDPE.

6. Underdrain pipes shall be placed in a trench approximately one (1) to one and one-half (1-1/2) feet below sanitary sewer main.

7. Underdrain main shall be provided with a minimum of 6 inch clean-outs.. Underdrain cleanouts will not be permitted in public storm or sanitary sewer manholes.

8. If groundwater is present, underdrain pipe may be perforated in the lower quadrants and shall be contained within a geotextile fabric.

9. The underdrain system shall discharge directly to the detention pond, and shall not discharge into any part of the storm or sanitary sewer system.

B. Services

1. A minimum of four (4) inch HDPE pipe is required for underdrain services. Underdrain services shall be black HDPE pipe, with cleanouts as appropriate,

2. Underdrain services shall be the responsibility of the Owner.

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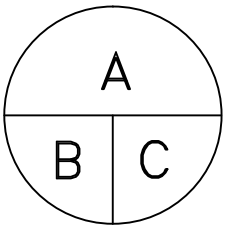
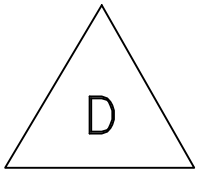


A=BASIN DESIGNATION

B=AREA IN ACRES

C=COMPOSITE RUNOFF COEFFICIENTS



D=DESIGN POINT DESIGNATION

SUMMARY RUNOFF TABLE
(TO BE PLACED ON DRAINAGE PLAN)

DESIGN POINT	CONTRIBUTING AREA (ACRES)	RUNOFF 5YR (CFS)	PEAK 100YR (CFS)
XX	XX.XX	XX.X	XX.X

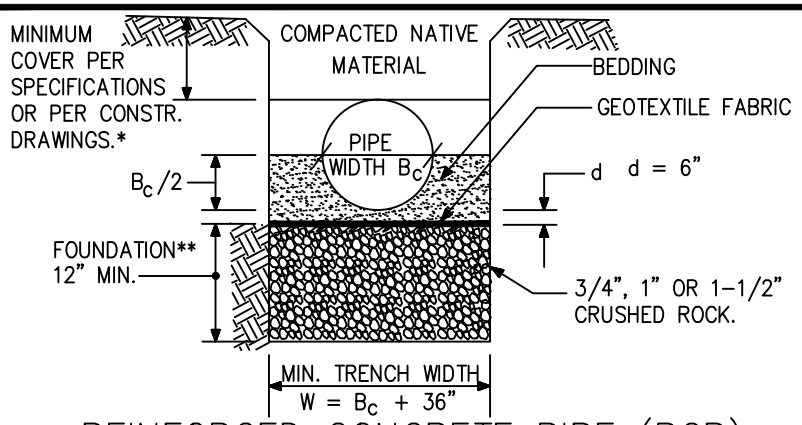
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

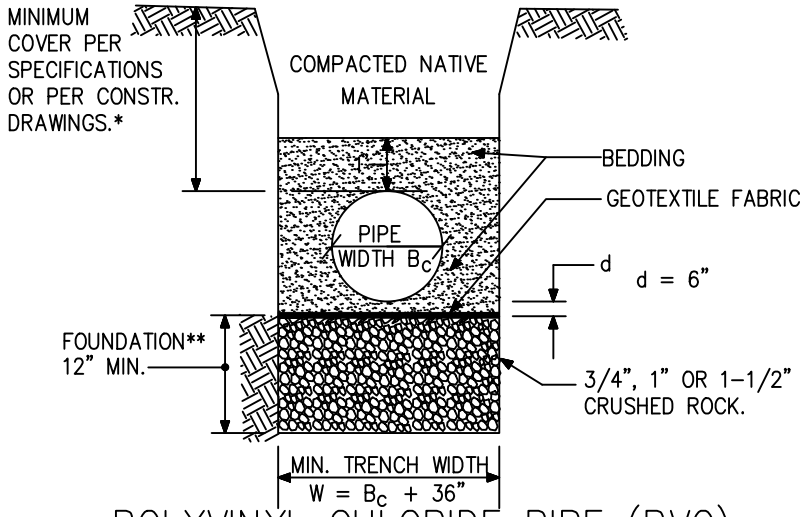
DRAWING SYMBOL CRITERIA & HYDROLOGY REVIEW TABLE

ISSUED:
APRIL 1993
REVISED:
APRIL 2010

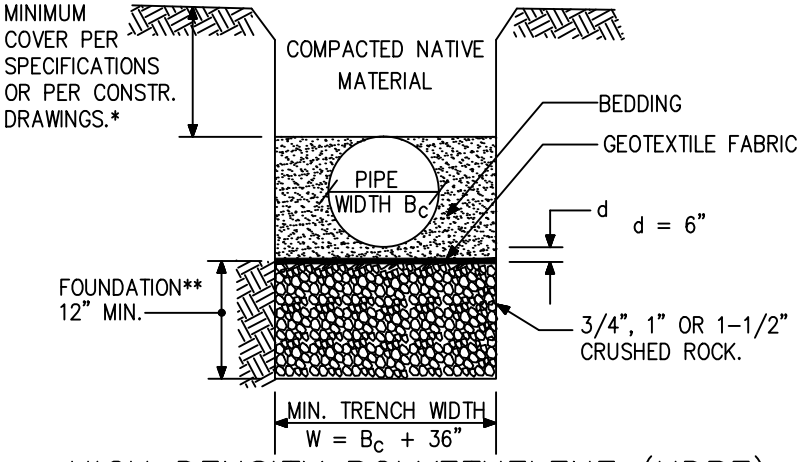
DRAWING NO.
400-1



REINFORCED CONCRETE PIPE (RCP)



POLYVINYL CHLORIDE PIPE (PVC)



HIGH DENSITY POLYETHELENE (HDPE)

NATIVE SOIL:	BEDDING:
COARSE GRAINED SAND AND GRAVEL (50% OR MORE BY WEIGHT RETAINED ON # 40 SIEVE)	CDOT CLASS A FILTER MATERIAL (SECTION 703.0q)
FINE GRAINED SOIL (LESS THAN 50% RETAINED ON # 40 SIEVE)	UDFCD TYPE 1 FILTER MATERIAL, CDOT FINE AGGREGATE FOR CONCRETE AASHTO M6 (SECTION 703.01)

* MINIMUM COVER SHALL NOT INCLUDE PAVEMENT.

** MAY BE REQUIRED IN AREAS WITH HIGH GROUNDWATER TABLE OR UNSUITABLE SUB-GRADE.

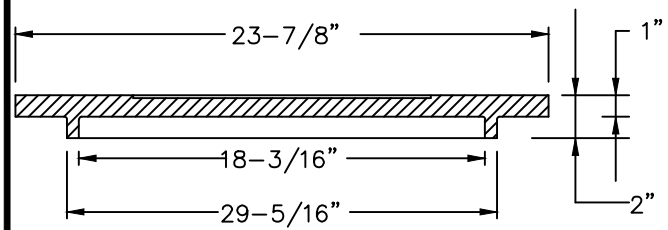
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

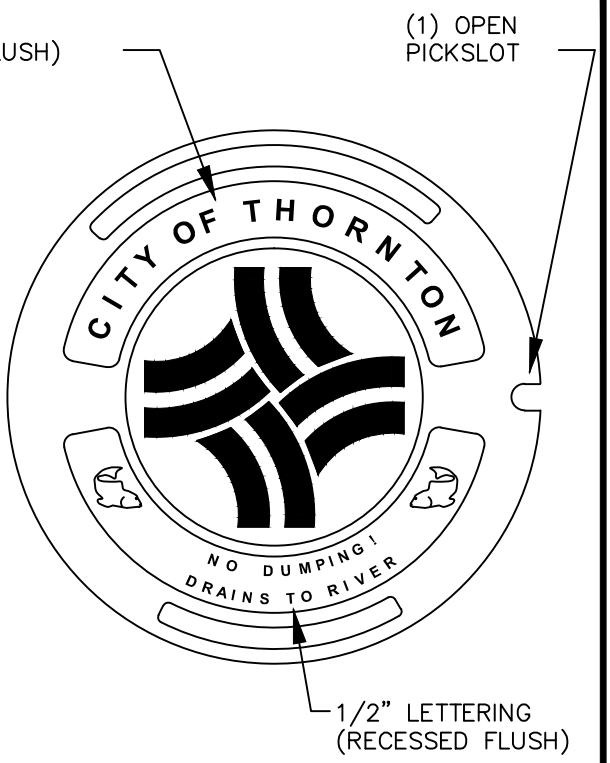
STORM DRAINAGE PIPE BEDDING DETAILS

ISSUED:
DECEMBER 2002
REVISED:
APRIL 2010

DRAWING NO.
400-2



COVER SECTION



TOP VIEW

NOTES:

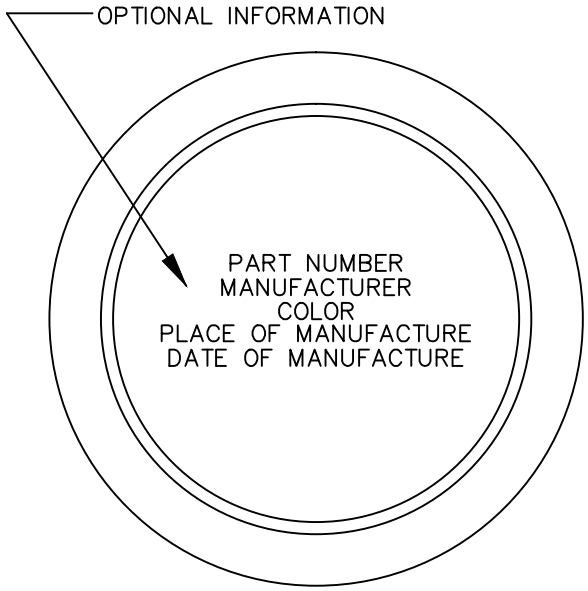
EST. WT = 112 LBS.

COVER – GRAY IRON ASTM A48 CL35B

HEAVY DUTY LOAD RATING.

MANHOLE TO BE EAST JORDAN IRON WORKS, INC.

CATALOG NO. 2408A OR APPROVED EQUAL.



BOTTOM VIEW

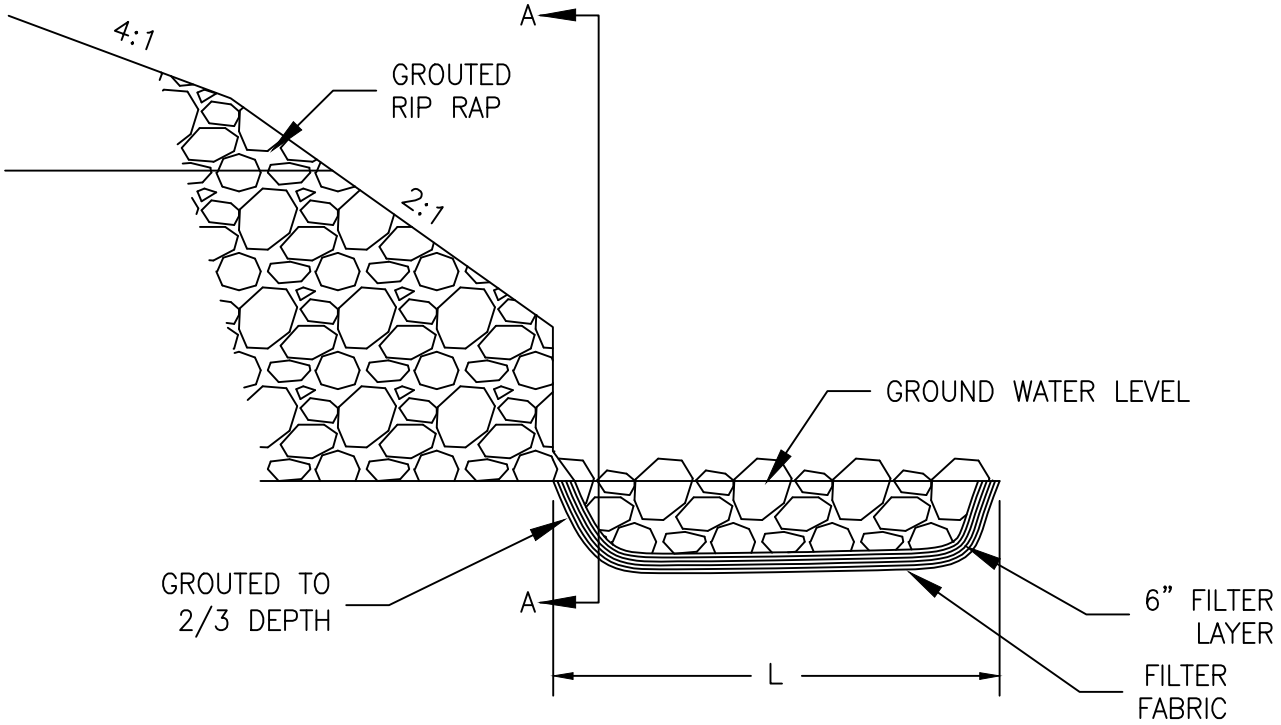
N.T.S.

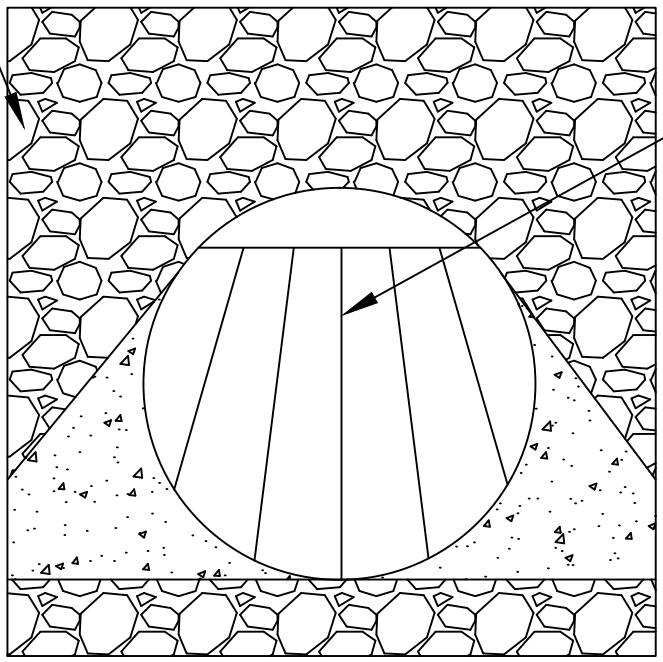
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STORM MANHOLE COVER

ISSUED:
NOVEMBER 2005
REVISED:
APRIL 2010

DRAWING NO.
400–3





NOTES:
1. L, D, AND W DIMENSIONS TO BE PROVIDED BY THE ENGINEER OF RECORD
2. RIP RAP SHALL BE HAND PLACED
3. SEE SPECIFICATIONS FOR MATERIALS
4. FILTER LATER AND FABRIC ARE INCIDENTAL TO RIP RAP
5. ADD RIP RAP OVER TOP OF PIPE
6. PIPE SHALL BE RCP TO FIRST STRUCTURE

SECTION A–A

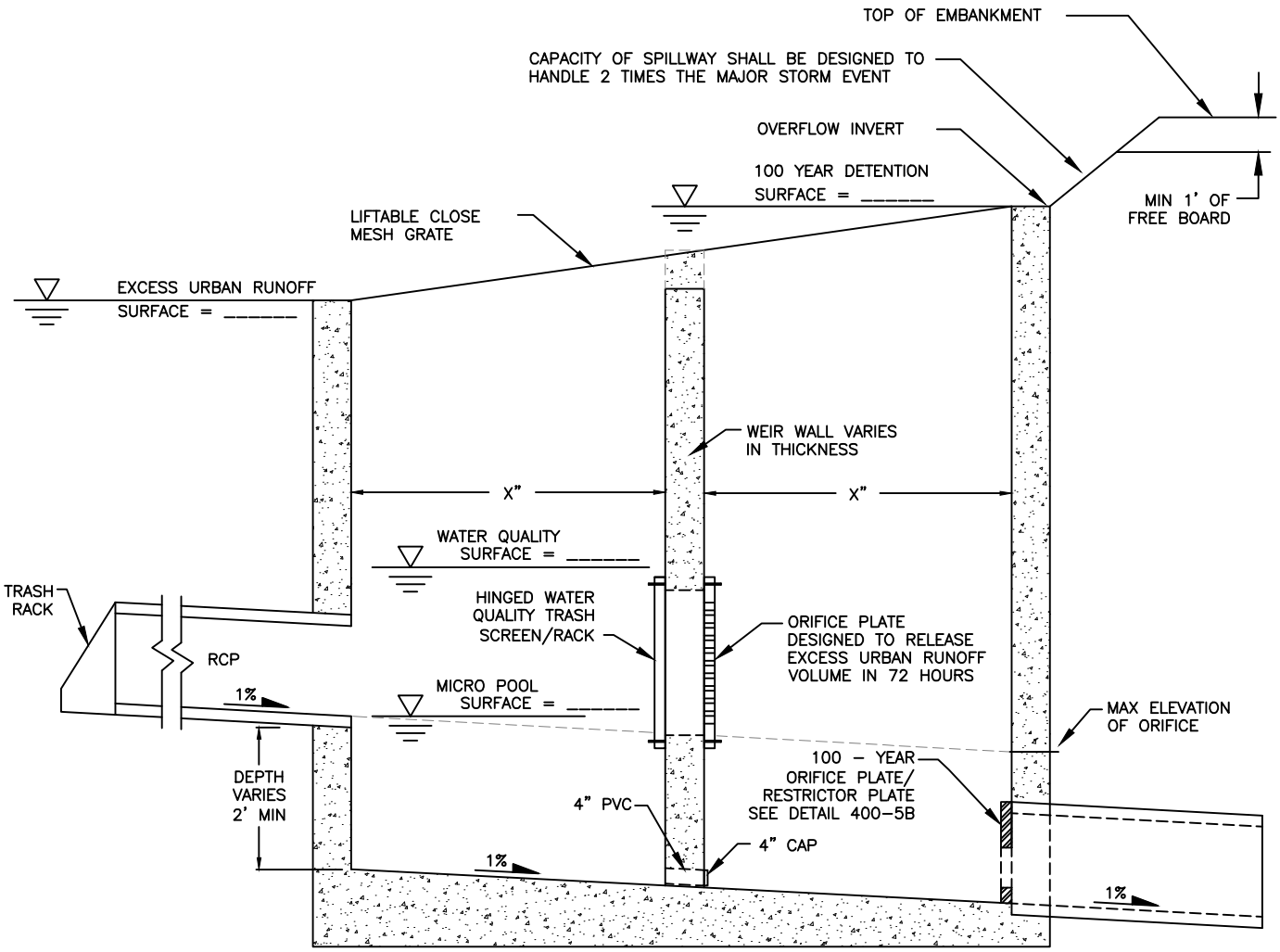
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

RIP RAP AT CULVERT OUTLET DETAIL

ISSUED:
APRIL 1995
REVISED:
APRIL 2010

DRAWING NO.
400–4



NOTE:
THE ENGINEER OF RECORD MUST PROVIDE THE REBAR SPECIFICATIONS (DESIGN)

N.T.S.

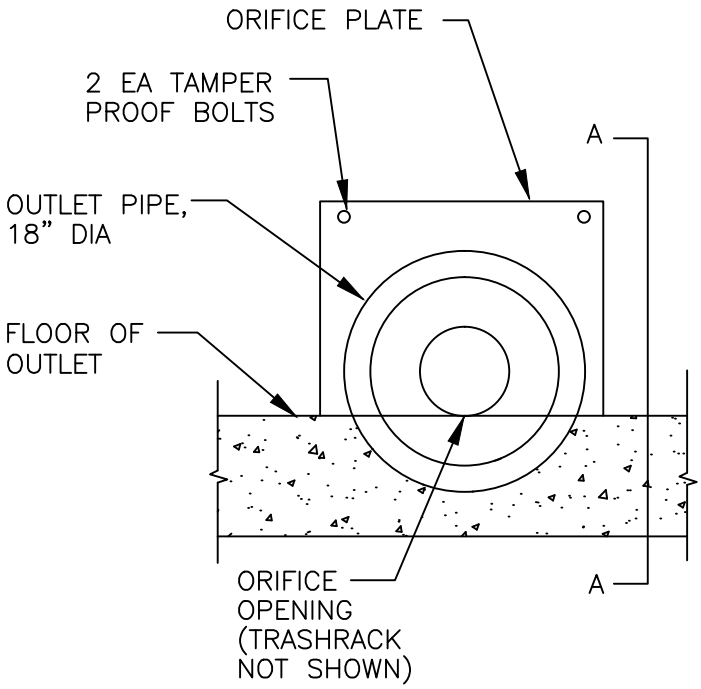
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

DETENTION POND OUTLET CONFIGURATION DETAIL

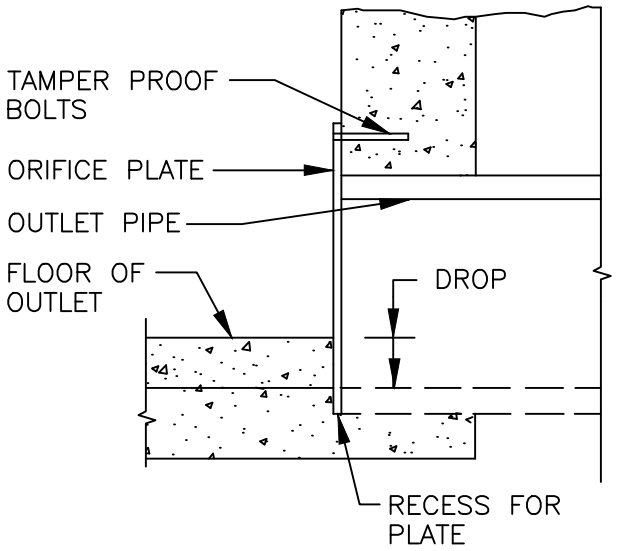
ISSUED:
APRIL 2010
REVISED:

DRAWING NO.
400-5A

ORIFICE PLATE DETAILS



ELEVATION



SECTION A–A

NOTE: TRASHRACK CAPACITY TO BE 10 TIMES ORIFICE CAPACITY.

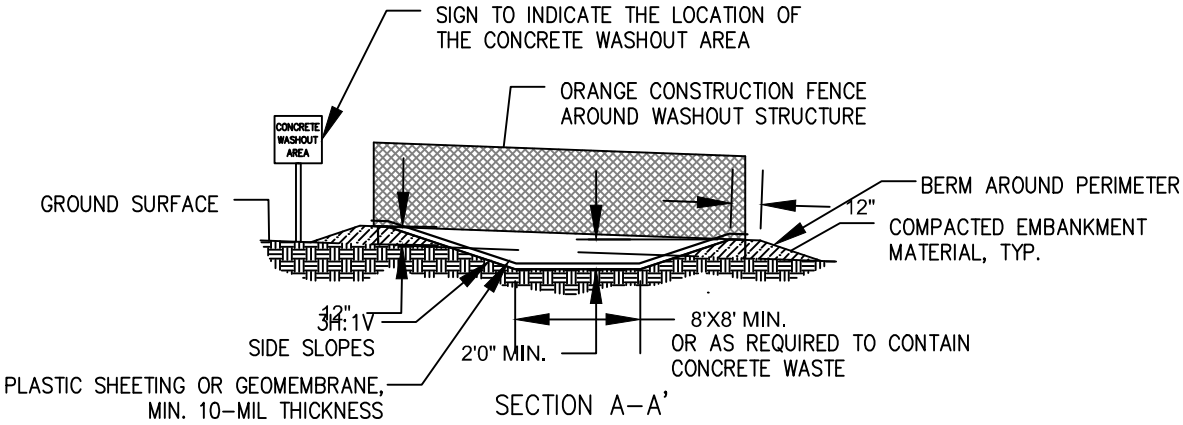
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

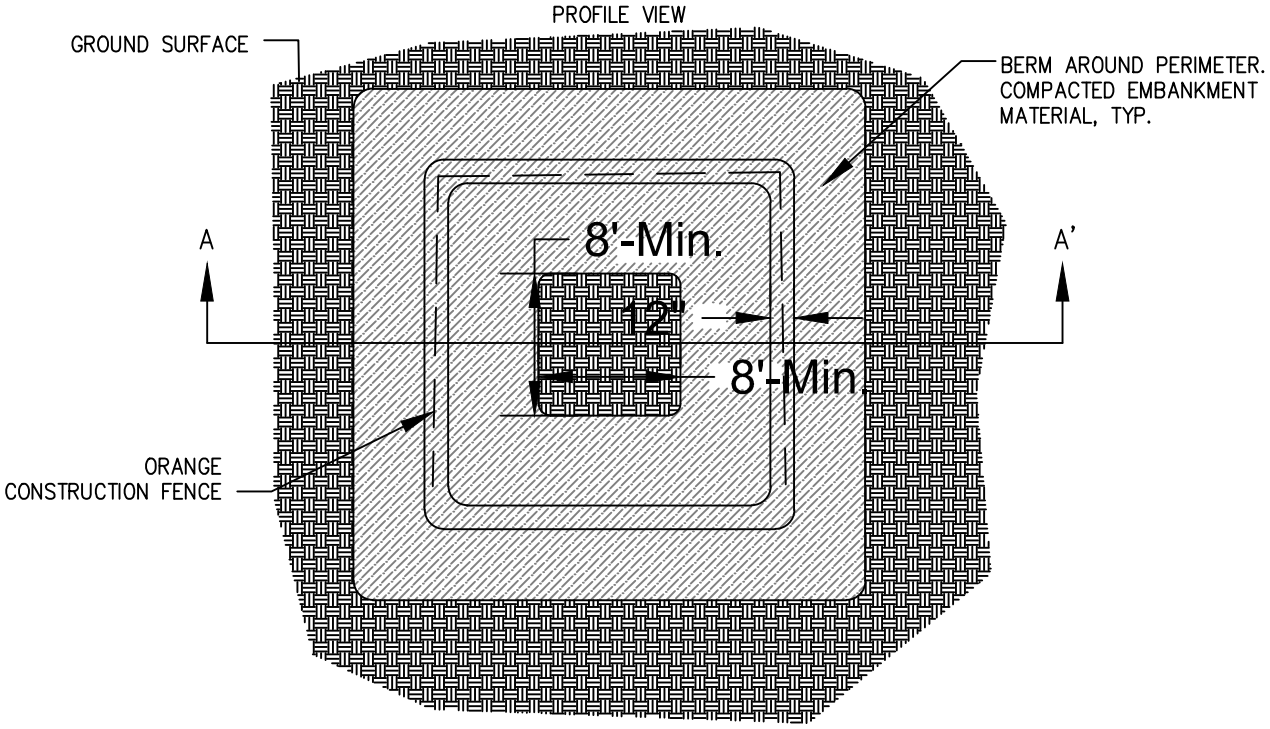
DETENTION POND DETAILS

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
400–5B



SECTION A–A'



PLAN VIEW

NOTES:

1. CONCRETE WASHOUT AREA SHALL BE INSTALLED PRIOR TO ANY CONCRETE PLACEMENT ON SITE; PLACED A MINIMUM 50' FROM STATE WATERS.
2. VEHICLE TRACKING CONTROL IS REQUIRED AT CONCRETE WASHOUT ENTRANCE IF ACCESS TO CONCRETE WASHOUT AREA IS OFF PAVEMENT.
3. A PLASTIC SHEETING OR GEOMEMBRANE LINER SHALL BE PLACED. MINIMUM 10–MIL THICKNESS..
4. THE CONCRETE WASHOUT AREA SHALL BE REPAIRED AND/OR ENLARGED AS NECESSARY TO MAINTAIN CAPACITY FOR WASTE CONCRETE.
5. WASTE MATERIAL FROM CONCRETE WASHOUT OPERATIONS MUST BE REMOVED AND LEGALLY DISPOSED OF WHEN IT HAS ACCUMULATED TWO–THIRDS OF THE WET STORAGE CAPACITY OF THE STRUCTURE AND AT THE END OF CONSTRUCTION.
6. WHEN THE CONCRETE WASHOUT AREA IS REMOVED, THE DISTURBED AREA SHALL BE SEEDED AND MULCHED OR OTHERWISE STABILIZED IN A MANNER ACCEPTED BY THE CITY.
7. NO STORMWATER RUN–OFF SHALL DRAIN INTO CONCRETE WASHOUT AREA.

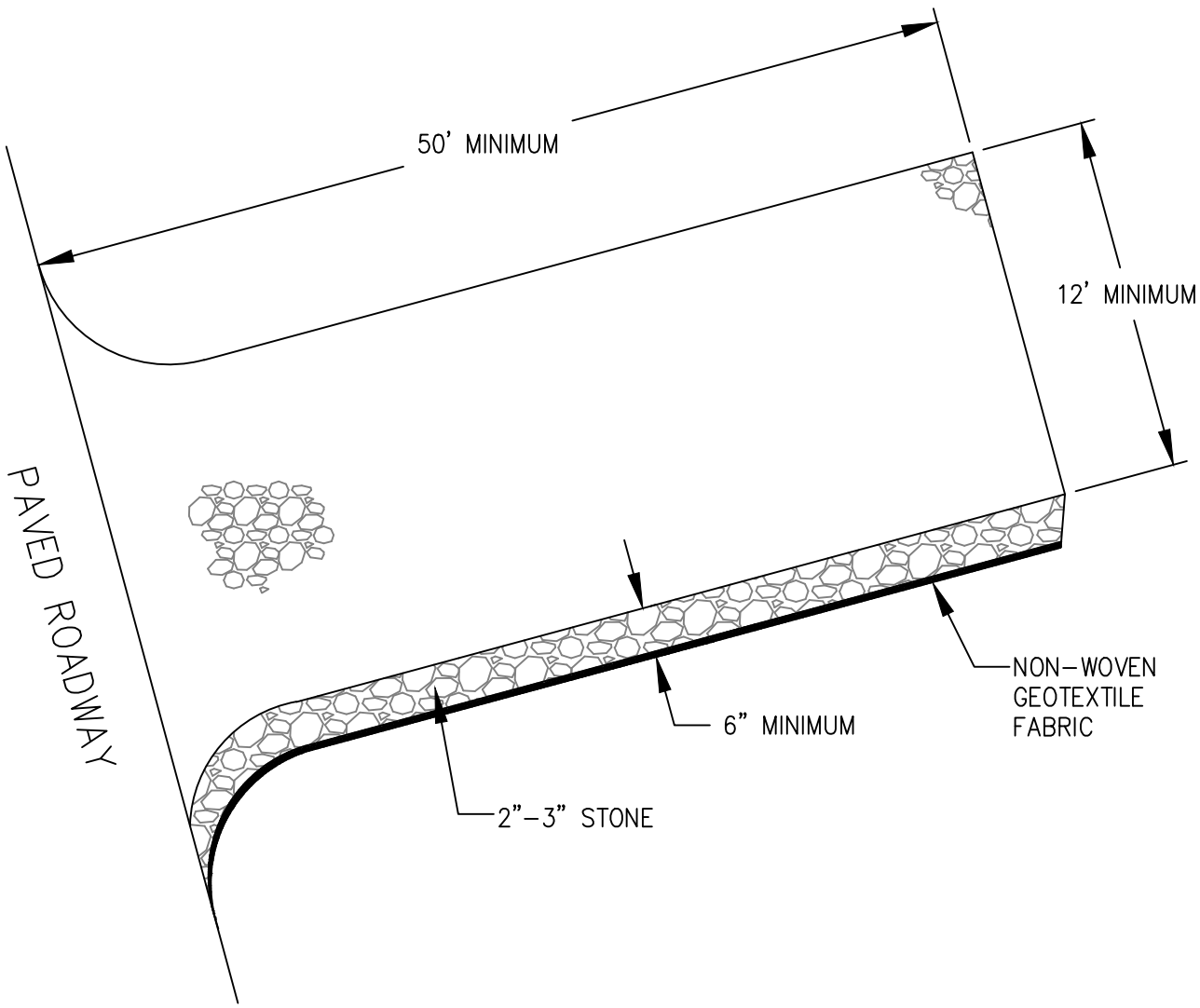
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CONCRETE WASHOUT AREA DETAIL

ISSUED:
MARCH 2005
REVISED:
NOV 08

DRAWING NO.
400–6



NOTES:

1. PAVED ROADWAY TO BE KEPT CLEAN OF MUD, DIRT, ROCKS, AND DEBRIS AT ALL TIMES.
2. GEOTEXTILE FABRIC SHALL COMPLY WITH CDOT 712.08b.
3. 2"-3" STONE SHALL CONTAIN LESS THAN 10% FINES.
4. CONSTRUCTION EXIT SHALL BE MAINTAINED AT ALL TIMES. STONE SHOULD BE BLADED AND/OR ADDITIONAL 2"-3" STONE SHOULD BE PLACED IF VOIDS BEGIN FILLING WITH DEBRIS.
5. IF A DRAINAGE DITCH EXISTS NEXT TO ROADWAY, INSTALL TEMPORARY CULVERT UNDERNEATH STONE CONSTRUCTION EXIT TO CONVEY FLOW.
6. PROVIDE INLET PROTECTION FOR ANY INLETS LOCATED IMMEDIATELY ADJACENT TO THE CONSTRUCTION EXIT.
7. IF TRACKOUT DOES OCCUR, ROADWAY SHOULD BE SWEPT IMMEDIATELY.
8. RECYCLED CONCRETE OR RECYCLED ASPHALT SHALL NOT BE USED.

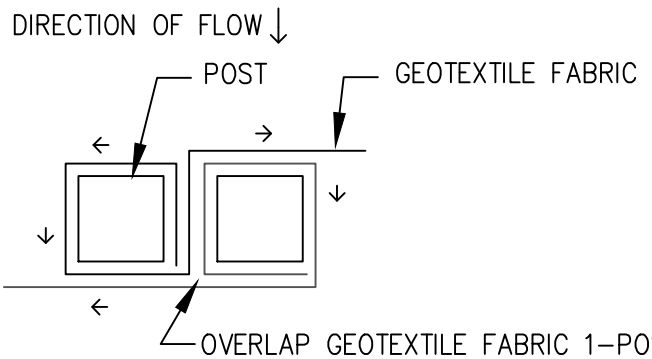
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

VEHICLE TRACKING PAD

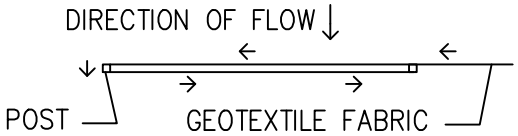
ISSUED:
NOV 08
REVISED:

DRAWING NO.
400-7

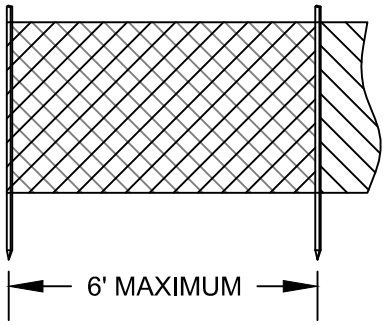


PLAN VIEW

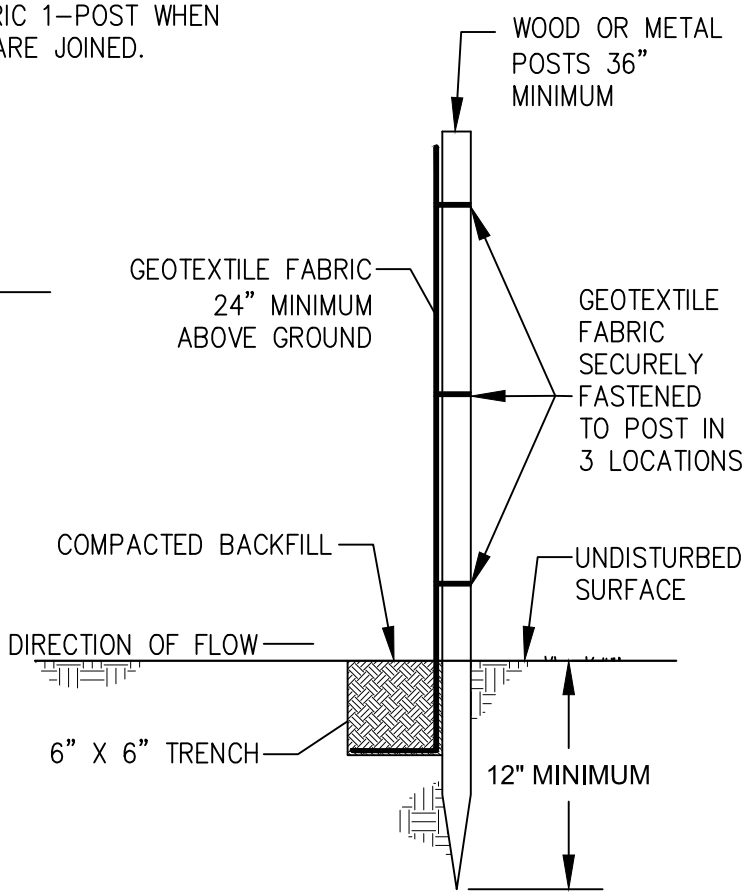
TRANSITION DETAIL
N.T.S.



PLAN VIEW



END DETAIL
N.T.S.



NOTES:

1. WOOD POSTS SHALL HAVE A MINIMUM DIAMETER OR CROSS–SECTION OF 2 INCHES. METAL POSTS SHALL BE STUDDED "T" OR "U" TYPE.
2. GEOTEXTILE FABRIC SHALL COMPLY WITH CDOT 712.08b.
3. GEOTEXTILE FABRIC SHALL EXTEND A MINIMUM OF 6" BELOW GRADE AND ANOTHER 6" HORIZONTALLY IN A "L" SHAPE BEFORE BACKFILLING AND COMPACTING THE TRENCH. (SLICING METHOD IS ALSO ACCEPTED)
4. SILT FENCE SHALL NOT BE USED IN CONCENTRATED FLOWS.
5. SILT FENCE SHALL ONLY BE PLACED PARALLEL TO SURFACE CONTOURS.
6. CLEAN AND REMOVE SILT WHEN THE SILT REACHES ½ THE HEIGHT OF THE GEOTEXTILE FABRIC.
7. UPON PERMANENT STABILIZATION OF AREAS UPSLOPE OF THE SILT FENCE, THE SILT FENCE SHALL BE REMOVED AND DISTURBED AREAS PERMANENTLY STABILIZED.

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CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SILT FENCE

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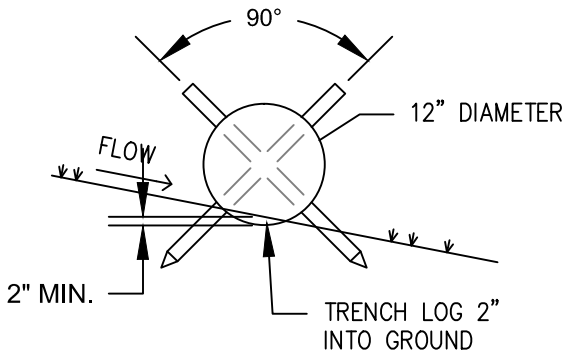
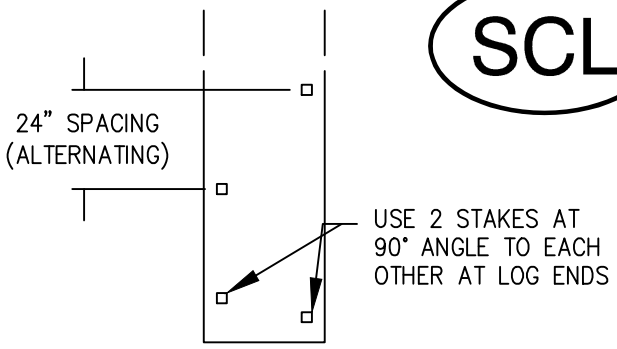
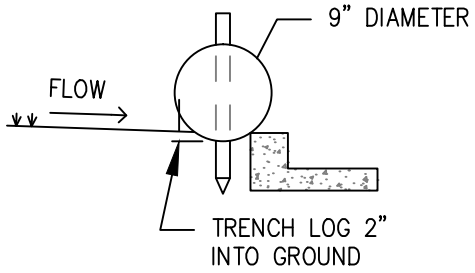


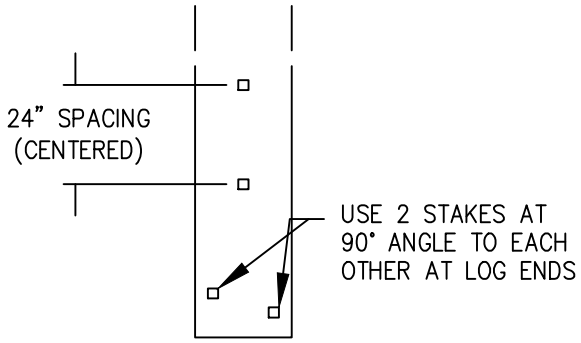
PROFILE VIEW



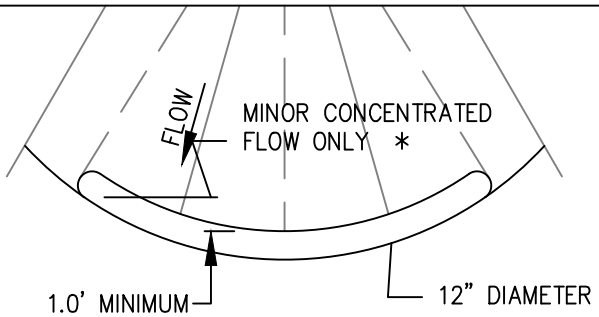
PLAN VIEW



PROFILE VIEW

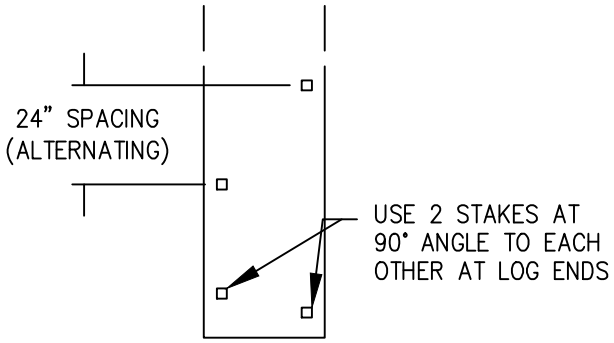


PLAN VIEW



PROFILE VIEW

* FOR MAJOR CONCENTRATED FLOWS, USE A ROCK CHECK DAM



PLAN VIEW

NOTES:

1. STAKES SHALL BE 1–1/2" x 1–1/2" x 24" MINIMUM AND EMBEDDED INTO GROUND A MINIMUM OF 12".
2. SEDIMENT CONTROL LOG SHALL BE TRENCHED 2" INTO GROUND.
3. FOR CONTINUOUS CONTROL, ADJACENT SEDIMENT CONTROL LOGS SHALL BE PLACED FIRMLY TOGETHER WITH NO GAPS.
4. SEDIMENT SHALL BE CLEANED/ REMOVED WHEN SEDIMENT DEPTH IS 1/2 THE HEIGHT OF THE SEDIMENT CONTROL LOG.

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CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SEDIMENT CONTROL LOG

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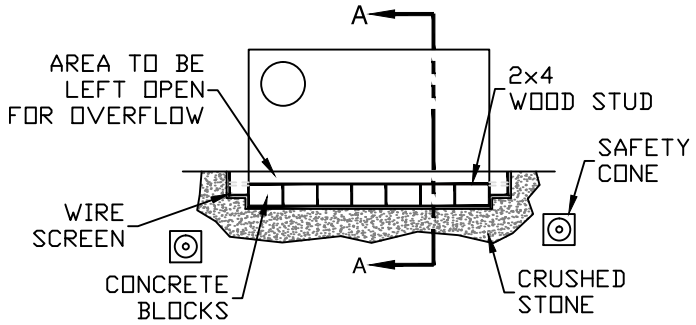
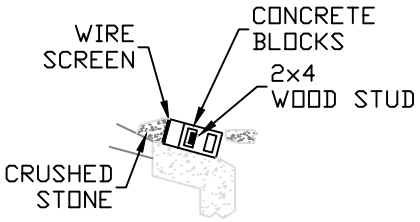
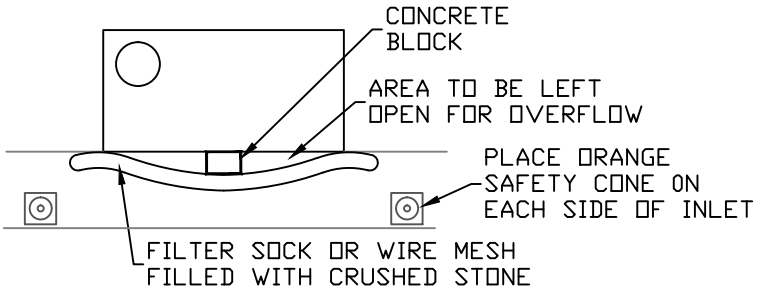


TYPE I - PLAN VIEW

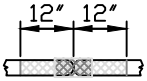
* ONLY TO BE USED IF STREET IS CLOSED TO THE PUBLIC



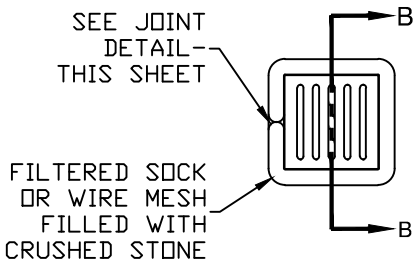
TYPE I - SECTION A-A



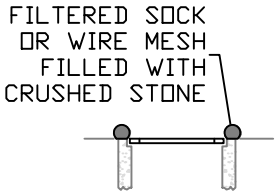
TYPE II - PLAN VIEW



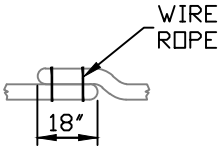
FOR WIRE MESH LOG, FILL GAPS IN JOINT WITH ADDITIONAL CRUSHED STONE AND WRAP WITH WIRE MESH



TYPE III - PLAN VIEW



TYPE III - SECTION B-B



FOR FILTER SOCK, OVERLAP JOINT BY 18" AND SECURE WITH 2 WIRE ROPES

JOINT DETAIL

NOTES:

1. CRUSHED STONE SHALL BE NO. 4 STONE WITH 0% PASSING THE 3/4" SIEVE.
2. SEDIMENT SHALL BE REMOVED WHEN SEDIMENT ACCUMULATION REACHES 1/2 THE INLET PROTECTION HEIGHT.
3. INLET PROTECTION SHALL BE PLACED IN A MANNER NOT TO CAUSE SIGNIFICANT FLOODING IN PUBLIC STREETS OR AREAS.
4. INSET FILTER BAGS WITH OVERFLOW PORTS MAY BE USED IN HIGH TRAFFIC AREAS AS A SUBSTITUTE.
5. IF LARGE DEPOSITS OF SEDIMENT ENTERS THE STORM SEWER, THE CONTRACTOR SHALL CLEAN THE STORM SEWER TO THE SATISFACTION OF THE CITY.

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CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

INLET PROTECTION

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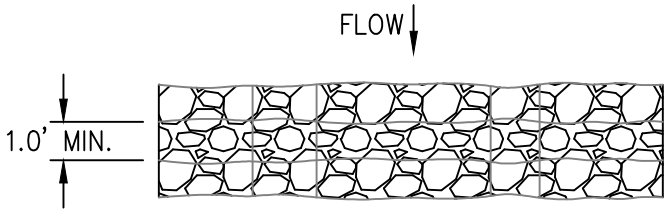
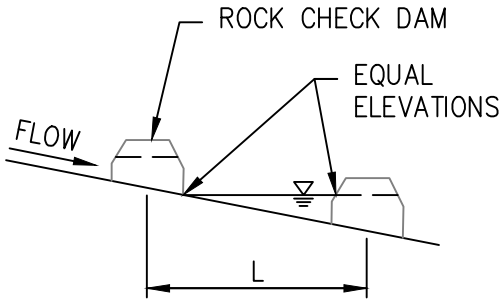
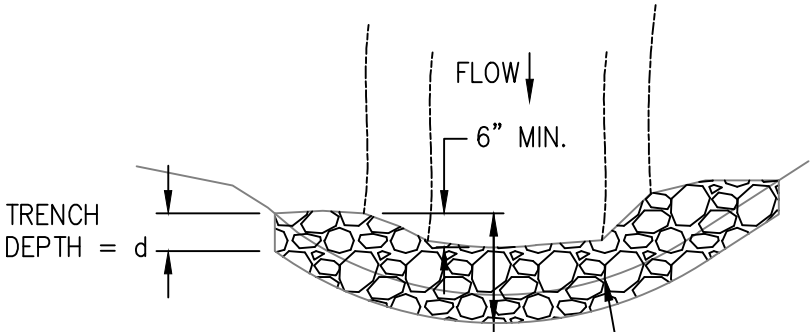


PLAN VIEW



SPACING (L)



d=d50 in inches, min
(for example: d50=6"
d=6" trench depth)

PROFILE VIEW

NOTES:

1. CHECK DAMS SHALL BE INSTALLED PRIOR TO UPSTREAM EARTH DISTURBING ACTIVITIES.
2. STONE SHALL HAVE < 10% FINES.
3. EACH END OF CHECK DAM SHALL BE 6" MINIMUM HIGHER THAN CENTER.
4. SEDIMENT SHALL BE REMOVED FROM THE CHECK DAM WHEN THE SEDIMENT DEPTH REACHES 1/2. THE HEIGHT OF THE CENTER.
5. CHECK DAM SHALL BE REMOVED ONCE ALL UPSTREAM DISTURBED AREAS HAVE BEEN STABILIZED.
6. UPON REMOVAL OF CHECK DAM, EXCAVATIONS SHALL BE FILLED WITH SUITABLE COMPACTED FILL, SEEDED AND COVERED WITH AN EROSION CONTROL BLANKET ADEQUATE FOR EXPECTED CHANNEL VELOCITY.

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CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CHECK DAM

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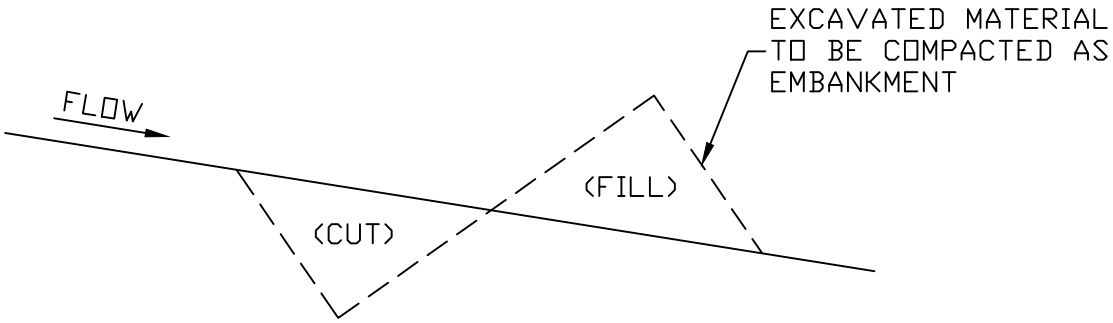

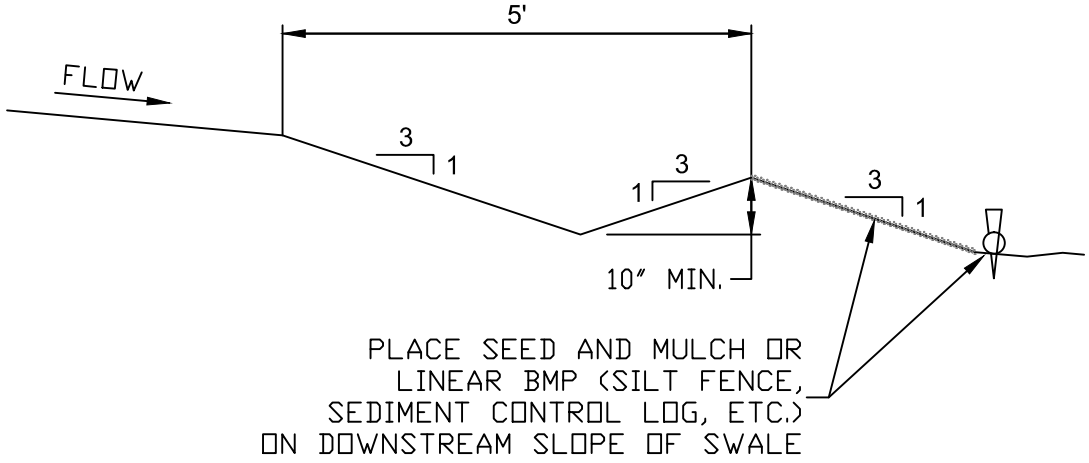

NOTES:

1. CHECK DAMS OR EROSION CONTROL BLANKETS MAY BE REQUIRED IF VELOCITY BEGINS TO ERODE DITCH/ SWALE.

2. DIVERSION DITCHES/ SWALES SHALL BE DISCHARGED TO SEDIMENT TRAPS OR BASINS WHICH HAVE BEEN SIZED APPROPRIATELY.

3. IF SEDIMENT BEGINS TO COLLECT IN THE SWALE, THE SEDIMENT SHALL BE REMOVED WHEN IT REACHES 1/3 THE HEIGHT OF THE SWALE.

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CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

DIVERSION DITCH / SWALE

ISSUED:
NOV 08
REVISED:

DRAWING NO.
400–12

SECTION 500 - STREET AND PARKING FACILITIES CONSTRUCTION
TABLE OF CONTENTS

TABLES

DETAIL DRAWINGS

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SECTION 500 - STREET AND PARKING FACILITIES CONSTRUCTION

501 GENERAL PROVISIONS

501.1 Purpose

This section contains minimum criteria to be met on newly designed and constructed public and private (open to general public) streets and parking lots in the City. Roadway design shall meet or exceed these Standards and Specifications. Policies and technical criteria not specifically addressed in this document shall follow the provisions of the American Association of State Highway and Transportation Officials (AASHTO), CDOT Standard Specifications for Road and Bridge Construction (CDOT S&S), Highway Capacity Manual, Manual on Uniform Traffic Control Devices (MUTCD), and the Colorado Department of Transportation's Standard Plans ("M-Standards"). Improvements shall also be in conformance with the Development Code.

502 DESIGN CRITERIA

502.1 Geometric Cross Section

A. Street cross sectional elements shall conform to the detail drawing as determined by the Development Engineering Manager. Collector and arterial streets shall be constructed whenever the alignment of the proposed street is generally the same as the collector and arterial streets shown on the Comprehensive Plan, Transportation Plan, or whenever a traffic engineering analysis of the future traffic volumes indicates the need of a cross section greater than that of a local residential street. These cross sections can be found in Details 500-1 through 500-4.

B. Additional ROW may be required to satisfy other criteria contained in these Standards and Specifications. Areas outside the ROW shall be contour graded, compacted, and sloped, as required for proper drainage, soil stability, and maintenance accessibility.

502.2 Curb Radii

Curb radii criteria for various intersections are listed on Table 500-1:

TABLE 500–1
CURB RADII CRITERIA

Classification	Major Arterial	Minor Arterial	Collector	Local
Major Arterial	45 feet	45 feet	45 feet	N/A
Minor Arterial	45 feet	40 feet	35 feet	N/A
Collector	45 feet	35 feet	30 feet	25 feet
Local	N/A	N/A	25 feet	20 feet

502.3 Horizontal Alignment

Streets shall intersect or connect to other streets at right angles, and intersections shall be constructed so that lanes are not offset through the intersection. If a street approaching another street is at an oblique angle, then the design shall have the intersecting streets at right angles for 100 linear feet from the intersecting flowlines. Horizontal and vertical alignment and ROW limits shall be coordinated so as not to obstruct sight distance at intersections, in accordance with City Code.

502.4 Street Design Criteria

Street design criteria for various street types are listed on Table 500-2. The requirements of the City of Thornton Development Code, the City Transportation Plan, and the City's Comprehensive Plan shall be adhered to.

TABLE 500-2
STREET DESIGN CRITERIA

Design Element	Major Arterial	Minor Arterial / Parkway Collector	Major& Minor Collectors****		Local Streets	Parking Lots & Private Streets
Cross Section	Refer to Details 500-1 through 500-4					N/A
Street Light Spacing*	150' (+/- 50')	150' (+/- 50')	200' (+/- 40)		200' (+/- 40')	
Right & Left Turn Lanes***	Required at all accesses along arterials. May be required at accesses along collectors but shall be determined at time of development by the Development Engineering Manager. Minimum dimensions: 150' storage, 100' taper, with the exception of arterial/arterial intersections which shall be design to accommodate 200' storage and 100' taper.**					
Cross Slope without Super Elevation	Maximum 4% - Minimum 2%					Max 4% – Min 1%
Maximum Curb Line Grade Break without Vertical Curve	1% at Curb Returns, 0.5% at Other Locations					1%
Super Elevation Maximum	4%	4%	4%		N/A	N/A
Minimum Degree Curve	7 (820'R)	8.5 (675'R)	Minor 10 (575' R)	Major 22 (260'R)	38.2 (150' R)	N/A
Maximum Street Grade	5%	5%	5%	7%	7%	7%
Minimum Street Grade	0.75%	0.75%	0.75%		0.75%	.75%
Maximum Grade at Intersection	2% for 400'	2% for 300'	3% for 300'	4% for 150'	4% for 50'	4% for 50% when approaching ROW
Tangents between Horizontal Curves	500'	400'	300'	150'	N/A	N/A
Design Speed	50	45	40	35	30	N/A
Posted Speed	45	40	35	30	25	N/A
K-Values Sag Crest	 96 84	 79 61	 64 44	 37 19	 37 19	N/A

* A photometric design is required to be submitted for street lights. Spacing indicated is per same side of the roadway.

** Turn lanes shall be designed to have the larger of either the 95 %ile queue utilizing the long range future scenario as required in the Traffic Impact Analysis, or the requirements of Table 500-2. Refer to Section 100 for all Traffic Impact Analysis requirements.

*** Turn lanes should be avoided on curves.

**** Major collector designation shall be utilized if there will be commercial development on both sides, or the roadway connects several developments.

502.5 Cul-De-Sacs – Details 500-6 & 500-7

A. Hammerhead cul-de-sacs, as shown in Detail 500-7, require approval of the Development Engineering Manager. Lengths of cul-de-sacs are required to be no greater than 500 feet.

B. Surface drainage shall be directed toward the intersecting street, or if this is not reasonably practical, a drainage structure and 20 foot easement shall be provided at the end of the cul-de-sac.

502.6 Requirements of Improvements Adjacent to Existing Roadways

A. Where proposed street construction will widen existing roadways or add a right turn lane, then the following requirements shall apply:

1. Existing cross slope of adjacent lanes shall be maintained. Where this is not possible, the change in cross slope for the new lane shall not exceed 2.0%.

2. The removal limits shall be sawcut in a clean straight line and shall not be in the traveled wheel path.

3. The entire adjacent lane along the new improvements shall be roto-milled two (2) inches and overlayed with the final lift of the new improvements. Geosynthetic fabric may be required at the joint to prevent the pavements from reflective cracking.

4. A geotechnical investigation shall be conducted on all roadways adjacent to the development to evaluate the condition of the asphalt. The investigation shall consist of borings or other suitable method of sampling, at spacing of no more than 250 feet unless otherwise accepted by the Development Engineering Manager. The results of this investigation shall be submitted to the City for determination of what, if any, existing asphalt may be utilized to meet the requirements of the Developer's Agreement.

502.7 Off-Site Design

A. 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 three hundred feet (300') or to its intersection with an arterial roadway.

B. If the off-site roadway adjacent to the proposed development is not fully improved, the Responsible Party is responsible for the design and construction of a transition for the safe conveyance of traffic from the improved section to the existing roadway. The following formula shall be applied to the taper of lane change necessary for this transition:

For roadways with speeds less than 45 mph:

$L = WS^2/60$

For roadways greater than or equal to 45 mph:

$L=WS$

Where:

L = Length of Transition in Feed
W = Width of Offset in Feet
S = Posted Speed Limit

C. Type 4 object markers shall be accompanied by a "future street extension" sign for the entire cross section of the roadways if it is planned for the street to be continued in the future.

503 PAVEMENT DESIGN ANALYSIS

503.1 General

This subsection provides the basic criteria and design procedure for roadway pavements. Recommended design methodologies for asphalt and Portland cement concrete are addressed and essentially follow the CDOT and AASHTO methodology. Some standardization of criteria has been made in design procedures.

503.2 Minimum Pavement Section

The following table provides the minimum acceptable pavement sections for each roadway classification. Final pavement designs shall be based on subgrade support test results.

TABLE 500-3
MINIMUM ACCEPTABLE PAVEMENT SECTIONS

Classification	Composite Section Asphalt Inches	 Roadbase Inches	Full Depth Asphalt Inches	Portland Cement Concrete Inches
1-Local,Private streets and parking lots	4	6	5	6
2-Collector A-Minor B-Major	 5 5	 6 7	 5 6	 6 7
3-Minor Arterial	7	11	8	8
4-Major Arterial	7	12	9	8
5 – Emergency Access Only	4	6	5	6

503.3 Pavement Design Reports

A. Prior to any roadway construction, the Responsible Party shall provide a pavement design report that recommends typical pavement structural sections based on the known site soil conditions. The report shall consist of the following:

B. The report shall be prepared by or under the supervision of and signed by a PE registered in the State of Colorado and shall include the following information:

1. Vicinity map to locate the investigated area.

2. Scaled drawings showing the location of borings.

3. Scaled drawings showing the estimated extent of subgrade soil types and EDLA/ESAL for each street.

4. Pavement design alternatives for each street on a scaled drawing.

5. Tabular listing of sample designation, sample depth, Group Number, Liquid Limit, Plasticity Index, % passing the No. 200 sieve, Group Index, Unified and AASHTO Classification, and soil description.

6. Proctor Compaction Curves.

7. Subgrade support testing of each soil type used in the design. (see 503.6.(c))

8. Pavement design computer printouts or nomographs properly drawn to show soil support, EDLA/ESAL, and structural number.

9. Design calculations. Include for all phases of project.

10. Design coefficient used for asphalt, base course, etc.

11. A discussion regarding potential subgrade soil problems including, but not limited to:

    a. Heave or settlement prone soils,

    b. Frost susceptible soils,

    c. Ground water,

    d. Drainage considerations (surface and subsurface),

    e. Cold weather construction (if appropriate), and

f. Other factors, properties, or fill areas which could affect the design or performance of the pavement system.

12. Recommendations to alleviate or mitigate the impact of problems discussed in item 11 above.

503.4 Equivalent 18 Kip Daily Load Applications (EDLA) / Equivalent Single Axle Load (ESAL)

The pavement design procedure in this chapter provides for a 20 year service life of pavement, given that normal maintenance is provided to keep the roadway surface in an acceptable condition. EDLA/ESAL and design traffic number (DTN) are considered equivalent units based on 20 year design criteria and an 18 kip axle loading. Data is based on the EDLA/ESAL units for pavement loading repetitions. EDLA/ESAL criteria for each roadway classification are given in Table 500-4.

TABLE 500-4
EDLA/ESAL Criteria

CLASSIFICATION	CLASS MODIFIER	EDLAVALUES (1)	ESALVALUES
Local	All Others	10	73,000
Collector	MinorMajor	50 75	365,000 547,500
Minor Arterial	All	465	3,394,500
Major Arterial	All	620	4,526,000

Alternatively higher EDLA/ESAL values may be considered with justification provided by the Traffic Impact Study, proposed land uses, and traffic analysis that defines proportion of truck vehicles.

503.5 Design Serviceability and Reliability

TABLE 500-5
SERVICEABILITY/RELIABILITY INDEX

Roadway Classification	SI	R
Arterials (minor, major)	2.5	90
Collectors		
Major	2.5	85
Minor	2.0	85
Local	2.0	75

503.6. Subgrade Investigation Requirements

A. Field Investigation

The geotechnical investigation shall consist of borings or other suitable method of sampling subgrade soils to a depth of at least five (5) feet below proposed subgrade elevation, with a 10 foot boring every third hole, at spacings of no more than 250 feet unless otherwise accepted by the Development Engineering Manager. Samples shall be taken after grading is completed and the subgrade is rough cut.

B. Classification Testing

Each subgrade sample shall be tested to determine liquid limit, plastic limit, plasticity index and the %age passing the U.S. Standard No. 200 sieve. Samples of sands and gravels may require gradation analysis for classification determination. These data shall be determined using the following methods:

Liquid Limit - AASHTO T 89
Plastic Limit - AASHTO T 90
% Passing No.200 - AASHTO T II
Gradation - AASHTO T 27

The results of these tests shall be used to calculate the AASHTO Classification and Group Index using AASHTO M 145.

C. Subgrade Support Testing

1. Individual subgrade samples shall be tested to determine the subgrade support value using Hveem Stabilimeter (R-value), or California Bearing Ratio (CBR) and Unconfined Compressive Strength (Qu) testing, or direct measurement of resilient modulus of soil AASHTO T-307. These values shall be used in the design of pavement sections in accordance with the procedures outlined below. Tests shall be conducted in accordance with this procedure.

2. R-Value Tests - Hveem Stabilimeter tests shall be conducted in accordance with AASHTO T 190. The design R-value shall be at 300 psi exudation pressure. The reported data shall consist of:

   a. Dry density and moisture content for each sample.

   b. Expansion pressure for each sample.

   c. Exudation Pressure - corrected R-value curve showing the 300 psi design R-value.

3. CBR Tests: California Bearing Ratio Tests shall be conducted in accordance with AASHTO T193 with the following modifications:

   a. Note 4 of AASHTO T193 shall not apply. A 3-point CBR evaluation is required.

   b. The compaction method used for the CBR test shall be determined by the soil classification.

   c. Surcharge shall be calculated using a unit weight of 140 pcf for HMA and 135 pcf for ABC.

   d. The design CBR value shall be determined from the CBR dry density curve and shall be the CBR value at 95 % compaction.

   e. In addition to the values requested in AASHTO T193 Stress Penetration curves for each sample, a CBR dry density curve and Proctor compaction test results shall be reported.

503.7 Pavement Design Procedures

A. Flexible Pavements

1. The following procedure should be used in determining the Structural Number (SN) of the pavement being designed:

   a. Determine roadway classification and corresponding EDLA/ESAL (Table 500-4)

   b. Determine the Serviceability Index (SI) of the roadway classification (Table 500-5)

   c. Determine the reliability (R) of the roadway classification (Table 500-5)

   d. Approved proper nomographs

   e. Determine the required structural number using AASHTO pavement design software or nomographs from AASHTO or CDOT along with soil support test results and EDLA/ESAL values previously determined. If used, copies of the nomograph determinations must be included with the design submittal.

   f. Once the Structural Number (SN) has been determined, the design thicknesses of the pavement structure can be determined by the general equation:

      SN = a(1)D(1) + a(2)D(2) + a(3)D(3) + ...

      where

      A(1), Aa(2), Aa(3), Aa(n) = strength coefficients

      D(1),D(2),D(3),D(n) = thickness of pavement component sections

      The strength coefficients for various components of the pavement structure are given in Table 500-6.

   g. The component thickness selected must meet two (2) conditions:

      i. Total thickness selected cannot be less than the minimum specified in Table 500-1 for the roadway classification.

ii. The base course thickness selected cannot exceed two and one-half (2.5) times the asphalt thickness selected in Table 500-3.

h. Pavement section calculations shall be rounded up to the next thickness one-half (½) -inch increment.

i. The standard deviation for design of asphalt pavements shall be 0.44

j. The design must reference any mitigation measures required when the subgrade contains swelling soils. Design reports recommending alternative methods or materials to address swelling soils (i.e. base course, lime, cement, etc) must present the measures to be used to ensure adequate drainage of such layers and to maintain separation of the layers from the swelling soils. Swell tests shall be conducted for samples with probable expansion (volume change estimate) greater than two (2)% based on actual tests. Surcharge pressure shall be 150 psf, or as specified by the Development Engineering Manager.

k. Alternative methods and materials shall be approved specifically in writing by the Development Engineering Manager prior to any construction of the roadway. With this approval, Table 500-6 shall be utilized for appropriate strength coefficients. Also, if approved in writing, minimum design requirements for composite sections can be found in Table 500-3.

B. Rigid Pavement

1. Rigid pavements are those that possess a high bending resistance and distribute loads over a large area of foundation soil. Examples include Portland cement concrete pavement or Portland cement concrete surfaced with asphalt. Rigid pavement shall only be utilized as specifically authorized by the Development Engineering Manager.

2. The design of rigid pavements is a function of support characteristics of the subgrade soil (R-value, CBR, or resilient modulus), traffic (EDLA/ESAL), and the strength of the concrete (working stress). In comparison to the strength of the concrete slab, the structural contributions of underlying layers to the capacity of the pavement are relatively insignificant. Therefore, the use of thick bases or subgrades under concrete pavement to achieve greater structural capacity is considered to be uneconomical and is not recommended.

3. Use the following procedure to obtain required thickness:

a. Determine roadway classification and corresponding EDLA/ESAL (Table 500-4).

b. Determine design Serviceability Index (SI) of the roadway (Table 500-5).

c. The working stress of the concrete (F_t) used in the design shall be 75% of that provided by third-point beam loading, which shall have a minimum laboratory 28-day strength of 600 psi based on actual tests of materials to be used .

d. The reliability factor for design of all concrete pavements shall be 90%.

e. The standard deviation for design of concrete pavements shall be between 0.30 and 0.40.

f. Determine the structural numbers using AASHTO pavement design software. Nomographs of the AASHTO or CDOT parameters may be used instead. If used, copies of the nomograph determinations must be included with the design submittal.

f. Using EDLA/ESAL and working stress data, locate point on the pivot line; connect this point to the R-value or CBR value on the soil support scale to determine slab thickness.

g. Use slab thickness from step f. (rounded upward to the nearest one-half (1/2) inch) or the minimum thickness from Table 500-5.

h. For swelling soils (swell potential greater than two (2)%, under 200 psf surcharge pressure) concrete paving shall not be permitted without subgrade treatment.

i. Pavement joint detail plans. With rigid pavement designs, the construction plans shall include a joint pattern layout for each street, alley or intersection. All joints and joint filling in rigid pavements shall be designed and detailed in accordance with the current CDOT M&S Standards.

TABLE 500-6
STRENGTH COEFFICIENTS

Pavement Component	Strength Coefficients	(Limiting Test Criteria)
Conventional Materials		
Hot Mix Asphalt	0.44	(Rt 90+)
Aggregate Base Course	0.14	(CBR 80+ or R 78+)
Granular Subgrade Course	0.07	(CBR 15+ or R 50+)
Recycled Asphalt/Concrete Pavement Subgrade Course	0.07	(CBR 15+ or R 50+)
Treated Materials		
Cement Treated Aggregate Base	0.23	(7 day 650-1000 psi) *
Lime Treated Subgrade	0.14	(7 day, 160 psi, PI <6) *

* 100 degree moist oven

504 HOT MIX ASPHALT (HMA)

504.1 General

A. The intent of this section is to specify materials and methods to be used for the construction, overlaying, seal coating and pavement rejuvenating of streets, parking lots, walks, and other miscellaneous work requiring the use of aggregates. The work covered shall include general requirements that are applicable to aggregate base course, bituminous base and pavements of the plant mix type, bituminous prime coat, bituminous tack coat, rejuvenating applications, and asphalt concrete overlay. Workmanship and material shall be in accordance with requirements of these Standards and Specifications and in conformity with the lines, grades, depths, quantity requirements, and the typical cross section shown on the plans or as directed by the Development Engineering Manager.

B. These specifications include general requirements applicable to all types of plant mixed hot mix asphalt (HMA). Also included are requirements for Stone Matrix Asphalt (SMA). Reference to HMA shall also mean SMA is Included. This work consists of one (1) or more courses of asphalt mixture constructed on a prepared foundation in accordance with specifications. The design intent is to provide pavement with adequate thickness and quality to provide a serviceable life of at least 20 years. It is also the intent to provide construction in accordance with these specifications with a high standard of practice. This item shall include all labor, equipment, and materials to manufacture, place and compact asphaltic concrete for pavement purposes.

C. TEST PROCEDURE DEFINITIONS

1. CP-## Colorado Department of Transportation: Field Materials Manual (Colorado Testing Procedures)
2. ASTM American Society for Testing & Materials
3. AASHTO American Association of State Highway & Transportation Officials
4. CP-L #### Colorado Department of Transportation: Laboratory Manual of Test Procedures (Lab Testing Procedures)

D. When references to both an AASHTO and either a CP or CP-L and test procedure are given, CP or CP-L shall be used, unless the Development Engineering Manager has stipulated to ONLY use and require AASHTO test procedures

504.2 Materials

A. Pavement shall be hot mix asphalt plant mix type unless otherwise approved in writing by the Development Engineering Manager. Materials and construction shall be in accordance with the CDOT S&S, Section 403, and the following requirements:

1. The hot mix asphalt shall be composed of a mixture of aggregate, filler, hydrated lime and asphalt binder. Some mixes may require polymer modified asphalt binder. Some mixes may allow up to 20%

reclaimed asphalt pavement (RAP) as approved by the Development Engineering Manager. All RAP introduced shall meet the requirements of section 504.2 F. Stone Mastic Asphalt (SMA) mixtures are to be used in the top lift only, and are required at intersections per Detail 500-16.

2. Experimental materials such as Warm Mix Asphalt shall be approached as a variance and is subject to the approval of the Development Engineering Manager.

NOTE: SMA specifications are adapted from the CDOT S&S and incorporated throughout other sections of this specification.

B. Aggregate

Aggregates for HMA shall be of uniform quality, composed of clean, hard, durable particles of crushed stone, crushed gravel, or crushed slag. Excess of fine material shall be wasted before crushing. The material shall not contain clay balls, vegetable matter, or other deleterious substances and shall meet the following requirements:

TABLE 500-7
AGGREGATE PROPERTIES

Aggregate Test Property	Coarse: Retained on #4	Fine: Passing the #4
Fine Aggregate Angularity, CP-L 5113 Method A or AASHTO T 304 Note: Fine aggregate angularity does not apply to RAP aggregates		45% Min
Two Fractured Faces, CP-45 or ASTM D 5821 SG Mixtures Top and Middle Lifts Bottom Lifts SMA Mixtures	 90% Min. 80% Min. 70% Min. 100% required	
LA Abrasion, AASHTO T 96	45% Max.	
Flat and Elongated (Ratio 5:1) %, AASHTO M 283	10% Max.	
Adherent Coating (Dry Sieving) ASTM D 5711	0.5% Max.	
Sand Equivalent. AASHTO-T 176		45% Min.
Micro Deval CP-L 4211 or AASHTO T 327	18% Max	

1. Reclaimed Asphalt Pavement material (RAP) shall be used only where specifically allowed and shall be of uniform quality and gradation with a maximum size no greater than the nominal aggregate size of the mix. Mixes shall not contain more than 25% RAP.

2. The Proposed Design Job Mix Formula (PDJMF) gradation shall be wholly within the control point gradation range set forth in the following applicable Table 500-7 for dense graded mix designs or Table 500-8 for Stone Matrix Asphalt (SMA). The Allowable Job Mix Formula (AJMF) gradation for production shall be the PDJMF gradation with the tolerances of section 504.14 B. applied. The PDJMF and the final AJMF gradation for production shall report all sieve sizes listed in the applicable Table 500-7 or Table 500-8.

3. Mineral filler for the Stone Matrix Asphalt pavement shall be limestone dust and shall meet the requirements of this subsection and have a maximum Plasticity Index (AASHTO T90) of four (4)%.

4. The Responsible Party shall submit hydrometer analysis (AASHTO T88) for the gradation of mineral filler used in the SMA mixture.

TABLE 500-8
DENSE GRADED HMA GRADATION RANGE
(% by Weight Passing Square Mesh Sieves, CP-31, AASHTO T 11 & T 27)

Mixture Grading	SX (1/2" nominal)		S (3/4" nominal)		SG (1" nominal)	
Sieve Size	Control Points	Caution Zone*	Control Points	Caution Zone*	Control Points	Caution Zone*
11/2"					100	
1"			100		90-100	
3/4"	100		90-100		@	
1/2"	90-100		@		@	
3/8"	@		@		@	
#4	@		@		@	39.5
#8	28-58	39.1	23-49	34.6	19-45	26.8-30.8
#16	@	25.6-31.6	@	22.3-28.3	@	18.1-24.1
#30	@	19.1-23.1	@	16.7-20.7	@	13.6-17.6
#50	@	15.5	@	13.7	@	11.4
#200**	2.0-8.0		2.0-7.0		1.0-7.0	

* The caution zone is a guideline only. It is recommended that mix design gradations go above the caution zone boundaries, on the "fine" side.
** These limits shall include the required one (1)% of lime by weight.
@ These sieve sizes used only to determine the final Allowable Job Mix Formula (JMF) in accordance with Section 500.

TABLE 500-9
SMA AGGREGATE GRADATION RANGE PROPERTIES
(% by Weight Passing Square Mesh Sieves, CP-31, AASHTO T 11 & T 27)
(Ref: CDOT Table 703-5)

Sieve Size	Stone Mastic Grading Designation (% by Weight Passing Square Mesh Sieves)			
	#4 Nominal	3/8" Nominal	½" Nominal	¾" Nominal
1"				100
3/4"			100	90-100
1/2"	100	100	90-100	50-88
3/8"	100	90-100	50-80	25-60
#4	90-100	26-60	20-35	20-28
#8	28-65	20-28	16-24	16-24
#16	22-36			
#30	18-28	12-18	12-18	12-18
#50	15-22	10-15		
#200	12-15	8-12	8-11	8-11

C. Performance Graded Asphalt Binders

1. The Responsible Party shall provide to the Development Engineering Manager acceptable 'Certifications of Compliance' of each applicable asphalt binder grade from the supplier. Upon non-conformance with the specifications, the asphalt binder may be rejected as directed by the Development Engineering Manager. When production begins, the Responsible Party shall, upon request, provide to the Development Engineering Manager a one (1) quart can of each specified asphalt binder. Additionally, when requested, the Responsible Party shall provide the refinery test results that pertain to the asphalt binders used during production.

2. Asphalt binder shall meet the requirements of the Superpave Performance-Graded Binders (PG) as presented in Table 500-10 below.

TABLE 500-10
PROPERTIES OF PERFORMANCE GRADED BINDERS

Usage for each Binder Grade	PG 58-28	PG 64-22	PG 76-28
Traffic Loading, Total 18 kip ESALs Over Design Life (Usually 20 Years)***	Low Volume (0-100,000)	100,000 to <10.0 Million	3.0 Million to <10 Million
Superpave Compactor Design gyrations Recommended Usage	N_{design} = 50	N_{design} = 75	N_{design} = 100
Property of Binder Grade	PG 58-28	PG 64-22	PG 76-28
Flash Point Temperature, ºC, AASHTO T 48	230 Min.	230 Min.	230 Min.
Viscosity at 135 ºC, Pas, ASTM D 4402	3 Max.	3 Max.	3 Max.
Dynamic Shear, Temperature ºC, where C*/Sin δ @ 10 rad/sec. ≥ 1.00 Kpa, AASHTO TP 5	58 º C	64 º C	76 º C
Rolling Thin Film Oven Residue Properties, AASHTO T 240			
Mass Loss, %, AASHTO T 240	1.00 Max.	1.00 Max.	1.00 Max.
Dynamic Shear, Temperature ºC, where G*/Sin δ @ 10 rad/sec. ≥ 2.20 Kpa, AASHTO TP 5	58 º C	64 º C	76 º C
Elastic Recovery1, 25°C, % Min.*	N/A	N/A	50 Min.
Pressure Aging Vessel Residue Properties, Aging Temperature 100 ºC AASHTO PP1			
Dynamic Shear, Temperature ºC, where G*/Sin δ @ 10 rad/sec. ≤ 5,000 Kpa, AASHTO TP 5	19 º C	25 º C	28 º C
Creep Stiffness, @ 60 sec. Test Temperature in ºC, AASHTO TP 1	-18 º C	-12 º C	-18 º C
S, Mpa, AASHTO TP 1	300 Max.	300 Max.	300 Max.
m-value, AASHTO TP 1	0.300 Min.	0.300 Min.	0.300 Min.
**Direct Tension Temperature in ºC, @ 1.0 mm/min., Where Failure Strain >1.0%, AASHTO TP 3	-18 º C	-12 º C	-18 º C

* Elastic Recovery by Task Force 31, Appendix B Method.
** Direct tension measurements are required when needed to show conformance to AASHTO MP.1.
*** Development Engineering Manager is to determine PG Binder.
*** Use PG Binder 76-28 for all Major Arterial surface course.

D. Additives – Hydrated Lime**.**

Lime shall be added at the rate of one (1)% by dry weight of the aggregate and shall be included in the amount of material passing the No. 200 sieve. Hydrated lime for aggregate pretreatment shall conform to the requirements of ASTM C 207, Type N. In addition, the residue retained on a 200-mesh sieve shall not exceed 10% when determined in accordance with ASTM C 110. Drying of the test residue in an atmosphere free from carbon dioxide will not be required.

E. Tack Coat

When tack coat is specified on the plans or required by the Development Engineering Manager, the materials and construction shall be in accordance with the requirements of the CDOT S&S, Section 702. The emulsified asphalt, for Tack Coat shall be CSS-1h or SS-1h and conform to AASHTO M208 or M140.

F. Reclaimed Asphalt Pavement

1. Reclaimed Asphalt Pavement (RAP) may be allowed in the HMA mixture by the Development Engineering Manager. It shall be of uniform quality and gradation with a maximum size particle no greater than the maximum size allowed in the HMA mixture. HMA mixtures containing RAP shall meet the same gradation requirements as a virgin HMA mix. The Development Engineering Manager may allow mixtures with a maximum of 25% RAP of any HMA pavement. RAP is not allowed in Stone Mastic Asphalt Mixtures, except by agreement by the Development Engineering Manager.

2. The reclaimed asphalt pavement shall meet all the requirements for HMA pavement, as contained herein. The Responsible Party shall have an approved mix design for the amount of RAP to be used prior to placement.

3. The Development Engineering Manager may require the Responsible Party to maintain separate stockpiles for each type of RAP material. All processed material shall be free of foreign materials and segregation shall be minimized. Any RAP material that cannot be readily broken down in the mixing process, and/or affects the paving operation, shall be processed prior to mixing with the virgin material.

4. Fine Aggregate Angularity requirements shall not apply to any RAP aggregate. The RAP will not contain clay balls, vegetable matter, or other deleterious substances.

5. Verification testing for asphalt content and gradation will be performed on RAP at the frequencies listed in section 504.2 G, below. The Development Engineering Manager may request the mix supplier's testing results on RAP at any time. In addition, the mixture shall be tested for properties as listed in Table 500-10

6. When the use of RAP is allowed, the following additional conditions shall apply:

a) The processed RAP must be 100% passing the one and one-fourth inch (1¼) inch sieve. The aggregate obtained from the processed RAP shall be 100% passing the one (1) inch sieve. The aggregate and binder obtained from the processed RAP shall be uniform in all the measured parameters in accordance with the following schedule:

TABLE 500-11
RAP AGGREGATE UNIFORMITY TOLERANCES

Element	Uniformity*
Binder Content	0.5
% Passing ¾"	4.0
% Passing ½"	4.0
% Passing 3/8"	4.0
%Passing #4	4.0
% Passing #8	4.0
% Passing #30	3.0
% Passing #200	1.5

* Uniformity is the Maximum allowable Standard Deviation of test results of processed RAP.

b. The Responsible Party shall have an approved RAP Quality Control (QC) Plan that details how the RAP will be processed and controlled. The QC plan must address the following:

i. RAP Processing Techniques. This requires a schematic diagram and narrative that explains the processing (crushing, screening, and rejecting) and stockpile operation for normal plant operation or a specific project.

ii. Control of RAP Asphalt Binder Content: - Minimum Testing Frequency: 1/1,000 tons of processed RAP material (minimum 3 tests) for recent production of the mix type.

iii. Control of RAP Gradation (CP31 or AASHTO T-30): Minimum Testing Frequency: 1/1,000 tons of processed RAP material (minimum 3 tests) for recent production of the mix type.

iv. Process Control Charts shall be maintained for binder content and each screen listed, during addition of any RAP material to the stockpile. The Responsible Party shall maintain separate control charts for each RAP stockpile. The control charts shall be displayed and shall be made available to the Development Engineering Manager upon request.

G. Example of RAP QUALITY CONTROL PLAN

1. Initial quality control of the reclaimed asphalt pavement shall be performed prior to and during crushing. Material for reclamation shall be separated by quality and source before being accepted for processing. Reclaimed asphalt must be free of concrete, dirt and organic materials. These stockpiles shall be built from the ground up, completely mixing all loads as they come in.

2. Crushing of the reclaimed asphalt pavement shall be accomplished by means of a cone crusher and a screen deck. Oversize material shall be rejected on a three-fourths (¾) inch scalping material, which reprocesses the material through the cone additional times. The processed material shall be stockpiled at the crushing facility and kept in separate piles and separate from other products to prevent intermingling of products, as well as the feed bins to prevent intermingling of the aggregates.

3. The reclaimed asphalt pavement material shall be sampled during the crushing operations according to AASHTO T 2 at frequencies greater than 1/1000 tons and tested for gradation and asphalt content in accordance with AASHTO T 27 AND T11, and AASHTO T 308. Testing shall be done randomly on a daily basis to ensure conformance to specifications.

4. The reclaimed asphalt pavement material at the asphalt plant shall be again sampled and tested according to the appropriate procedures to ensure that the asphalt content and gradation meet specifications and represent initial quality control data. Once data is collected, a statistical analysis shall be performed to determine the blend for the asphalt mixture design. This analysis shall be provided with the Asphalt Mixture Design submittal. The RAP will meet the Uniformity Specification of Table 500-11 above.

5. The RAP system at the asphalt plant consists of a feed bin with a variable speed motor controlled by the plant computer, which ensures the proper quantity of RAP material called for by the mix design. Material is delivered to the asphalt-mixing chamber of the asphalt plant by means of conveyor belts. The RAP material falls from one conveyor to another through a shaker screen that serves to break up any RAP material that has recompacted. Any oversize material shall be rejected at the shaker screen. While in production, the front-end loader shall works the full face of the stockpile, to ensure a representative batch is being produced.

6. Prior to starting a project and at any other time necessary, the RAP feed system shall be calibrated by placing an amount of RAP measured by certified external scales into the feed bin. That measured material is fed from the RAP bin across the belt scales. The weights are compared and, if outside of accepted tolerances for the blending system, adjustments are made by the plant-blending computer. This process is the same for all other components of the mix design.

504.3 Mix Design and Plant Produced Mixture Requirements

The mix design materials shall be those listed in Section 504.3 and used for the project. No substitutions are allowed during production, unless approved by the Development Engineering Manager.

The Responsible Party shall indicate on Detail 500-19 the project specific criteria concerning mix design method, traffic level, asphalt binder type, mixture grading, and maximum amount of RAP allowed. This information shall be provided on Detail 500-19, or other construction documents.

Grading SG (1-inch nominal aggregate) shall only be designed using the 150 mm Superpave molds. Hveem Stability and Lottman test are not required for Grading SG mixtures. Grading S and SX shall be designed using 100 mm Superpave molds.

A. Superpave Mixture Design Method

1. The Responsible Party shall submit a Proposed Design Job Mix Formula (PDJMF) for each mixture required by the Contract. The mixture design shall be determined using AASHTO T-312 or Colorado Procedure CP-L 5115 for the Superpave Method of Mixture Design. Guidance is provided in "Superpave Level 1 Mix Design" SP-2 published by the Asphalt Institute. Mixture design and field control testing shall meet the following requirements of Table 500-12 for Dense Graded HMA.

2. Mixture design and field control testing of SMA shall meet the following requirements of Table 500-12.

TABLE 500-12
SUPERPAVE MIXTURE PROPERTIES FOR DENSE GRADED HMA

Property or Test	Traffic Levels (ESALs)		
Traffic Loading, Total 18 kip ESALs Over Design Life (Usually 20 Years)	Low (0-100,000)	Medium (100,000 to <3.0 Million)	High (3.0 Million to <30 Million)
Design gyrations, N_{design} (Air Void: 3.5% to 4.5%) (See Note 1,2)	50	75	100
Air Voids in Total Mix (VTM) CPL 5115 or AASHTO T 312	(See Note 1)	(See Note 1)	(See Note 1)
Hveem Stability CP-L 5106 or AASHTO T 246 (Grading S & SX only) (See Note 3)	N/A	28 Min.	30 Min.
Voids Filled with Asphalt (VFA), MS-2	70-80	65-78	65-75
Lottman, Tensile Strength Ratio, % Retained, CP-L 5109 or AASHTO T 283, Method B	80 Min.	80 Min.	80 Min.
Lottman, CP-L 5109 or AASHTO T 283 Dry Tensile Strength, psi	30 Min.	30 Min.	30 Min.
VMA %. CP-48 or AASHTO PP 19 (See notes 2,3,4)	Minimum VMA criteria applies to the mix design only (Table 500-7). The minimum VMA criteria shall be linearly interpolated based on actual air voids. See 504.14 B for production tolerances		

Note 1: Select the target Job Mix Optimum Binder Content for HMA gradings as close to 4.0% air voids as possible (3.5% to 4.5% air voids). VTM is also referred to as Pax in CPL 5115, and %Gmmx in T 312
Note 2: Maximum Theoretical Specific Gravity of mix by CP-51 or AASHTO T 209.
Note 3: Refer to Section 504.13 B for production tolerances.
Note 4: VMA shall be based on tests of the Bulk Specific Gravity of the Compacted Mix (CP-L 5103 or AASHTO T 166) and Aggregate (AASHTO T 84 & T 85), and calculated according to CP-48 or AASHTO PP 19. All mixes shall meet the minimum VMA specified in Table 500-14, below.

TABLE 500-13
SUPERPAVE MIXTURE PROPERTIES FOR OPEN GRADED SMA

Property	Test Method	Value for SMA
Lab compaction (Revolutions) N_{Design}	CPL 5115 or AASHTO T 312	100
Air Voids, % at: N_{Design} (See Note 1)	AASHTO T 312	3.0 – 4.0
Hveem Stability	CP-L 5106 or AASHTO T 246	30 Min.
Accelerated Moisture Susceptibility, tensile strength Ratio, (Lottman)	CPL 5109 or AASHTO T 283, Method B	80 Min.
Dry Split Tensile Strength, psi	CPL 5109 or AASHTO T 283, Method B	30 Min.
Grade of Asphalt Binder	n/a	PG 76-28
Voids in the Mineral Aggregate (VMA) %, minimum (see note 2)	CP 48 or AASHTO PP 19	17
Draindown at Production Temperature	AASHTO T 305	0.3 maximum
% VCA_{MIX} (See Note 3)	AASHTO PP 41-02	Less than VCA_{DRC} (See Note 4)

General Note: Copies of AASHTO PP 41-02 and MP 8-02 (for designing SMA mixes) can be obtained from the CDOT Region Materials or the Development Engineering Manager.

Note 1: Select the target Job Mix Optimum Binder Content for SMA grading at 3.0% to 4.0% air voids.

Note 2: VMA shall be based on tests of the Bulk Specific Gravity of the Compacted Mix (CP-L 5103 or AASHTO T-166) and Aggregate (AASHTO T 84 & T 85), and calculated according to CP-48 or AASHTO PP 19. All mixes shall meet the minimum VMA specified in Table 500-14, below.

TABLE 500-14
MINIMUM VOIDS IN MINERAL AGGREGATE (VMA) for Dense Graded HMA & Open Graded SMA, %

Nominal Maximum* Particle Size	Air Voids **		
	3.5%	4.0%	4.5%
1"	12.2	12.7	13.2
¾"	13.2	13.7	14.2
½"	14.2	14.7	15.2
SMA	17.0	17.0	17.0

* Nominal Maximum Particle Size is defined as one (1) sieve size larger than the first sieve to retain more than 10%, but shall not exceed the 100% passing size. The Nominal Maximum Particle Size can vary during mix production even when the 100% passing size is constant.

** Minimum VMA criteria apply to the mix design only. The minimum VMA criteria shall be linearly interpolated based on actual air voids. See Section 504.14 for tolerances.

504.4 Mix Design Submittals

A. General Requirements

1. The Responsible Party shall submit all mixture designs, Certificates of Compliance, and laboratory data to the Development Engineering Manager for approval at least seven (7) calendar days before construction is to begin. The mix design (Proposed Design Job Mix) must be approved by the Development Engineering Manager prior to the start of construction.

2. Mixture designs shall be performed in a materials laboratory under the direct supervision of and shall be stamped and signed by a Professional Engineer licensed in the State of Colorado and practicing in this field. In addition, the Responsible Party shall submit, as part of the mixture design, laboratory data documents to verify the following:

   a. Source of materials.

   b. Gradation, specific gravity, source and description of individual aggregates and the final blend.

   c. Aggregate physical properties.

   d. Source and Grade of the Performance Graded Binder (PG Binder).

   e. Proposed Design Job Mix: aggregate and additive blending, final gradation shown on 0.45 power graph, optimum asphalt content.

   f. Mixing and compaction temperatures used.

   g. Mixture properties determined at a minimum of four (4) asphalt contents and interpolated at optimum and graphs showing mixture properties versus asphalt content.

3. Development Engineering Manager approval of any mix design for HMA or SMA must be given prior to placement,

4. The Development Engineering Manager reserves the right to verify the Responsible Party's mix design for each hot mix asphalt grading utilizing materials actually produced and stockpiled. If requested, the Responsible Party shall provide, at no cost, a sufficient quantity of each aggregate, mineral filler, RAP, and additive for the required laboratory tests, by the Development Engineering Manager. The Development Engineering Manager may request a Certificate of Conformance or Certificate of Compliance at any time on any material used. The Development Engineering Manager may request the mix supplier’s testing results on RAP at any time.

B. Change in Source or Grade

Should a change in the source of Lime occur, or more than one temperature grade change on either the high or low end of Performance Graded Asphalt Binders - (PG Binder) occur, a one point verification test (at optimum asphalt content) of the mix must be performed to verify that the applicable criteria shown on Table 500-12 (Dense Graded HMA)) or Table 500-13 (SMA), and Table 500-14 (VMA), is still met. If this testing shows noncompliance, a new Design Job Mix will be established and approved by the Development Engineering Manager before the new Performance Graded Asphalt Binders (PG Binder) or Lime source is used. Any change in aggregate type or source will require a new mix design. The one point verification test may be performed on lab mixed samples or on plant mixed samples

C. Mix Production Verification

Production verification shall occur prior to the start of the project. The production verification shall be performed by LABCAT Level C certified technicians with current Certification to verify the volumetric properties of the mix. If the mix has been produced for another project within the last 90 days, data from that project can be submitted for this verification. Volumetric properties of the mix verification testing shall be within the following tolerances compared to the Proposed Design Job Mix. The mix verification test reports shall be submitted to the Development Engineering Manager prior to mix placement.

TABLE 500-15
MIX DESIGN VERIFICATION TOLERANCES

Air Voids	+/- 1.2%
VMA	+/- 1.2%
Asphalt Binder Content	+/-0.3%
Stability	Applicable minimum

The tolerances in this table are for mix design verification only.
See section 504.13 for production tolerances.

D. Pre-paving Meeting

1. Development Engineering Manager may require a pre-paving meeting of all parties involved in supply, haul, laydown inspection, quality control and quality acceptance of HMA. Areas of responsibility and contact names and numbers should be shared. A construction (joint) plan will be submitted at the pre-paving meeting, see Section 504.9 and 504.10 for joint requirements.

2. A minimum of two (2) weeks prior to the proposed use of any Stone Matrix Asphalt pavement on the project, a pre-paving conference will be conducted. Prior to that time, the Responsible Party shall submit to the Development Engineering Manager, a mix design meeting the appropriate specification requirements for the items in Table 500-13.

504.5 HMA Equipment

A. Mixing Plant

1. The mixing plant shall be capable of producing a uniform material, have adequate capacity, and be maintained in good mechanical condition. Defective parts shall be replaced or repaired immediately if they adversely affect the proper functioning of the plant or plant units, or adversely affect the quality of the HMA.

2. Dust, smoke, or other contaminants shall be controlled at the plant site to meet all air quality requirements in the "Colorado Air Quality Control Act," Title 25, Article 7, CRS and regulations promulgated there under.

3. Acceptable safety equipment, approved by the Development Engineering Manager, shall be provided by the Responsible Party to accommodate sampling and testing.

B. Hauling Equipment

Trucks used for hauling HMA material shall have tight, clean, smooth beds, or functional and maintained conveyor belt bottom that is thinly coated with a minimum amount of paraffin oil, lime solution, or other approved release agent. Petroleum distillates such as kerosene or fuel oil will not be permitted. Each truck shall have a cover of canvas or other suitable material to protect the mixture from the weather and excessive temperature loss or cooled layers of mix in truck as covered in 504.6 C. Hauling, later in this specification.

C. Bituminous Pavers

1. Self-propelled pavers shall be provided for full lane width paving capable of spreading and finishing the HMA, material in full lane widths applicable to the typical section and thicknesses shown in the Contract and shall be equipped with:

   a. Anti-segregation devices.

   b. A vibratory screed assembly capable of being heated.

2. Pavers used for shoulders, patching and similar construction, not requiring fine grade control, shall be capable of spreading and finishing courses of HMA material in widths shown in the Contract without segregation.

3. The paver's receiving hopper shall have sufficient capacity for a uniform spreading operation and shall have an automatic distribution system that will place and spread the mixture uniformly in front of the screed.

4. The paver shall be capable of operating at forward speeds consistent with uniform and continuous laying of the mixture. Stop and go operations of the paver shall be avoided. The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, or gouging the mixture. Self-propelled pavers shall be equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, and maintaining the screed at the specified longitudinal grade and transverse slope. The sensors may be contact or non-contact type devises. The sensor shall be constructed to operate from either or both sides of the paver and shall be capable of working with the following devices when they are required for the situation:

    a. Grade control device at least 30 feet in length.

    b. Joint matching device.

    c. Adequate length of control line and stakes, if no other type of geometric control is present.

    d. A straight edge at least 10 feet in length will be available to verify the crown on the screed, at the request of the Development Engineering Manager.

5. The controls shall be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 %. Automatic mode should be used where possible. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained.

6. If the Responsible Party fails to obtain and maintain the specified surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

7. Placement of HMA on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or protective covering.

504.6 Manufacture

A. Preparation of Aggregates

1. Heating and drying of the aggregates shall be accomplished without damaging the aggregate. Hydrated lime shall be added to achieve complete and uniform coating of the aggregate, in accordance with one of the following methods:

    a. Lime Slurry Added to Aggregate: The hydrated lime shall be added to the aggregate in the form of slurry and then thoroughly mixed in an approved pugmill. The slurry shall contain a minimum of 70% water by weight.

    b. Dry Lime Added to Wet Aggregate: The dry hydrated lime shall be added to wet aggregate (a minimum of three (3)% above saturated surface dry) and then thoroughly mixed in an approved pug mill.

2. The lime-aggregate mixture may be fed directly into the hot plant after mixing or it may be stockpiled for not more than 90 days before introduction into the plant for mixing with the asphalt binder. The hydrated lime may be added to different sized aggregates and stockpiled by adding 75% of the lime to the aggregate passing the No.4 sieve and 25% to the aggregate retained on the No. 4 sieve.

3. A minimum of one (1)% hydrated lime by weight of the combined aggregate shall be added to the aggregate for all Dense Graded and Open Graded Stone Matrix Asphalt mixtures.

B. Mixing

1. The dried aggregates and asphalt binder shall be combined in the mixer in the quantities required to meet the design job mix. The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt binder is uniformly distributed throughout the aggregate, Baghouse fines shall be fed back to the mixing plant in a uniform and continuous manner to maintain uniformity in the mixture. The Baghouse, fines feeder, auger, and related equipment, shall be in good working condition and operated in accordance with manufacturer's recommendation. If the Development Engineering Manager determines that non-uniform operation of the equipment is detrimental to the mixture, it may suspend all paving operations until the Responsible Party takes appropriate action.

2. The minimum temperature of the mixture when discharged from the mixer shall be as shown in the following table:

TABLE 500-16
MIXTURE DISCHARGE TEMPERATURES

Asphalt Grade	Minimum Discharge Temperature	Maximum Discharge Temperature
PG 58-28	275º F	310º F
PG 64-22	290º F	325º F
PG 76-28*	318º F	326º F

* Contractor or Binder supplier must supply production temperature as required by their product

3. The Responsible Party may provide refinery information that recommends revised discharge temperatures depending on the base binder grade or source being used. HMA mix shall be produced at the lowest temperature within the specified temperature range that produces a workable mix and provides for uniform coating of aggregates (95 % minimum in accordance with AASHTO T 195), and that allows the required compaction to be achieved.

4. HMA mix may be stored provided that any and all characteristics of the mixture are not altered by such storage. If storing or holding of the mixture causes segregation, excessive heat loss, or adversely affects the quality of the finished product, corrective action shall be taken. Unsuitable mixture shall be disposed of at the Responsible Party's expense.

5. When placing hot mix asphalt over bridge decks covered by waterproofing membrane, the minimum temperature of the mixture, when rolling operations begin, shall be 250° F. The job mix temperature may be increased up to 30° F to obtain this temperature.

6. The mineral filler for SMA shall be stored in a separate silo and added automatically in the correct proportion. The mineral filler addition equipment shall be electronically or mechanically interlocked to the aggregate feed sensors so that the proper amount of mineral filler is added whenever SMA is produced.

7. The SMA mineral filler shall be added at the same point the asphalt binder is added to the aggregate.

C. Hauling

Each truck shall use full covers (tarps) to completely protect the mix during transport at all times. The Development Engineering Manager can reject any mix, which shows an excess or deficiency of asphalt cement, damage due to burning or overheating, an improper gradation, or thermal segregation with cold areas 10° F below the minimum discharge temperature.

504.7 Tack Coat

A. Prior to placement of HMA, a tack coat shall be applied to all existing concrete and asphalt surfaces. The material shall be in accordance with 504.2 E. The emulsified asphalt shall be diluted 1:1 with water and applied at 0.10 ± 0.01 gallons per square yard of diluted material. The Development Engineering Manager may direct other application rates to match the age of condition of the surface. The surface prior to receiving the tack coat shall be dry and cleaned by sweeping, or other approved method, until dust, debris, and foreign matter are removed. The tack coat shall then be applied uniformly by squeegee, brooms, or distributor. Prior to paving, all water must have evaporated from the tack coat. Contaminated areas shall be cleaned and tack coat shall be reapplied.

B. Prior to placement of SMA, tack coat between the existing pavement and Stone Matrix Asphalt pavement shall be placed at a rate between 0.03 and 0.05 gallons per square yard

504.8 Placement

A. Hot mix asphalt shall be placed only on approved, properly constructed surfaces that are free from loose material, water, frost, snow or ice. The hot mix asphalt and tack coat shall be placed in accordance with the temperature limitations of Table 500-16 and only when weather conditions permit the pavement to be properly placed and finished as determined by the Development Engineering Manager. Placement temperature as stated shall be increased by 5° F for each 10 miles per hour wind velocity to a maximum increased minimum placement temperature of 70 ° F.

TABLE 500-17
MINIMUM AIR AND SURFACE TEMPERATURES
LIMITATIONS FOR MIX PLACEMENT (HMA)

Compaction Layer Thickness	Top Layer of Pavement*		Lower Layers *	
	PG 58-28 PG 64-22	PG 76-28	PG 58-28 PG 64-22	PG 76-28
<2 inches (not recommended)	60º F	75º F	N/A	N/A
2 inches to <3 inches	50º F	65º F	40º F	50º F
> 3 inches	50ºF	50º F	40º F	40º F
SG mix only	N/A	N/A	38º F	38º F

* Air temperature is taken in the shade. Surface temperature is taken on the subgrade or base. The Development Engineering Manager may not waive the above temperature limitations for PG 76-28.

B. The mixture shall not be placed at a temperature lower than 245° F for mixes containing PG 58-28 or PG 64-22 asphalt, and 290° F for mixes containing polymer modified asphalt binder. Mix which is too cold or damaged by weather will be rejected.

C. The mixture shall be placed on an approved surface, spread and struck off to obtain the required grade and elevation after compaction. The minimum lift thickness shall be at least three (3) times (preferably four (4) times) the nominal particle size. The un-compacted mixture should be placed approximately 10-25 % thicker than the existing surrounding mat to account for compaction based on the materials being placed. Raking is discouraged and will not be allowed except to correct major problems of grade and elevation. Casting or raking that causes any segregation will not be permitted.

D. On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to the required compacted thickness plus approximately 25 % based on the materials being placed. Carefully move or minimally work the HMA mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt binder require more rapid completion of handwork areas than for normal mixtures. Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Excessive starting and stopping shall not be allowed. A construction joint shall be placed any time the paver stops, and the screed drops enough to cause a surface dip in violation of section 504.13, Production Tolerances; or the mat temperature falls below that allowed in section 504.12, Compaction. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable. Echelon paving will be permitted.

E. SMA PI & Compaction

A Roller Pass Study (RPS) for Density and 1000 foot demonstration control strip are required for placement of lifts less than or equal to 1.5 inch thick, optional for thicker lifts.

1. For Thin Lift SMA less than or equal to 1.5 inch thick:

   a. In-place density shall be determined through the completion of a Roller Pass Study (RPS) to be conducted during placement of the required 1000-foot demonstration control strip. The RPS will determine the necessary roller compaction process needed to produce a minimum pavement density of 94 % of theoretical maximum density (RICE). During the RPS, a minimum of three (3) sets of three (3) four (4) inch diameter cores each shall be taken to measure SMA mat density for the various sections of the RPS. All coring shall be completed by the Responsible Party and submitted to the Development Engineering Manager. The densities of the three (3) cores will be averaged to produce the density for each RPS section tested.

   b. Full production of the thin SMA shall not begin until density test results are determined and the project compaction process is established by the Responsible Party and approved by the Development Engineering Manager. The approved compaction process established from the RPS shall be used for the duration of the thin SMA paving. Changes to the thin SMA mixture will be reviewed and a new RPS may be required.

   c. Using the same method for determining density during the RPS, density will be determined daily for each day of full production and tested to confirm pavement density. If a daily density check

shows density below 92 % of RICE, the Responsible Party shall stop production and the Responsible Party will again complete a RPS to establish the necessary compaction process. The Responsible Party will be allowed two (2) daily density checks below 92 % of RICE to be addressed in this manner during the project. All subsequent daily checks that identify locations having density below 92 % of RICE shall be removed and replaced and a new RPS shall be completed and approved prior to again beginning production. Thin SMA density requirements will be enforced when the SMA mix design gradation and specified lift thickness are in accordance with or exceed the 3:1 requirements for the ratio of nominal maximum aggregate size to lift thickness.

d. The Responsible Party shall submit a plan for a Roller Pass Study (RPS) to the Development Engineering Manager for approval. Upon approval by the Development Engineering Manager, the Responsible Party shall perform a RPS. The plan for the RPS shall include, but is not limited to the following:

   i. Number, size, and type of rollers.

   ii. Amplitude, frequency, size and speed of vibratory rollers.

   iii. Temperature of mixture being compacted.

   iv. Roller patterns.

e. The method of measuring density will be by roller passes. If a density element is based on a RPS.

2. For SMA lifts greater than 1.5 inch thick:

   a. If in the opinion of the Development Engineering Manager, the roller pass study presented by the Responsible Party is inadequate, then the Responsible Party shall modify the compaction procedures as directed.

   b. Before Proceeding with SMA placement,

      i. The Responsible Party shall demonstrate the ability to produce and place a satisfactory mix.

      ii. The actual work may proceed when a full lane width demonstration control strip, having a minimum length of 1000 feet has been successfully placed. The Responsible Party shall determine properties (Superpave Air voids, VMA, in-place density, and Hveem Stability) of the project produced mix that is used in the demonstration control strip and provide the results to the Development Engineering Manager. No other SMA production or placement will be allowed until densities are determined. If the material in the demonstration control strip is not in close conformity with the specifications, the demonstration control strip will be removed and replaced at the Responsible Party‘s expense. The Development Engineering Manager will designate the location of the control strip.

      iii. SMA mixture shall be transported and placed on the roadway without drain-down or flushing. All flushed areas behind the paver shall be removed immediately upon discovery. If more than 50 square feet of flushed SMA pavement is ordered removed and replaced in any continuous 500 linear feet of paver width laydown, operations shall be discontinued until the source of the flushing has been found and corrected. The Development Engineering Manager will designate the depth and area of all flushed areas requiring removal and replacement. All costs associated with the removal and replacement of the flushed areas shall be at the Responsible Party’s expense.

      iv. Stone Matrix Asphalt Pavement shall be placed and compacted in accordance with the temperatures listed in Table 500-16 or as revised for the project.

      v. The relative compaction for all SMA mixtures will be measured from roadway cores in accordance with CDOT-CP 44 or AASHTO T-166, Method B, unless the SMA mixture is being placed on a structure (bridge deck) in which case the Development Engineering Manager may specify that nuclear gauge measurements be used.

      vi. When cores are used, the Responsible Party shall provide all labor and equipment for the coring operation and filling the core holes. When nuclear density gauges are used, the tests will be performed in accordance with CDOT-CP 81 or ASTM D 2950 and CDOT-CP 82 or AASHTO T 230.

vii. In-place density for SMA shall be 95 ± 2 % of the SMA Mix maximum specific gravity as measured according to Maximum theoretical value (Rice) (CDOT-CP 51 or AASHTO T 209).

504.9 Longitudinal Joints

A. The longitudinal joints in both a new pavement and an overlay pavement layer shall offset the joint in the layer immediately below by a minimum of six (6) inches. The joints in any pavement layer shall not fall in a wheel track or path. The joints in the top layer of new pavement, not built on top of an existing pavement, shall be located on lane lines, or as shown on the plans. Longitudinal joints shall be minimized, where feasible, with wide paving pulls or echelon paving. Joints shall be parallel to the flow of traffic and shall not cross any centerline, lane line, or edge line unless approved by the Development Engineering Manager. The Responsible Party shall submit, prior to paving, a joint plan and pavement marking plan showing locations and the methods to establish a field control line. The Development Engineering Manager must approve such plans prior to paving. The Responsible Party shall use a continuous string line to delineate longitudinal joints during paving as shown on the joint plan. All string lines shall be removed at the end of each day's paving.

B. The free edge of the paved pass shall be laid as straight as possible, to the satisfaction of the Development Engineering Manager. This joint, if cold, shall be tack coated prior to placement of adjacent paving.

C. The new compacted mat shall overlap the previously placed mat no more than one and one-half (1.5) inches. Excess overlap or thickness shall not be raked or cast onto the new mat, but shall be wasted by pulling back and removing. The hot edge shall be blocked or bumped in a smooth line consistent with the previous longitudinal edge. Minor raking will only be allowed to correct major grade problems or provide mix around manholes and meter covers. The longitudinal joint shall be rolled from the hot side and overlap the joint by approximately six (6) inches on the cold side.

504.10 Transverse Joints

A. The Responsible Party shall submit, prior to paving, a joint plan showing locations and the methods to be used to construct transverse joints. The Development Engineering Manager must approve such plans prior to paving. Placing of the HMA shall be continuous with a minimum of transverse joints, and rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Tack coat material shall be applied to contact surfaces of all joints just before additional mixture is placed against the previously compacted material.

B. The end of transverse joints shall be located so they will be constructed with a full head of mix in front of the screed. When butt joints are constructed, runoff boards shall be used to support the roller on the downstream side of the joint. All tapered sections, rounded edges and segregated areas shall be removed to achieve a vertical face at the butt joint before paving is restarted.

C. When a temporary tapered joint is required for temporary traffic access, the ramp shall be removed back to a full depth section before paving is restarted.

D. When restarting paving operations, the paver screed shall be placed on the starter block on the completed side of the transverse joint. The starter block should be approximately 25% greater than the thickness of the existing completed mat, so that adequate grade and compaction can be achieved on starting the paving operation. The screed should be nulled (angle removed) when on starting blocks and an up angle of attack set. Proper head of mix should be introduced into the paver prior to starting. The new compacted (downstream) side of the joint may be up to 3/16 inches higher than the old (upstream) side. Raking of this joint shall not be allowed except to correct major grade problems. The surface tolerance at the transverse joint must be verified by the Responsible Party with a 10-foot straight edge before the paver is more than 100 feet from the joint. If the surface tolerance is not within 3/16 inches, the Responsible Party shall make corrections before proceeding

504.11 Segregation

A. The asphalt mixture shall be transported and placed on the roadway without segregation. All segregated areas shall be removed immediately and replaced with specification material before the initial rolling. If more than 50 square feet of segregated pavement is removed and replaced in any continuous 500 linear feet of paver width laydown, operations shall be discontinued until the source of the segregation has been determined and corrected.

B. The Development Engineering Manager will visually determine areas that are segregated, and may also use density and gradation measures to help in this determination. The Development Engineering Manager will visually determine the extent of the segregation. The Responsible Party will not be allowed additional compensation for correction of segregated areas.

504.12 Compaction

A. The temperature of the mixture immediately behind the screed shall be sufficient to allow for proper compaction of the HMA layer and at least 245° F for PG 58-28 or PG 64-22 binder and between 297° F and 305° F for PG 76-28 binder. The breakdown compaction should be completed as quickly as possible after placement occurs.

B. The HMA shall be compacted by rolling. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density and surface texture while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continued until the required density is obtained. Final compaction shall be obtained using steel wheel rollers.

C. Pavement operations shall be suspended when density requirements are not met and the surface temperature falls below 185° F, or there is obvious surface distress or breakage, the problem shall be resolved prior to continuing paving operations. The criteria for mixtures containing PG 76-28 asphalt cements shall be 235° F. The minimum compaction temperatures may be adjusted according to the asphalt binder supplier recommendations. Adjusted minimum compaction temperatures must be shown on the approved mix design or on other asphalt binder supplier documents, and be available on the job site.

D. All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted on bridge decks.

E. The Responsible Party shall establish a rolling pattern or procedure during the beginning of paving operations, which will achieve the required compaction and surface tolerances. This procedure may be re-evaluated by the Responsible Party and Development Engineering Manager throughout the paving operations.

F. All HMA paving shall be compacted to 94.0 ± 2% of Maximum Theoretical (RICE) Density, (CP-51 or AASHTO T-209: Maximum Specific Gravity of Bituminous Paving Mixtures) as determined by ASTM D 2950. RICE values shall be used in calculating Relative Compaction according to CP-44 or .AASHTO T 166. The Responsible Party shall determine the proper RICE value to use for the initial day's placement. Subsequent day's RICE value(s) will be based on the current day's production. The Responsible Party shall provide the producer's RICE value, which shall be used for production until the actual day's RICE value is determined by the testing firm of record for the project as approved by the Development Engineering Manager.

G. All joints shall be compacted to 92.0 ± 2% of RICE, taken fully on each side of joint, every 200 Linear Feet. RICE values shall be used in calculating Relative Compaction according to AASHTO T 166, Cores if need will be used to verify compaction results.

H. The Responsible Party shall core the pavement, as required by the Development Engineering Manager, for field density tests in accordance with Colorado Procedure 44 or AASHTO T 230, Method B, or for field calibration of nuclear density equipment in accordance with the ASTM D 2950 or Appendix of Colorado Procedure 81. At a minimum, cores for nuclear density equipment calibration shall be taken at the beginning of placement of each pavement layer or change of mixture materials or gradation. Untested areas during placement will also require cores to be taken to verify compaction.

I. Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers.

J. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with fresh hot mixture and compacted to conform to the surrounding area.

K. Compaction requirements for SMA are covered in Section 504.8 E. Rollers shall not be used in a vibratory mode on SMA unless they are first used successfully in the demonstration control strip. Pneumatic wheel rollers shall not be used on SMA Mix.

504.13 Production Tolerances

A. Top Lift Surface Tolerances

The surface variation between any two (2) contacts shall not exceed three-sixteenths (3/16) inch in 10 feet for full lane width paving. For patching surface tolerances, the variation shall not exceed three-eighths (3/8) inch in 10 feet. Irregularities exceeding the specified tolerance shall be corrected at the Responsible Party's expense. Transverse measurements for variations shall exclude breaks in the crown sections.

B. Job Mix Formula Tolerances

Production test results that deviate from the design job mix by more than shown in the following table are subject to Section 504.13 C:

TABLE 500-18
JOB MIX FORMULA TOLERANCES

Item	Tolerances
Passing No. 3/8" and Larger (note 1)	± 6%
Passing No. 4 and No.8	± 5%
Passing No. 30 to No. 50	± 4%
Passing No. 200 (note 2)	± 2%
Air Voids	± 1.2%
VMA (note 4)	± 1.2%
Hveem Stability	(note 3)
Asphalt Content	± 0. 3%

Note 1 There is one (1.0)% tolerance for the maximum sieve size.
Note 2 Mixes with passing No. 200 sieve material produced over seven (7.0)% are allowed only when the above Air Voids and VMA tolerances are still met.
Note 3 Hveem Stability must meet the minimum value specified in Table 500-13.
Note 4 When calculating VMA, use the most current aggregate specific gravity $G_{sb,}$

C. When disagreements concerning determination of specification compliance occur, only valid tests from both the Development Engineering Manager and Responsible Party will be considered. The Development Engineering Manager shall determine validity. Generally, valid tests are those in which sampling and testing have been performed according to referenced procedures and the results are within stated precision statements. When disagreements occur with asphalt content and gradation tests results, solvent extracted aggregate testing shall take precedence over burn off oven extracted aggregate, which shall take precedence over cold feed belt testing.

505 CONCRETE PAVEMENT

A. The installation of concrete pavement, including materials, equipment, foundation and construction methods shall be in conformance with Section 412, "Portland Cement, Concrete Pavement" of the CDOT S&S, except as modified herein or as modified by the approval of the Development Engineering Manager.

B. Section 600 of these Standards and Specifications must be followed for concrete work. Concrete pavements shall only be designed where approved by the Development Engineering Manager. It shall be installed as shown on the approved plans. When concrete pavement is constructed on a curve, flexible forms shall be used having a radius of 200 feet or less, unless otherwise directed by the Development Engineering Manager. The Responsible Party shall furnish steel pins to use in setting grades for concrete pavement.

505.1 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. CDOT Class "D" mix shall be used.

A. Portland cement shall comply with the CDOT requirements. The type of cement shall be Type II or Type II Modified unless sulfate conditions dictate otherwise. Table 2.2.3 in Chapter 2.2 of ACI 201 indicates recommendations for sulfate resistance.

B. Fine aggregates shall meet CDOT S&S, Section 703.01 requirements.

C. Coarse aggregates shall meet CDOT S&S, Section 703.02 requirements.

D. Fly Ash shall comply with CDOT S&S, Section 701.02 if use is approved by Development Engineering Manager.

E. Water shall meet the requirements of CDOT S&S, Section 712.01.

F. Air entraining and chemical admixtures shall meet the requirements of CDOT S&S, Section 711.02 and 711.03. No chloride containing additives shall be permitted.

G. Curing materials shall be white pigmented liquefied membrane curing compound and meet the requirements of AASHTO M 148.

H. Reinforcing steel shall meet the requirements of CDOT S&S, Section 709.01, grade 40 minimum.

I. Minimum compressive strength shall be 4000 psi; minimum modulus of rupture or flexural strength shall be 600 psi.

505.2 Aggregate Base Course Material

A. 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 of AASHTO M 147, and to Section 703.03, CDOT S&S. In addition, the material shall have an R-value of 78 or greater or a CBR of 80 or greater and shall be moisture stable. Moisture stability is determined by R-value testing which shows a drop of 12 points or less in R-value between exudation pressures of 300 psi and 100 psi.

B. Only aggregate from approved sources shall be used. Approval of sources shall be at the discretion of the Development Engineering Manager and submissions shall, at a minimum, consist of supplying documented gradation, Atterberg limits and CBR/R-value testing on an annual basis. Only two (2) types of crushed aggregate base course are acceptable. The gradation specifications for these two types of base course are listed below:

TABLE 500-19
AGGREGATE BASE COURSE MATERIALS
AND CDOT SPECIFICATIONS

Sieve Designation	% Passing By Weight	
	Class 5	Class 6
1½"	100	---
1"	95-100	---
3/4"	---	100
No. 4	30-70	30-65
No. 8	---	25-55
No.200	3-15	3-12
Liquid Limit (LL)	30, Maximum	30, Maximum

505.3 Cement Treated Aggregate Base Course

A. This material shall consist of a mixture of aggregate materials, Portland cement and water as outlined in Section 308 of the CDOT S&S. Acceptable aggregates include CDOT Classes 4, 5, and 6. Other aggregates may be used, if previously approved by the Development Engineering Manager.

B. The materials to be used in construction shall be tested and a mix design submitted to the Engineer. As a minimum, the mix design report shall contain a description of material sources, gradations and Atterberg limits of aggregates, cement type, Proctor compaction curves and unconfined compressive strength results for each mix, strength versus cement content curves, a design mix and special construction procedures recommended. Testing shall be in accordance with appropriate AASHTO specification.

C. To be approved, the mix shall have a seven (7) day compressive strength of at least 650 psi and no more than 1,000 psi. The minimum acceptable cement content shall be five (5)% by weight. Only mix designs approved by the engineer shall be used.

505.4 Lime Treated Subgrade

A. This material consists of a mixture of native or imported soils, hydrated or quick lime and water as outlined by Section 307 of CDOT S&S.

B. The materials to be used in construction shall be tested and a mix design submitted to the Engineer for approval. As a minimum, the mix design report shall contain a description of material sources, gradation (-200) and Atterberg limits of native soils, Atterberg limits and seven (7) day unconfined compressive test results for each mix and special construction procedures are recommended. Testing shall be in accordance with appropriate AASHTO methods.

C. To be approved, the mix shall have a minimum seven (7) day compressive strength of 160 psi. In addition, the plasticity index of the treated soil shall not exceed six (6). The minimum acceptable hydrated lime content shall be four (4)% by weight.

D. Only mix designs approved by the Development Engineering Manager shall be used. Approvals are required on a project basis prior to issuing construction permits. Minimum in-place thickness for this material shall be six (6) inches.

506 MATERIALS AND CONSTRUCTION PRACTICES

506.1 General

Refer to Section 100 for excavation, testing, backfill, and compaction requirements.

506.2 Heating and Scarifying

When heating and scarifying treatment is specified on the approved construction plans or required by the Development Engineering Manager, the equipment, materials and construction shall be in accordance with requirements of the CDOT S&S, Section 405.

506.3 Grinding

A. Grinding shall consist of "milling", "grinding", or "cold planing" the existing pavement surface to establish a new surface profile and cross section in preparation for a bituminous overlay. After grinding, the surface shall have a grooved or ridged finish, uniform and resistant to raveling or traffic displacement. This textured surface shall have grooves of one-fourth (¼) inch plus or minus one-eighth (1/8) inch. The existing surface to be ground shall include bituminous pavement, concrete utility patches, and a small amount of concrete pavement.

B. "Wedge cut" grinding shall consist of grinding the existing pavement surface a minimum of four (4) feet wide at the existing concrete gutter. The edge of the gutter end of the finished wedge cut shall be one and one-half (1½) inches below the edge of the existing concrete gutter. The center line of street edge of the wedge cut shall be cut one-eighth (1/8) inch. The depth of cut shall be determined by measuring to the top of the ridges by placing a five (5) foot straight edge perpendicular to the grooving pattern. "Full width" grinding shall consist of grinding the existing pavement surface from edge of gutter to edge of gutter to a minimum depth of two (2) inches, unless otherwise directed by the Development Engineering Manager.

C. Grinding around utility castings to the depth of cut before and after encountering the castings shall be included in the area of the pavement surface ground. The Responsible Party may choose to remove the entire existing bituminous pavement around the castings where grinding is not completed, and replace it with bituminous surface course placed and compacted in three (3) inch lifts. The Responsible Party shall vertically cut the limits of the area to be patched, mechanically compact the existing base course, and prime the bottom and vertical edges before backfilling.

D. The grinding machine shall be a power operated, self-propelled machine, having a cutting drum with lacing patterns that shall attain a grooved surface and produce grinding chips of less than one (1) inch in size. The grinding machine shall be equipped with a pressurized watering system for dust control. The equipment shall be a type that has successfully performed similar work.

E. The Responsible Party shall remove the cuttings immediately behind the grind machine by belt loader, end loader, power sweeper and/or by hand. The removed material shall be disposed of as approved by the Development Engineering Manager.

F. The cleaning equipment shall be a type which shall efficiently remove loosened material, load it into trucks for hauling and spreading, and utilize a watering system for dust control. Because of the nature of the streets to be ground and the traffic restrictions, a beltloader followed by a power sweeper and manual sweeper is the most desirable method. Flushing into the City's storm sewer system as a means of cleanup shall not be allowed.

506.4 Geosynthetics

A. General

Any proposed Geosynthetic used in paving applications must be accompanied with a letter stating the purpose for use, and include the stamp of a licensed PE in the State of Colorado.

B. Fabric

Geotextile fabric shall meet criteria for the proper application and that set forth by the CDOT S&S, Sections 420 & 712, and subject to the approval of the Development Engineering Manager. This includes, but not limited to those geotextile fabrics for paving, weed control, and erosion control.

C. Geogrids

Geogrids shall meet the pavement or soil report criteria and are subject to the approval of the Development Engineering Manager.

507 APPURTENANT CONCRETE STRUCTURES

507.1 General

Curb, curb ramps, gutter, sidewalk, cross pan, and driveway construction shall conform to Section 600 of these Standards and Specifications.

508 ROADWAY INSPECTION AND TESTING

508.1 General

Work performed inside ROW and associated easements shall be tested by a materials testing firm which employs a full time PE, registered in the State of Colorado, who directly supervises work of the firm. Concrete technicians must be ACI or equivalent Level I technicians. The costs of testing and associated reporting shall be paid by the Responsible Party. Test and inspection results performed by the testing firm in the employment of the Responsible Party shall be submitted to the Development Engineering Manager at the time of testing or within 15 working days after the testing or retesting date.

508.2 Roadway Subgrade Preparation

A. Compaction

The subgrade shall be free of organic material and shall be scarified to a minimum depth of six (6) inches, or as stated in the Pavement Design Report, moisture treated to within two (2) % of optimum moisture content, or as otherwise specified in the approved geotechnical report, and compacted. Table 500-20 shall be used to determine the compaction.

B. Testing

Field moisture-density tests using methods acceptable to the Development Engineering Manager shall be required at random locations at the rate of one (1) for each 250 lineal feet of paving for each travel lane.

TABLE 500-20
MOISTURE-DENSITY CONTROL

Soil Classification (AASHTO M 145)	AASHTO T 99 Minimum Relative Compaction %	AASHTO T 180 Minimum Relative Compaction %
A-1, A-3, A-2-4, A-2-5	100	95
All Other	95	90

C. Final Proof-Rolling

After the subgrade has been compacted, tested and found to meet specifications, the entire subgrade shall be proof-rolled with a heavily loaded vehicle. The vehicle shall have a certified loaded GVW of 50,000 pounds with a loaded single axle weight of at least 18,000 pounds and a tire pressure of 90 psi. Subgrade which is pumping or deforming must be reworked, replaced or otherwise modified to form a smooth, stable, non-yielding base for subsequent paving courses. The Development Engineering Manager shall be notified at least 48 hours before final proof-rolling.

D. Acceptance

The results of field density tests and proof-rolling shall be submitted and reviewed by the Development Engineering Manager. Provided test results are acceptable, compaction shall be approved for the placement of the next paving course. Should testing indicate unsatisfactory work, the necessary reworking, compaction or replacement shall be required prior to continuation of the paving process. The approval is valid for 24 hours. Changes in weather, such as freezing or precipitation, shall require re-approval of the subgrade.

508.3 Lime Treated Subgrade

A. Materials

Lime treated subgrade shall be used only where a mix design has been previously submitted and approved by the Development Engineering Manager. Refer to Section 307 of the CDOT specifications for construction requirements.

B. Construction

Construction of lime treated subgrade shall be in accordance with the requirements of Section 307 of the CDOT S&S, except that the curing period shall be a minimum of 48 hours.

C. Testing

Lime treated subgrade shall be observed and tested on a full-time basis and paid for by the Responsible Party. Field moisture-density tests shall be taken at the rate of one (1) for each 250 lineal feet of travel lane for each lift. Compaction curves (AASHTO T 220) shall be required for each soil type and field density shall be compared to the appropriate curve for percentage compaction determinations. Field compacted seven (7) day strength and lime content (AASHTO T 232) determinations shall be required for each 500 tons of subgrade treated, with a minimum of one (1) per project.

D. Acceptance

The results of field density, lime content and strength tests shall be submitted and reviewed by the Development Engineering Manager. Provided test results are acceptable, the subgrade shall be approved and the next paving course can be placed. Should these tests fail to meet project specifications, the strength reduction shall be used to calculate increased pavement layer or overlay thicknesses required for the design section.

508.4 Aggregate Base Course

A. Materials

Aggregate base course materials shall be from a source approved by the Development Engineering Manager. The Responsible Party shall, upon request, provide verification of material properties.

B. Placement and Compaction

1. 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.

2. Aggregate base materials shall be placed, moisture treated and compacted as outlined in Section 304 of the CDOT S&S.

C. Testing

1. At least one (1) sample of aggregate base course for each 1,000 tons of material placed shall be tested to determine gradation and Atterberg limits. Should these tests indicate the material does not meet specifications, the material shall be removed and replaced.

2. During placement and compaction, Compaction Curves shall be required for each material used. Field moisture-density tests shall be taken of each lift of material at random locations, at approximate intervals of 250 feet in each travel lane. At least 20% of the tests shall be taken within one (1) foot of manholes, valves and curbs.

D. Approval

The results of field density tests shall be submitted and reviewed by the Development Engineering Manager provided the tests are acceptable, the aggregate base course materials, placement and compaction shall be approved and the next paving course can be placed. Should testing indicate unsatisfactory work, the necessary reworking, compaction or replacement shall be required prior to continuation of the paving process.

508.5 Cement Treated Aggregate Base Course

A. Materials

Aggregate and cement materials shall be from a currently approved source, and shall be approved by the Development Engineering Manager. The Responsible Party shall provide verification of material properties and an approved mix design.

B. Placement and Compaction

Materials shall be placed on a subgrade approved by the Development Engineering Manager and 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., materials shall not be placed until the subgrade is reapproved.

C. Testing

1. At least one (1) sample of cement treated aggregate base course for each 1,000 tons of material placed shall be tested to determine cement content, gradation and Atterberg limits. Six (6) field prepared Proctor mold samples shall be taken for each 500 tons placed and tested at seven (7) and 28 days to determine unconfined compressive strength.

2. During placement and compaction, Compaction Curves shall be required for each material used in accordance with AASHTO T 134. Field moisture-density tests shall be taken of each lift of material at random locations at approximate intervals of 250 feet in each travel lane. At least 20% of the tests shall be taken within one (1) foot of manholes, valves, and curbs.

D. Approval

The results of laboratory tests and field density tests shall be submitted and reviewed by the Engineer. Provided test results are acceptable, the cement treated aggregate base course materials, placement and compaction shall be approved and the next paving course can be placed. Should testing indicate unsatisfactory work, necessary adjustments shall be made to the pavement section to comply with original strength requirements.

508.6 Asphalt Prime and Tack Coats

A. Materials

See Subsection 504.2 E of these Standards and Specifications

B. Application

1. Prior to prime coat application, the surface shall be allowed to dry to approximately 80% of optimum moisture. The asphalt material shall be applied in the range of 0.05 to 0.15 gallons/square yard.

2. Tack coat shall be applied where additional HMA is to be placed over existing asphaltic or Portland cement surfaces. Tack coats shall not be required where HMA is less than 24 hours old and remains free of dust, dirt or debris. A 1:1 dilution shall be applied at 0.10 gallon per square yard and shall be used for a tack coat on existing pavement. A wand, or hand spray nozzle attached to the spray bar can be used for applying tack to gutter faces, valve boxes, manholes and rings.

C. Curing

Curing shall be required for prime and tack coats. The prime or tack coat shall be sticky, or tacky, when cured. The length of time required for curing shall depend on the air temperature, humidity and wind conditions and shall be black when cured.

D. Approval

Prime or tack coat shall be approved by the Development Engineering Manager upon acceptance of mill certifications, visual approval and verification of application rate. Dust or contamination of prime or tack coats shall require brooming and reapplication.

508.7 Plant Mix Bituminous Pavement

A. Materials

Asphalt, aggregate, fillers and additives shall be combined to form a mix design. The mix design shall be submitted to the Development Engineering Manager for approval.

B. Placement and Compaction

1. Materials shall be placed upon a City approved subgrade or previous paving course in accordance with Section 400 of the CDOT Standard Specifications. Prime or tack coats shall be applied in accordance with Subsection 504.2 E and 508.6 of these Standards and Specifications.

2. When more than one lift of pavement is required, the joints or seams between lifts shall be staggered so that joints are separated by at least two (2) feet in the horizontal direction. Joints in the final wearing course shall not be located in probable wheel paths.

3. The HMA mix shall be compacted to at least 95% of the mix specified density from Hveem testing to achieve design strength.

C. Testing

1. During placement and compaction of Hot Mix Asphalt pavement, observation and testing by City personnel shall be on a full-time basis at the expense of the Responsible Party.

2. If any materials furnished or work performed by the Responsible Party fails to fulfill the specification requirements, such deficiencies shall be reported to the Development Engineering Manager and the Responsible Party immediately. Preliminary written field reports of all tests taken and observation results shall be given to the Responsible Party and Development Engineering Manager within one (1) business day after samples were obtained or density testing performed. Field reports shall be forwarded to the Project Manager no later than one (1) week following the testing.

3. Reports of all tests taken, including failing tests, shall be reported to the Development Engineering Manager and to the Responsible Party no later than one (1) week following the sampling. Density test results will be given in writing at the time the testing occurs.

4. Testing of Hot Mix Asphalt Pavement shall be performed in accordance with Table 500-21. The tests shall be performed under the general supervision of and signed by a Professional Engineer registered in the State of Colorado. Laboratories shall be inspected by either AASHTO or accredited A2LA or equivalent in the elements listed below. Technicians taking samples and conducting compaction tests must have a LABCAT Level A certification or equivalent. Technicians conducting tests of asphalt content and gradation must have a LABCAT Level B certification or equivalent. Technicians performing volumetric testing must have a LABCAT Level C certification or equivalent.

TABLE 500-21
SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING
FOR HMA -PAVEMENT

Test	Standard*	Minimum Frequency
Sampling	AASHTO T 168, ASTM D 979 and ASTM D3665	One test for each day
Density	AASHTO T 166, T 238, T 230 Or CP-44, CP-81, CP-82	One test for each 250 lineal feet per Lane
Thickness (Core)	ASTM D 3549	One test for each 1000 lineal feet per Lane,
Air Voids & VMA	AASHTO T 166 & AASHTO PP 19 or CP-48	One test for each day (See note 4, Table 9.13.2)
Gradation	AASHTO T 27, T 11 or CP-31A, CP-31B	One test for each day
Hveem/Marshall Stability As Applicable	AASHTO T 245, AASHTO T 246 or CP-L 5106	One test for each day
Asphalt (AC) Content	AASHTO T 164 or CP-L 5120 or other methods agreed upon between Development Engineering Manager and Responsible Party	One test for each day
Maximum Theoretical Specific Gravity (Rice)	AASHTO T 209 or CP-51	One test for each day
Lottman Stripping, TSR & Dry Density	AASHTO T 283 or CP-L 5109, Method B	As requested by the Development Engineering Manager.
Micro Deval	AASHTO T 327 or CP-L 4211	One per 5000 tons or 1 per project minimum

* Development Engineering Manager may determine the method used (CP vs. AASHTO).

5. Inspectors shall be responsible for checking temperatures of mix in the truck and on pavement, segregation, rolling patterns and other construction means and methods that affect the performance of the pavement system. The Responsible Party shall provide assistance in sampling and testing at all facilities and at the job site.

6. The HMA or SMA mix design must be approved by the Development Engineering Manager before any pavement is placed on the project. In addition, the Responsible Party shall provide field control testing during production of the SMA mix and for the demonstration control strip. The Responsible Party shall perform the tests described in Table 500-22 and provide the results to the Development Engineering Manager during production:

7. If a SuperPave SMA mix design is used, the Responsible Party shall perform the tests described in Table 500-22 and provide the results to the Development Engineering Manager during production:

TABLE 500-22
SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING
HMA/SMA PAVEMENT

Superpave Mix Property	Frequency
Draindown (AASHTO T 305)	1/1000 tons or fraction thereof
% Voids in the total mix @ $N_{(design)}$	1/1000 tons or fraction thereof
VMA (% Voids in the Mineral Aggregate) @ $N_{(design)}$	1/1000 tons or fraction thereof
Lottman, CPL 5109 or AASHTO T 283, Method B	1/5000 tons or fraction thereof
Dry Tensile Strength, CPL 5109 or AASHTO T 283	1/5000 tons or fraction thereof
% AC & Aggregate Gradation CP 5120 or AASHTO T 308	1/1000 tons or fraction thereof

D. Approval

1. The results of field density and laboratory tests shall be submitted and reviewed by the Development Engineering Manager. Provided test results are acceptable, the HMA materials, placement and compaction shall be approved. Acceptable results shall be in compliance with tolerances for gradation and extraction. Should testing indicate unsatisfactory work, removal and replacement or overlay work shall be required.

2. Criteria used to determine satisfactory work shall be the following and shall be in compliance with the Pavement Evaluation Report:

   a. 90% of core tests shall meet or exceed design HMA thickness;

   b. Average of core tests shall meet or exceed design HMA thickness;

   c. Core test thicknesses shall exceed design HMA thickness, minus one-half (½) inch.

508.8 Portland Cement Concrete

A. Construction Requirements

Materials shall be proportioned, handled, measured, batched, placed and cured in accordance with Section 600 of these Standards and Specifications and Section 412 of CDOT S&S.

B. Placement

During placement of Portland cement concrete pavement, observation and testing by City personnel shall be on a full-time basis. For each day of production or 1,000 square yards placed, aggregate samples shall be obtained for gradation of both the coarse and fine aggregates.

C. Interval

Slump, air content, unit weight and mix temperature shall be tested three (3) times for every 1,000 square yards of pavement placed. Tests for slump and air content shall be on a random basis.

D. Cylinders

Four (4) compressive strength cylinders shall be cast for each 50 cubic yards, or for each day of pour placed. Cylinders shall be tested as follows:

1. one (1) at seven (7) days,
2. two (2) at 28 days
3. one (1), at 56 days, if 28-day test fails, otherwise discard.

E. Fly Ash

Portland cement and fly ash shall be accepted on the basis of certificates of compliance and pretesting by CDOT and subject to approval of Development Engineering Manager. Reinforcing steel, dowels and tie bars shall be accepted by certificate of compliance and mill reports. Only CDOT approved brands of air entraining agents, chemical admixtures and curing materials shall be used and shall be documented.

F. Thickness Check

Thickness of fresh concrete shall be checked every 300 linear feet in each traffic lane. Any noted deficient areas shall be corrected at that time. Surface smoothness shall be tested and corrected as necessary according to CDOT S&S, Section 412.

G. Approval

Test results shall be submitted and reviewed by the Development Engineering Manager. Provided test results are acceptable, the pavement shall be accepted. Should testing indicate unsatisfactory work, removal and replacement or grinding shall be required.

508.9 Test Listing

The testing of materials and construction shall be in conformance with the appropriate AASHTO or ASTM specifications. A partial list of approved testing methods includes those listed in Table 500-21.

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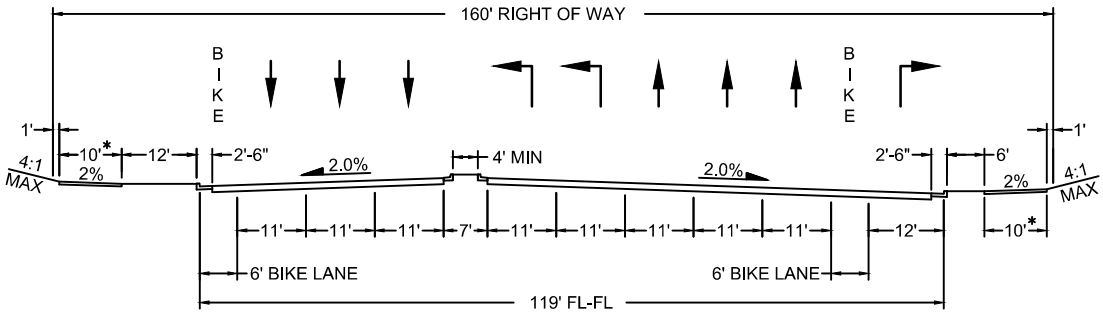
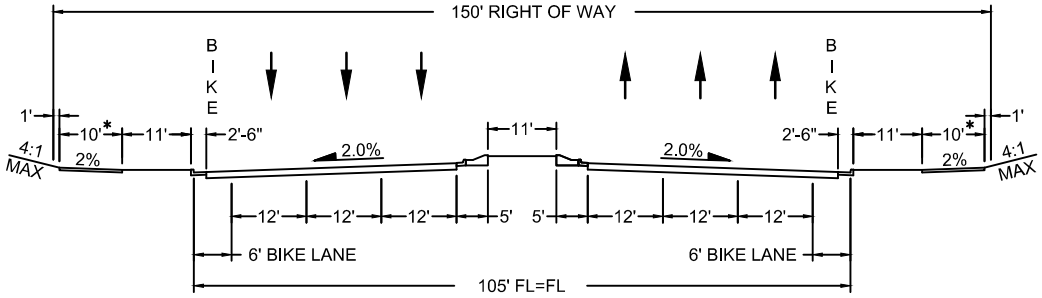


MAJOR ARTERIAL
INTERSECTION W/MAJOR OR MINOR ARTERIAL

(A1) 6 LANES W/ DUAL LEFT TURN LANES, 2 BIKE LANES, AND RIGHT TURN LANE

* ONE (1) 10 FOOT WIDE SIDEWALK IS REQUIRED ON ALL MAJOR ARTERIALS. THE SECOND SIDEWALK MAY BE EIGHT (8) FEET WIDE.



(A2) MAJOR ARTERIAL
6 LANE STRAIGHT SECTION WITH 2 BIKE LANES

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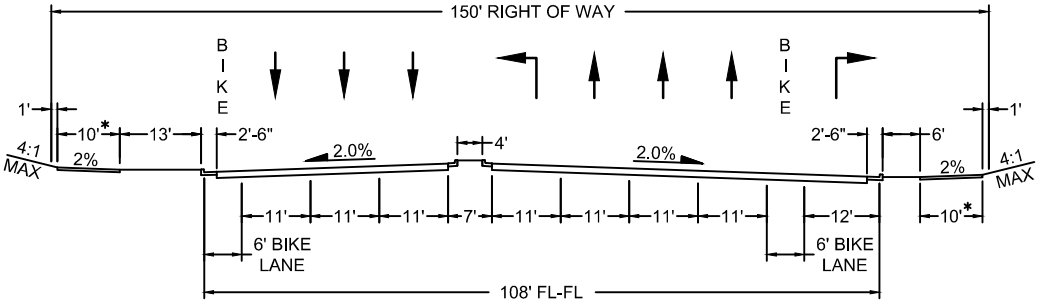


MAJOR ARTERIAL
INTERSECTION W/ COLLECTOR

(A3) 6 LANES W/ RT TURN, LT TURN, AND 2 BIKE LANES

* ONE (1) 10 FOOT WIDE SIDEWALK IS REQUIRED ON ALL MAJOR ARTERIALS. THE SECOND SIDEWALK MAY BE EIGHT (8) FEET WIDE.

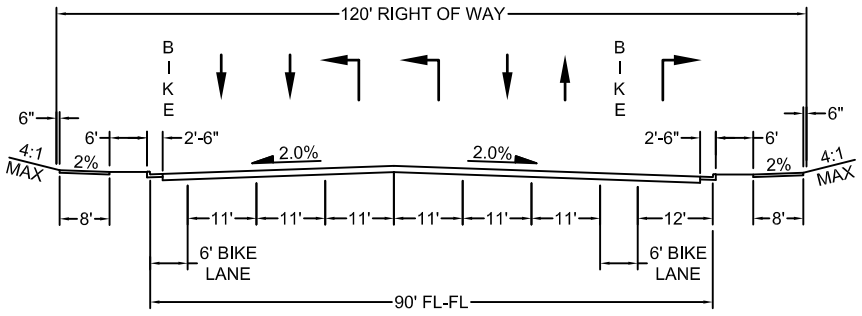
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

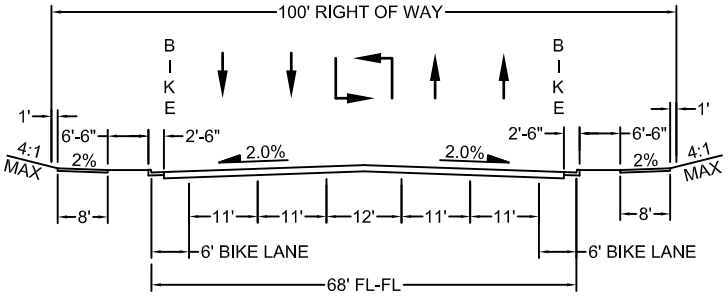
TYPICAL THOROUGHFARE CROSS SECTIONS – MAJOR ARTERIAL

ISSUED: APRIL 2010
REVISED: AUG 2012

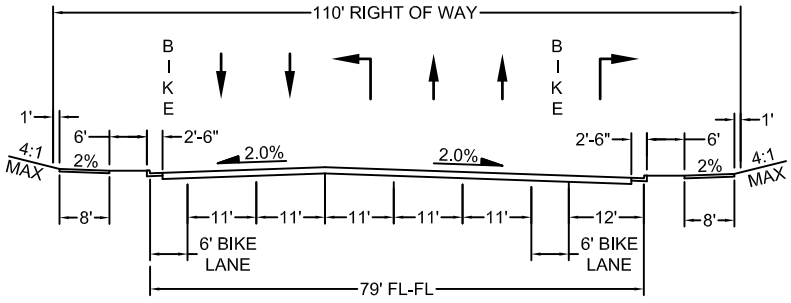
DRAWING NO. 500–1



MINOR ARTERIAL
INTERSECTION W/MAJOR OR MINOR ARTERIAL
(A4) 4 LANES W/ DUAL LEFT TURN LANES, 2 BIKE LANES, AND RIGHT TURN LANE



(A5) MINOR ARTERIAL
4 LANE STRAIGHT SECTION WITH 2 BIKE LANES



MINOR ARTERIAL
INTERSECTION W/ COLLECTOR
(A6) 4 LANES W/ RT TURN, LT TURN, AND TWO BIKE LANES

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL THOROUGHFARE CROSS SECTIONS – MINOR ARTERIAL

ISSUED:
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REVISED:
AUG 2012

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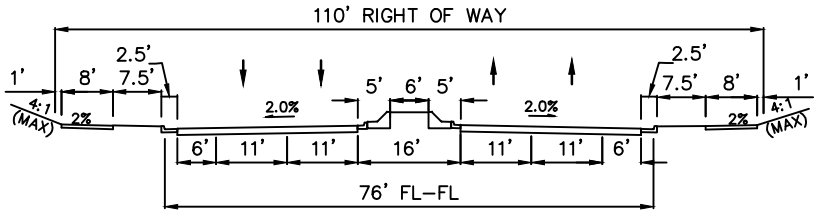
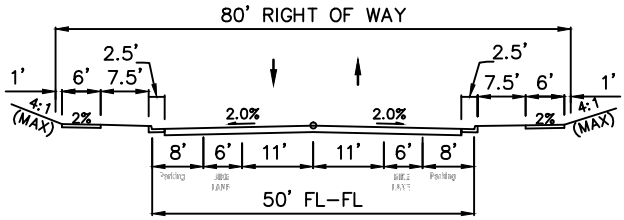
500–2



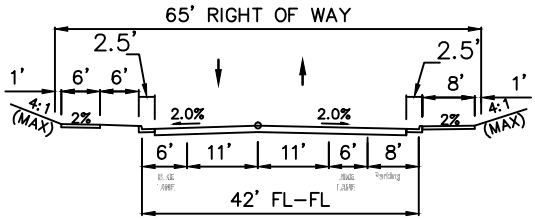
PARKWAY COLLECTOR
4 LANE STRAIGHT SECTION W/ BIKE LANES

(PC)



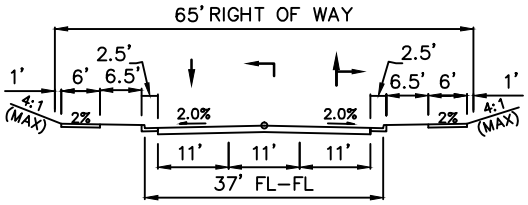
COLLECTOR
2 LANES W/ BIKE LANES
AND PARKING

(C1)



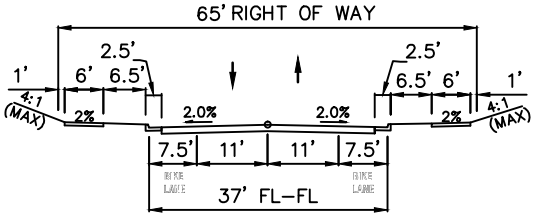
COLLECTOR
2 LANES W/ BIKE LANES
AND PARKING ALONG PARKS

(C2)



COLLECTOR
AT INTERSECTION

(C3)



COLLECTOR
2 LANES W/ BIKE LANES

(C4)

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL THOROUGHFARE CROSS SECTIONS – COLLECTOR

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SEPT 2012

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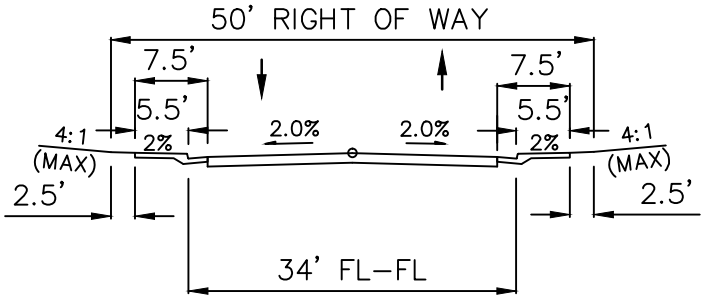
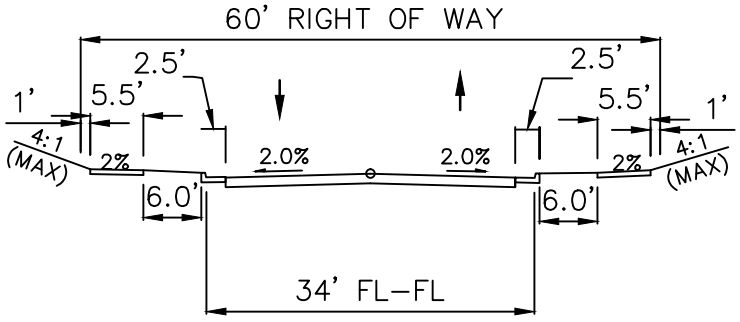
500–3



(L1) LOCAL RESIDENTIAL
2 LANE ATTACHED WALK
TYPE II INTEGRAL SIDEWALK



(L2) LOCAL RESIDENTIAL
2 LANE DETACHED WALK

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL THOROUGHFARE CROSS SECTIONS – LOCAL

ISSUED:
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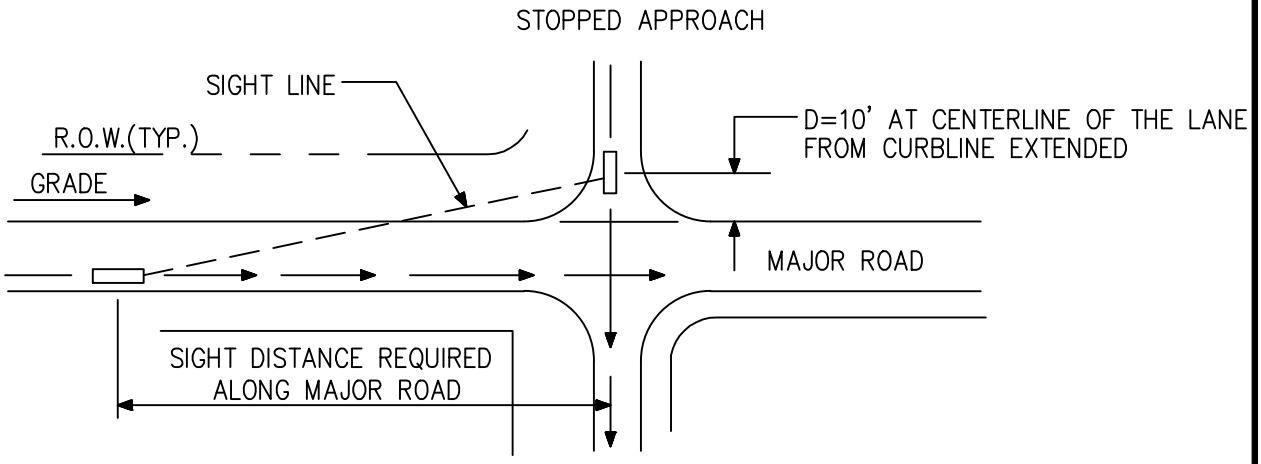
REVISED:

DRAWING NO.
500–4



DESIGN SPEED OF THRU ROADWAY (MPH)	MINIMUM SIGHT DISTANCE FOR STOPPED VEHICLE (FT.)	GRADE CORRECTION DISTANCE (FT.)				
		SPEED	UPGRADE TO		FOR DOWNGRADES	
			3%	6%	3%	6%
25	250					
30	300	25	0	−10	+10	+20
		30	0	−10	+10	+20
35	350	35	−10	−15	+10	+25
		40	−10	−20	+10	+30
40	400	45	−15	−25	+15	+40
45	450					
50	500					
55	550					

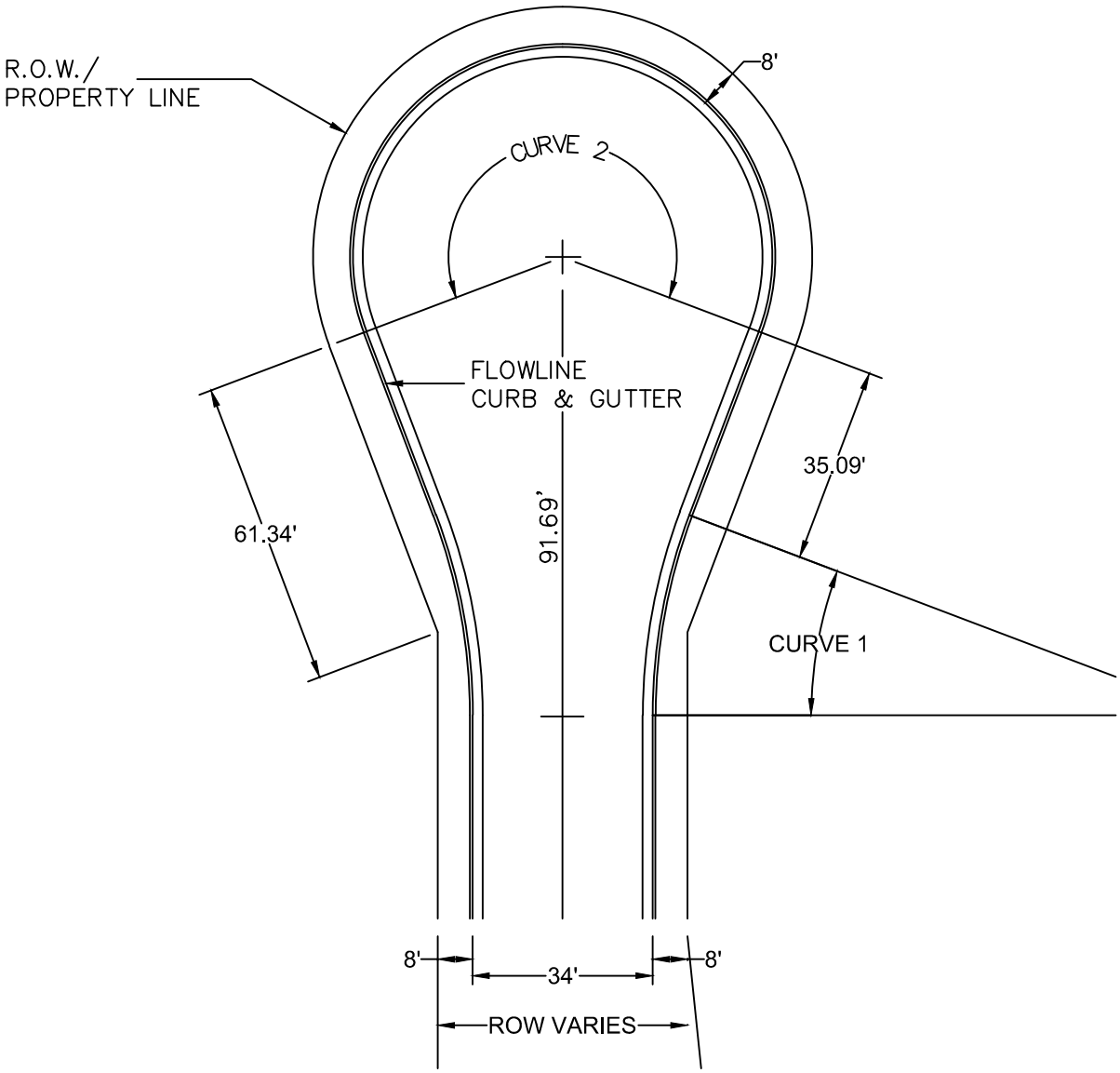
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SIGHT DISTANCE

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
500−5



CURVE 1				CURVE 2				
△	CURB FLOWLINE			△	CURB FLOWLINE		R.O.W./PROP.	
	RADIUS	LENGTH	TANGENT		RADIUS	LENGTH	RADIUS	LENGTH
22° 18' 40"	113'	44.00'	22.28'	224° 37' 20"	43'	168.58'	50'	193.33'

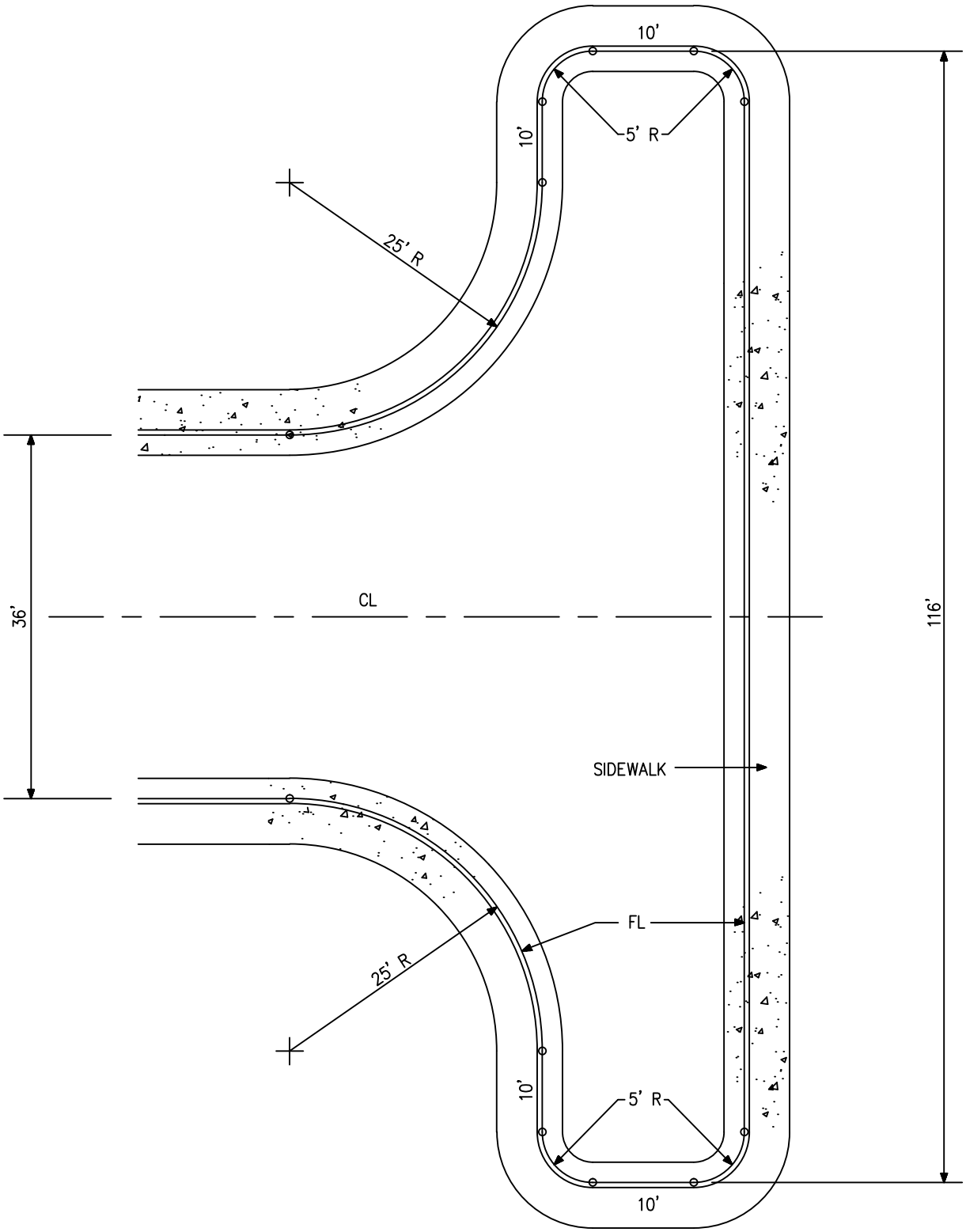
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CUL-DE-SACS

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
500-6



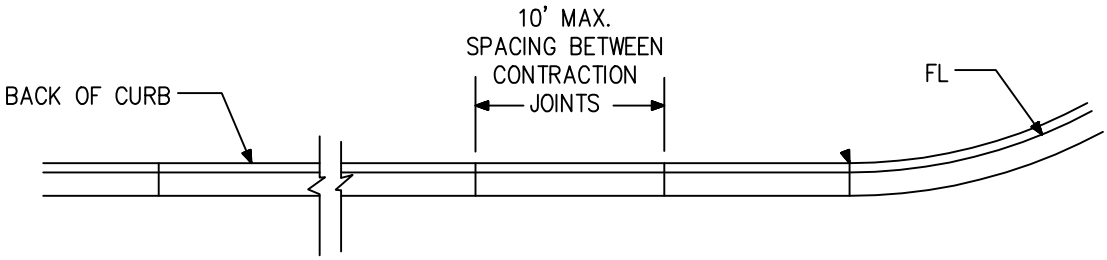
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CUL-DE-SACS
HAMMERHEAD (PRIVATE)

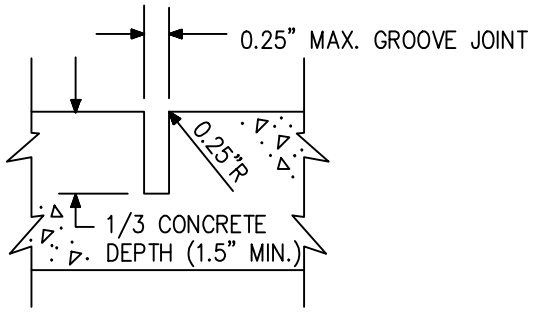
ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
500-7

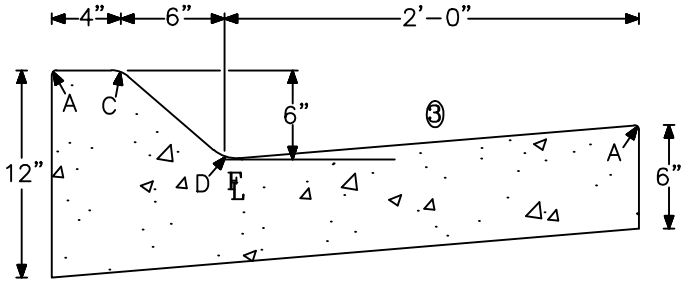


LAYOUT

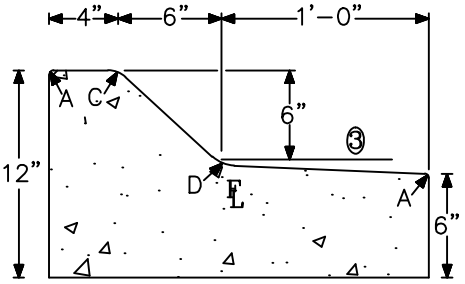
LEGEND FOR RADII
A = 1/8" TO 1/4"
B = 1"
C = 1-1/2"
D = 1-1/2" TO 2"



CONTRACTION JOINT



TYPE 2 CURB & GUTTER (SECTION IIM)



TYPE 2 CURB & GUTTER (SECTION IM)

NOTES:

1. ANY OVER-EXCAVATION SHALL BE REPLACED WITH GRANULAR BACKFILL COMPACTED TO 95% MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D-698.
2. TYPE 2 SPILL CURB MAY BE REQUIRED FOR SPECIAL CONDITIONS.
3. GUTTER CROSS SLOPES SHALL BE 1/2"/FT. WHEN DRAINING AWAY FROM CURB AND 1"/FT. WHEN DRAINING TOWARD CURB.
4. CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT

N.T.S.

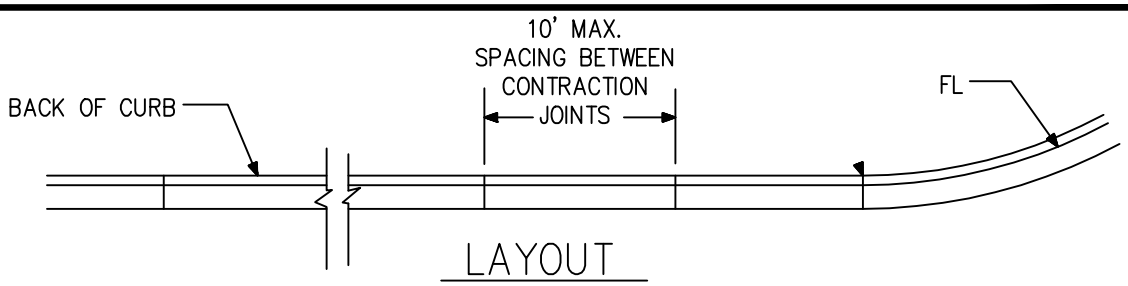
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CURB AND GUTTER

TYPE 2 (SECTION IM)
TYPE 2 (SECTION IIM)

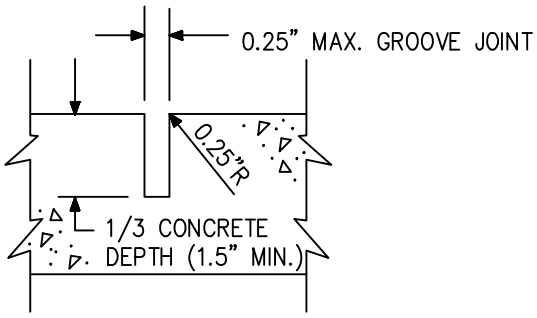
ISSUED:
DECEMBER 1998
REVISED:
APRIL 2010

DRAWING NO.
500-8

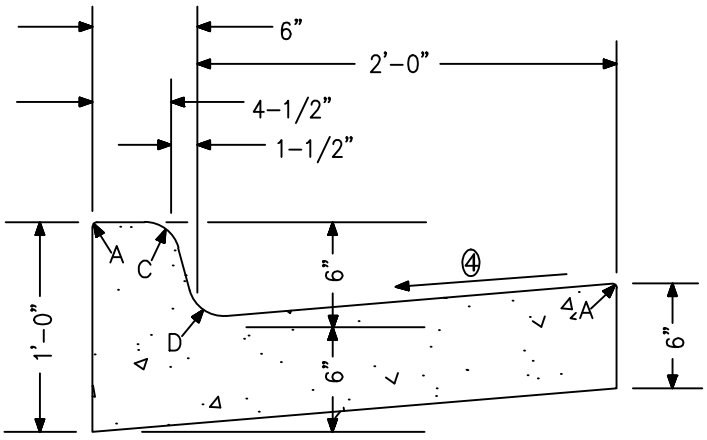


LAYOUT

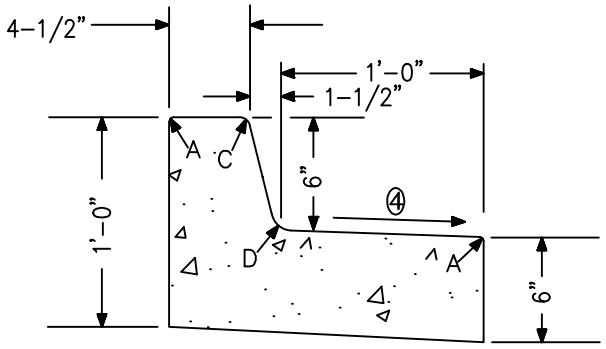
LEGEND FOR RADII
A = 1/8" TO 1/4"
B = 1"
C = 1-1/2"
D = 1-1/2" TO 2"



CONTRACTION JOINT



TYPE 2 CURB & GUTTER
SECTION IIB



TYPE 2 CURB & GUTTER
SECTION I B

NOTES:

1. TYPE 2 CURB & GUTTER IS FOR USE IN COMMERCIAL, ARTERIALS AND COLLECTOR STREETS.
2. ANY OVER-EXCAVATION SHALL BE REPLACED WITH GRANULAR BACKFILL COMPACTED TO 95% MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D-698.
3. TYPE 2 SPILL CURB MAY BE REQUIRED FOR SPECIAL CONDITIONS.

④ GUTTER CROSS SLOPE SHALL BE 1/2" /FT. WHEN DRAINING AWAY FROM CURB AND 1" /FT. WHEN DRAINING TOWARD CURB.

5. CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

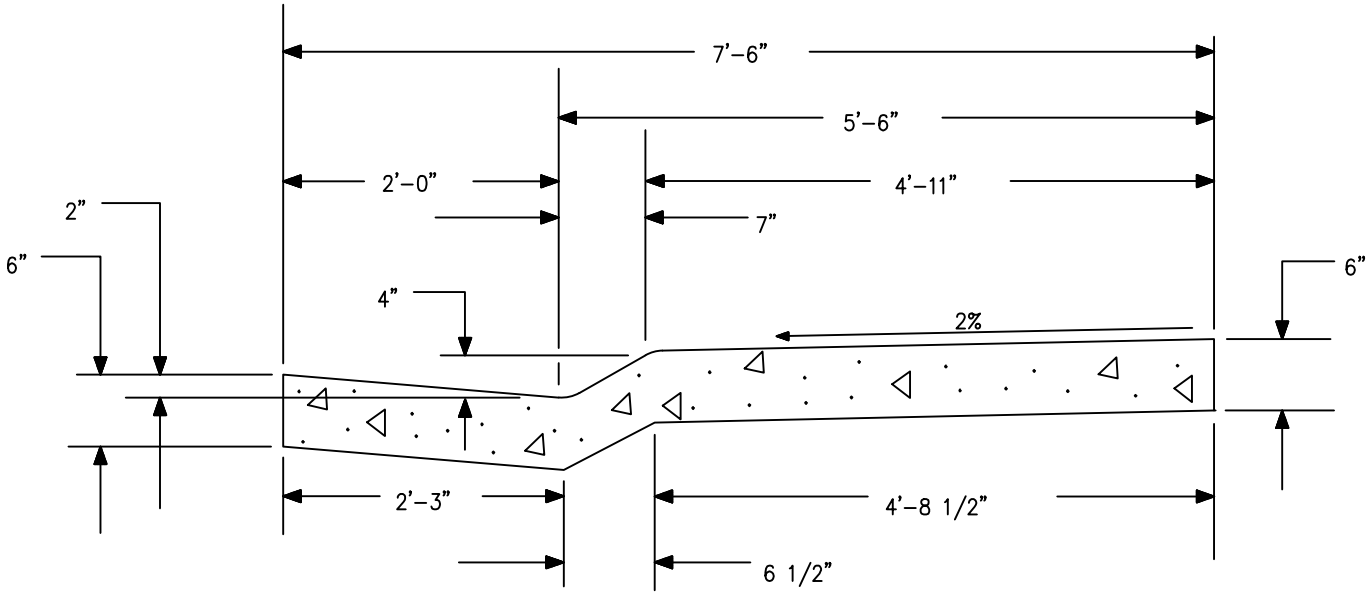
CURB AND GUTTER

TYPE 2 (SECTION IB)
TYPE 2 (SECTION IIB)

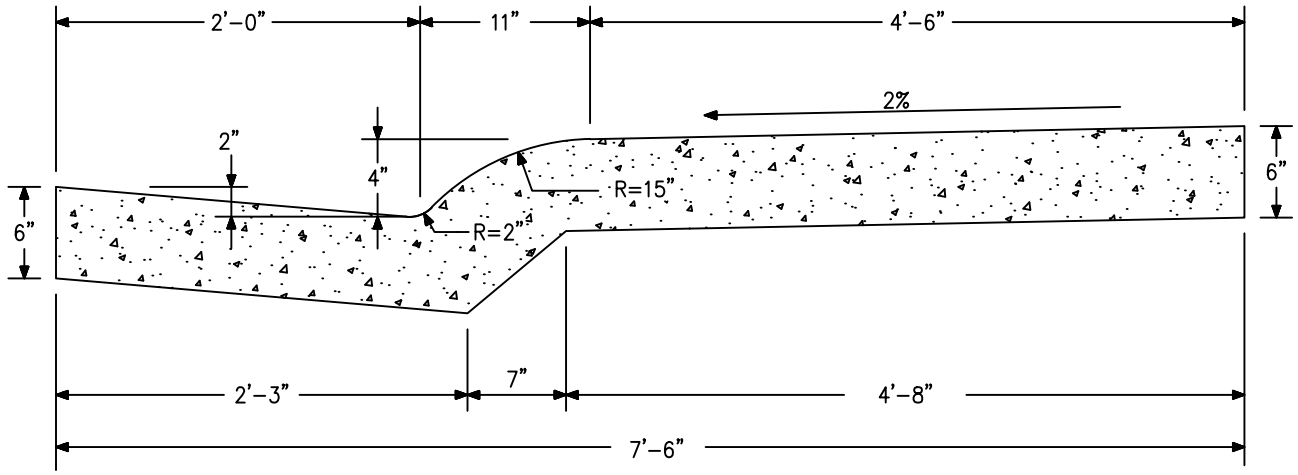
ISSUED:
DECEMBER 1998
REVISED:
APRIL 2010

DRAWING NO.
500-8A

NOTE:
CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600–CONCRETE.
4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT



LOCAL ATTACHED SECTION 1



LOCAL ATTACHED SECTION 2

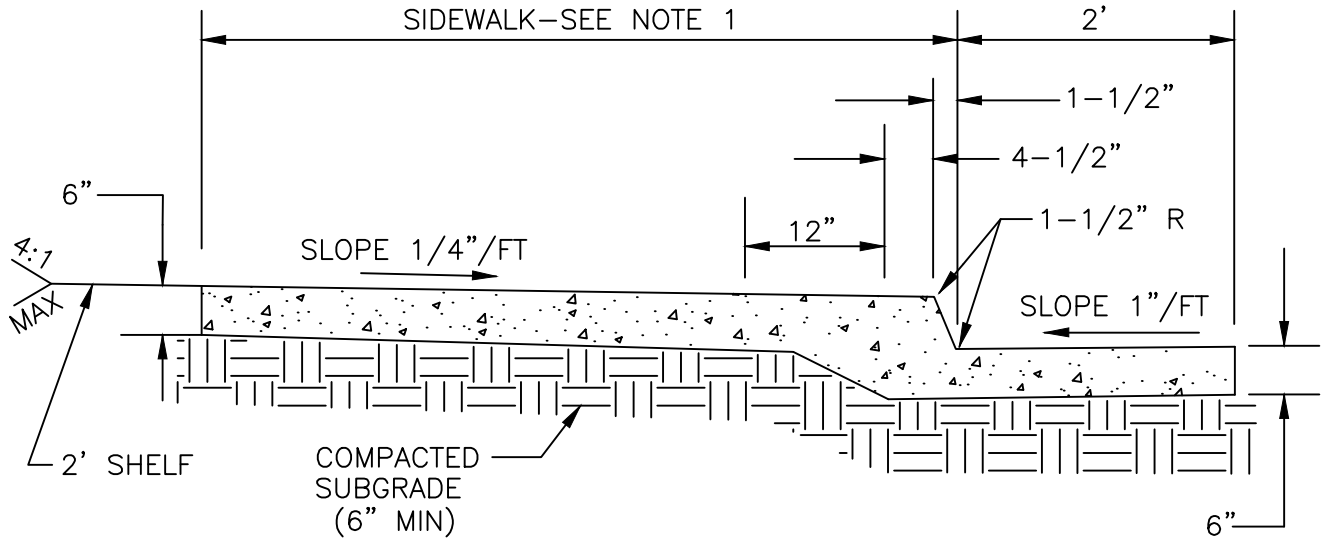
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPE 1 COMBINATION CURB, GUTTER AND SIDEWALK

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
500–9



NOTES

1. WIDTHS ARE TO BE 5'–6" IF STREET CLASSIFICATION IS LOCAL, 6'–6" IF STREET IS A COLLECTOR, 8'–6" IF STREET IS AN ARTERIAL OR 10'–6" IF SIDEWALK IS TO FUNCTION AS A BIKE TRAIL. DIMENSIONS ARE TO BE INCLUDED IN DETAILED CONSTRUCTION PLANS.
2. CONCRETE SHALL INCLUDE FIBER MESH.
3. SIDEWALK, CURB AND GUTTER SHALL BE POURED MONOLITHICALLY.
4. SEE DETAIL 500–8 FOR JOINT DETAILS AND COMPACTION NOTES.
5. CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600–CONCRETE. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT

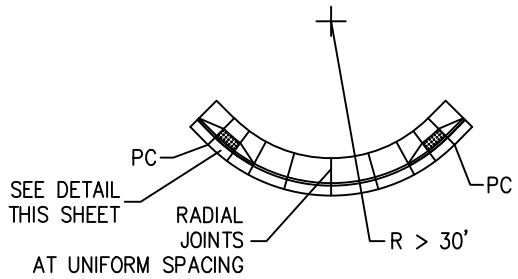
N.T.S.

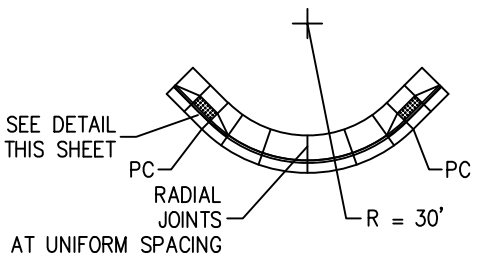
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPE IIB INTEGRAL SIDEWALK AND BIKE PATH

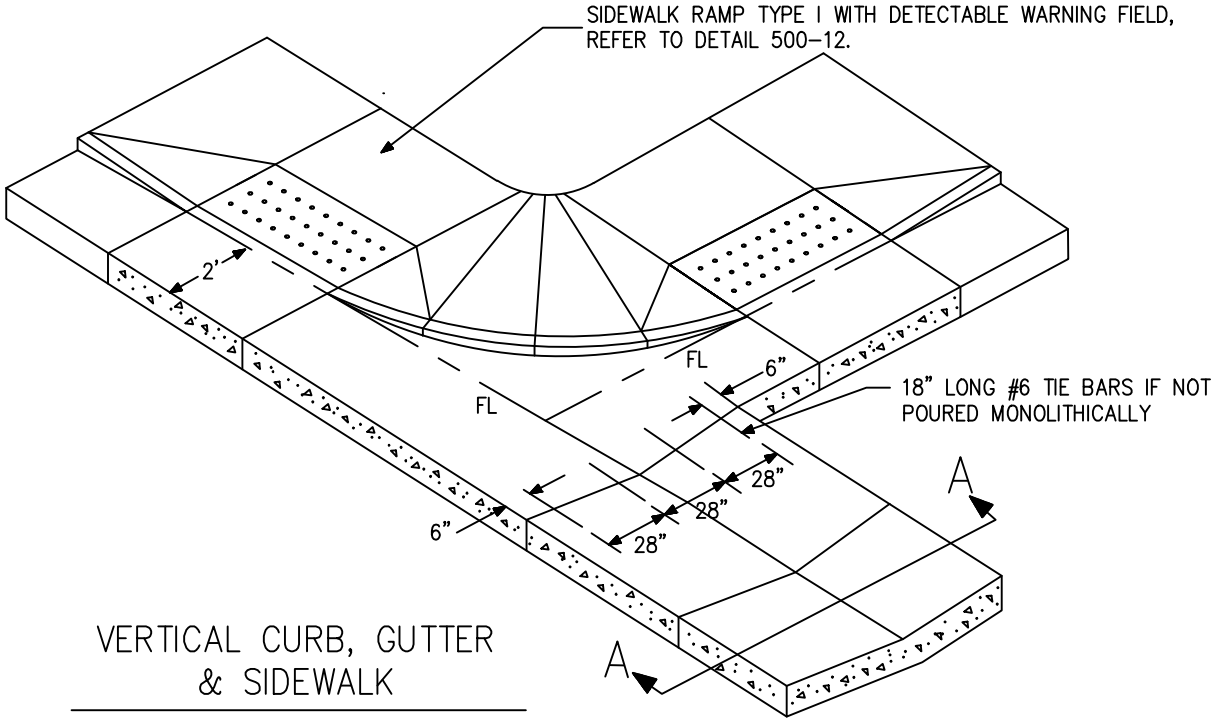
ISSUED:
JUNE 1995
REVISED:
APRIL 2010

DRAWING NO.
500–9A

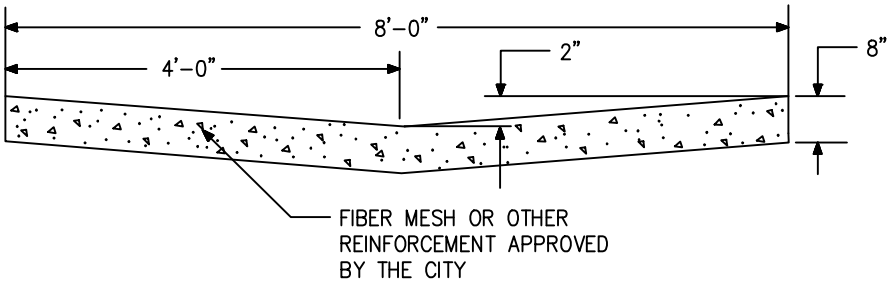




DIRECTIONAL RAMP LOCATIONS WITH ATTACHED SIDEWALK



VERTICAL CURB, GUTTER & SIDEWALK



SECTION A-A

NOTE:
CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE.
4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT

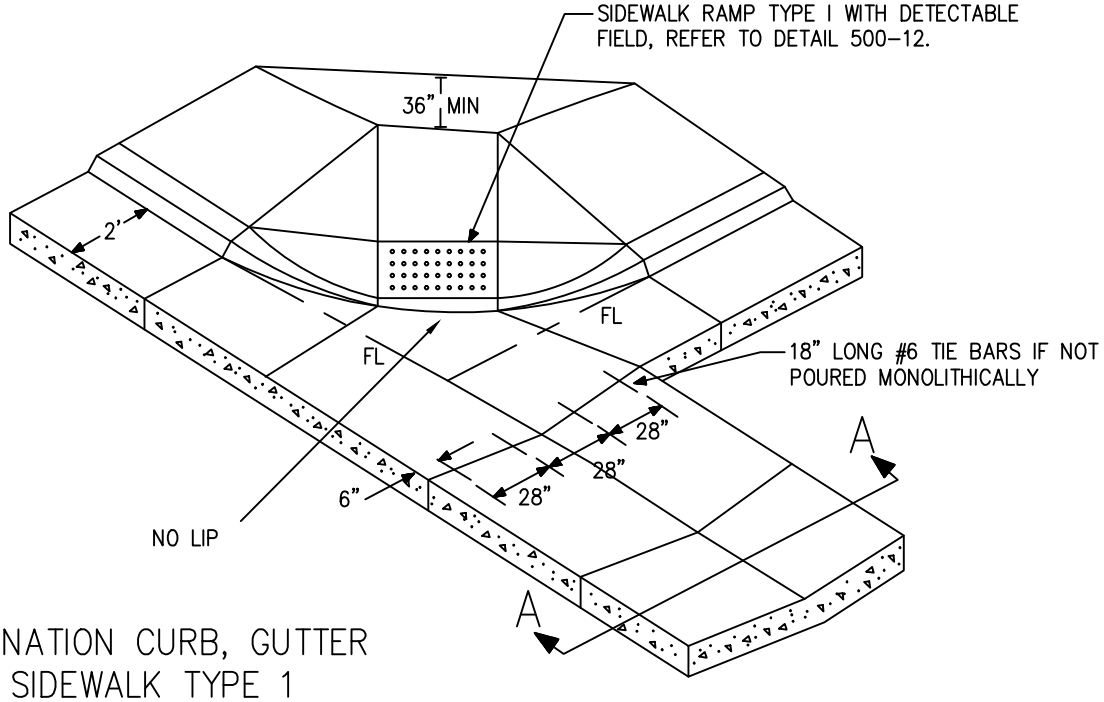
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

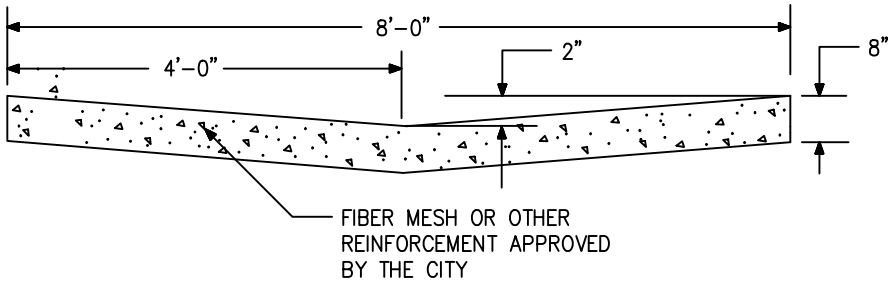
SQUARED RADIUS WITH CROSS PAN FOR ARTERIALS AND COLLECTORS

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
500-10



COMBINATION CURB, GUTTER & SIDEWALK TYPE 1



SECTION A-A

NOTE:
CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE.
4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT

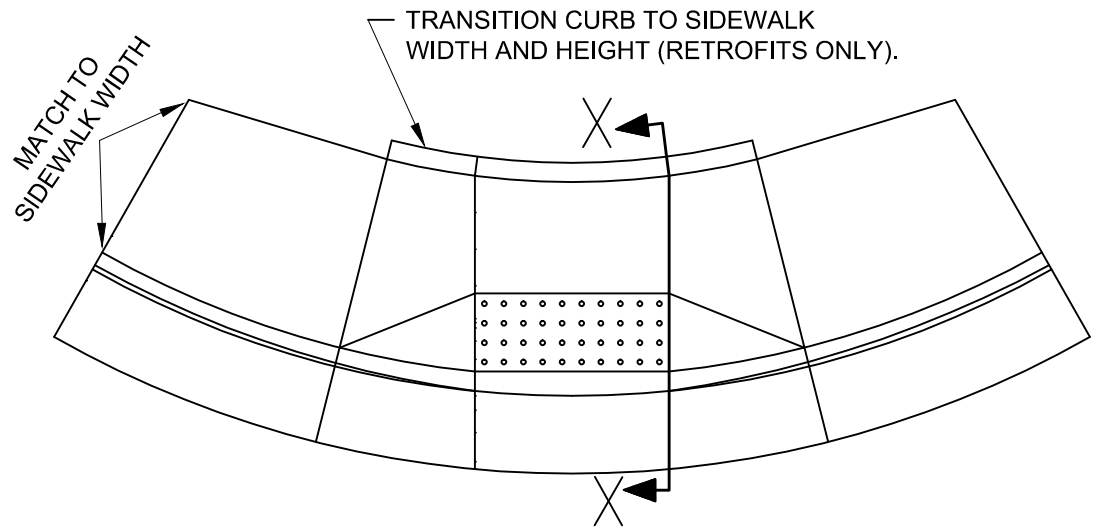
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SQUARED RADIUS WITH CROSS PAN FOR LOCAL STREETS

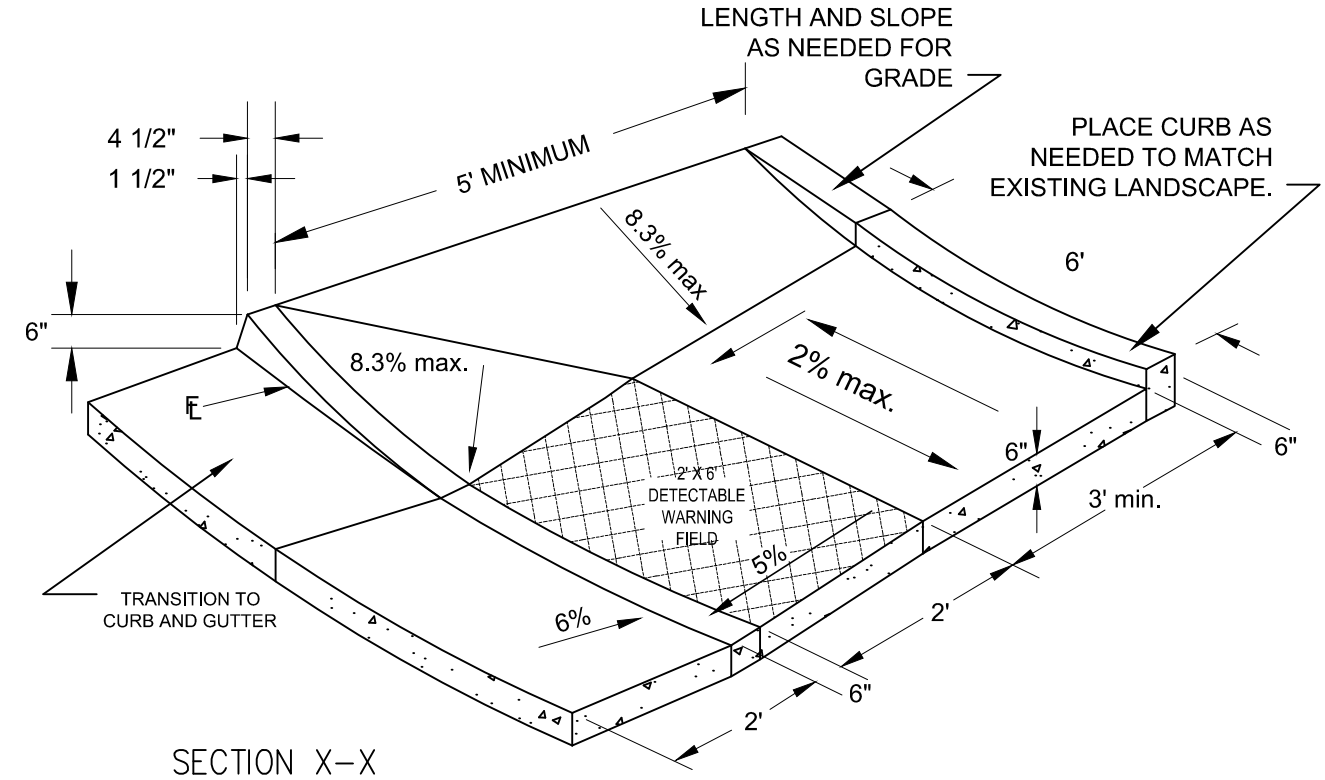
ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
500-11



NOTES

1. DETECTABLE WARNING FIELD SHALL BE CAST-IN-PLACE RED EAST JORDAN IRON WORKS OR APPROVED EQUAL.
2. CONCRETE SHALL CONFORM TO THE STANDARDS AND SPECIFICATIONS SECTION 600-CONCRETE WORK. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT
3. CHANGES IN GRADE SHALL NOT EXCEED 11%.



SECTION X–X

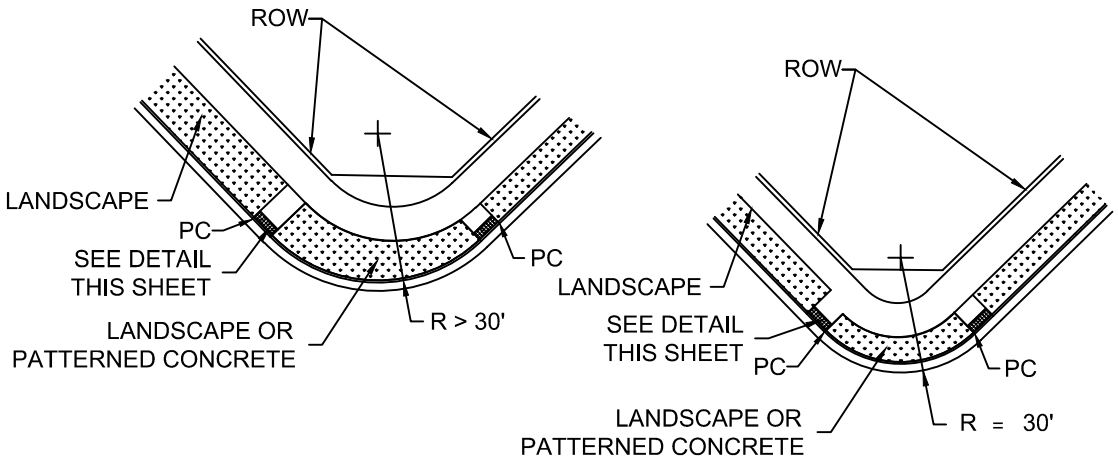
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPE I SIDEWALK RAMP – LOCAL STREETS (APEX)

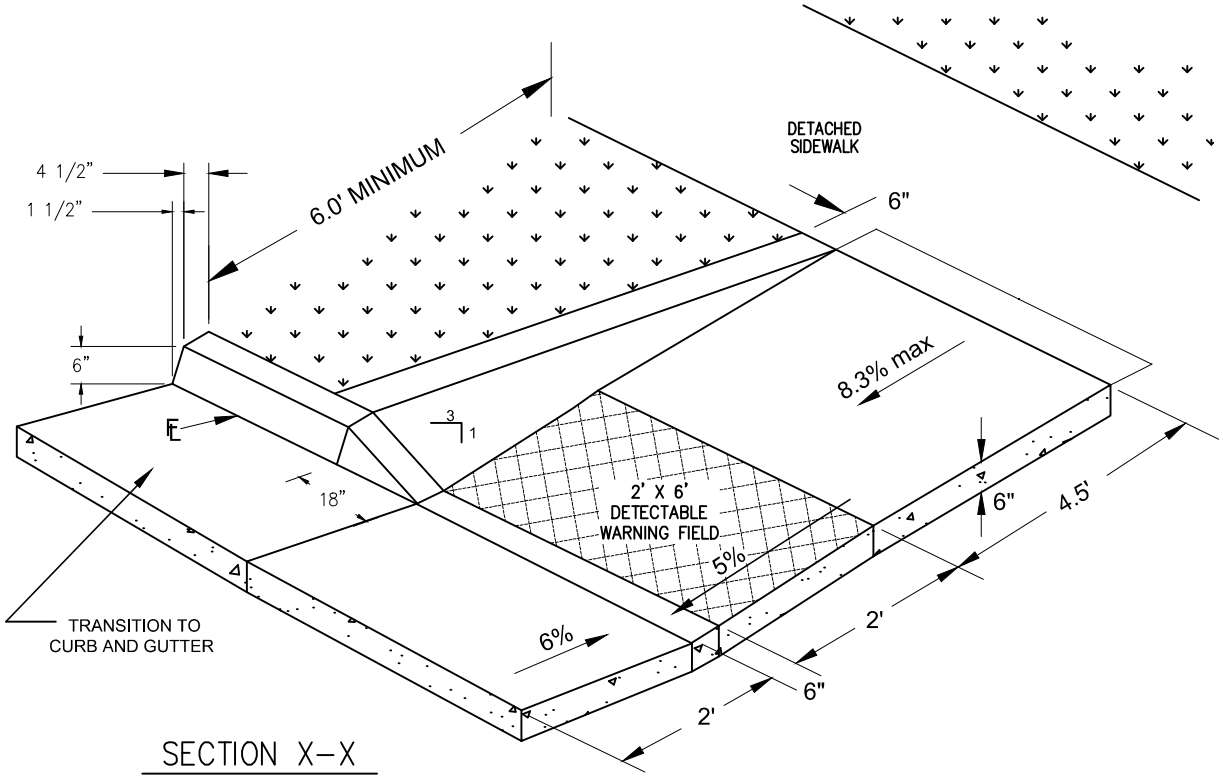
ISSUED:
APRIL 2010
REVISED:

DRAWING NO.
500–12



NOTES

1. DETECTABLE WARNING FIELD SHALL BE CAST-IN-PLACE RED EAST JORDAN IRON WORKS OR APPROVED EQUAL.
2. CONCRETE SHALL CONFORM TO THE STANDARDS AND SPECIFICATIONS SECTION 600-CONCRETE WORK. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT
3. CHANGES IN GRADE SHALL NOT EXCEED 11%.



SECTION X–X

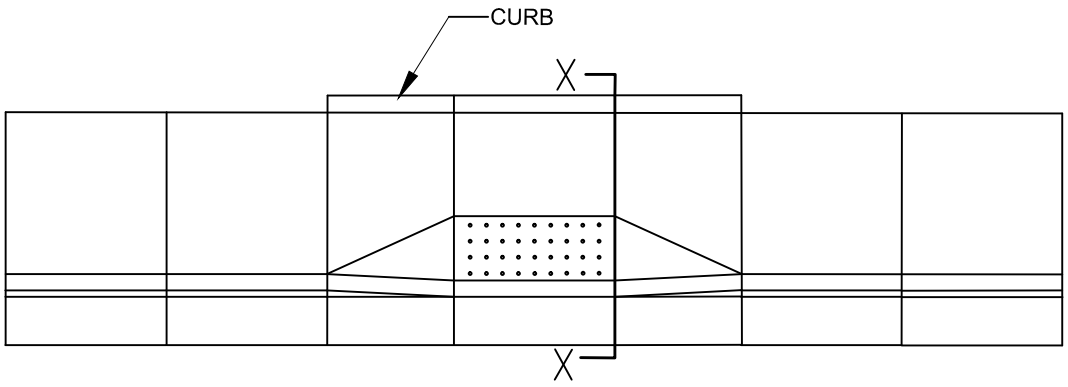
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPE II SIDEWALK RAMP – COLLECTOR/ARTERIAL (DIRECTIONAL)

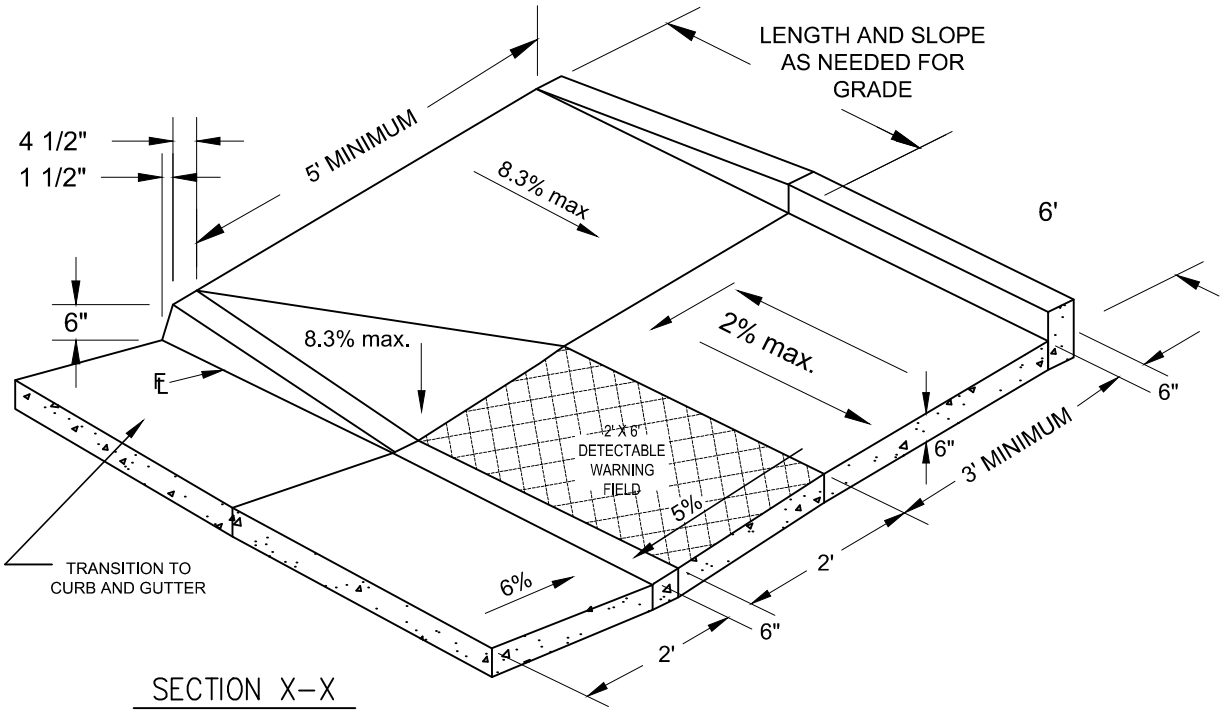
ISSUED: APRIL 2010
REVISED:

DRAWING NO. 500–13



NOTES

1. DETECTABLE WARNING FIELD SHALL BE CAST-IN-PLACE RED EAST JORDAN IRON WORKS OR APPROVED EQUAL.
2. CONCRETE SHALL CONFORM TO THE STANDARDS AND SPECIFICATIONS SECTION 600-CONCRETE WORK. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT
3. CHANGES IN GRADE SHALL NOT EXCEED 11%.



SECTION X–X

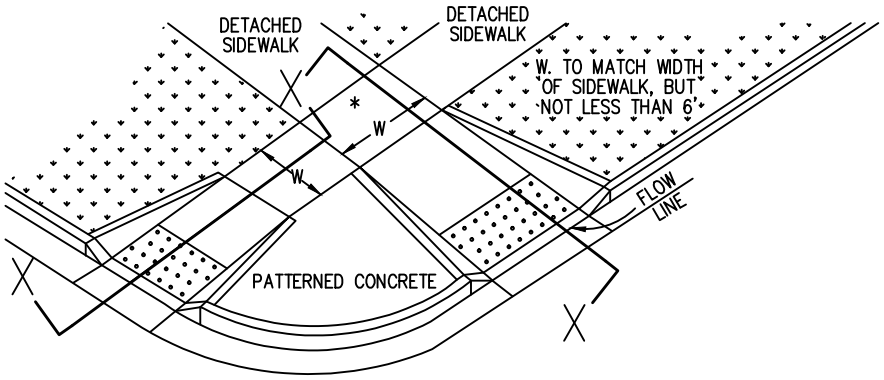
N.T.S.

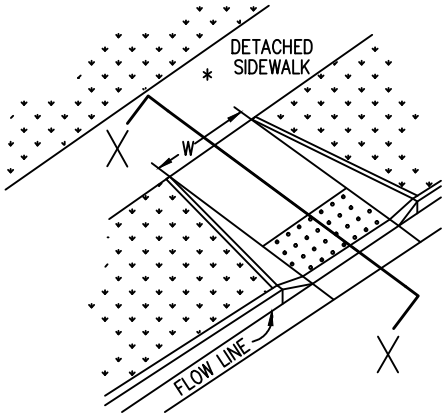
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPE III SIDEWALK RAMP (TEE)

ISSUED:
APRIL 2010
REVISED:

DRAWING NO.
500–14

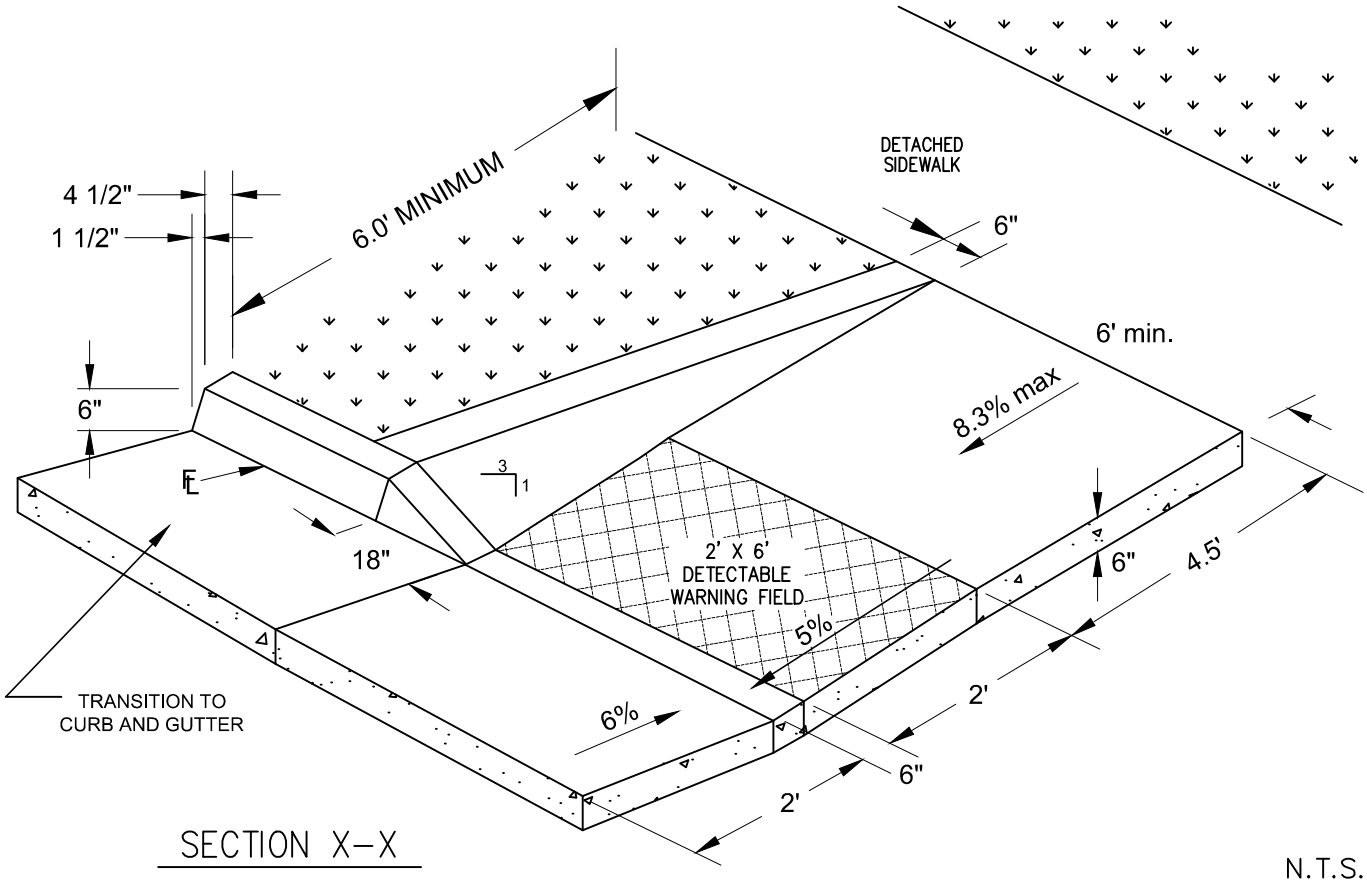




* SLOPE MUST BE < 2.0% IN BOTH DIRECTIONS

NOTES

1. DETECTABLE WARNING FIELD SHALL BE CAST-IN-PLACE RED EAST JORDAN IRON WORKS OR APPROVED EQUAL.
2. CONCRETE SHALL CONFORM TO THE STANDARDS AND SPECIFICATIONS SECTION 600-CONCRETE WORK. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT
3. CHANGES IN GRADE SHALL NOT EXCEED 11%.



SECTION X–X

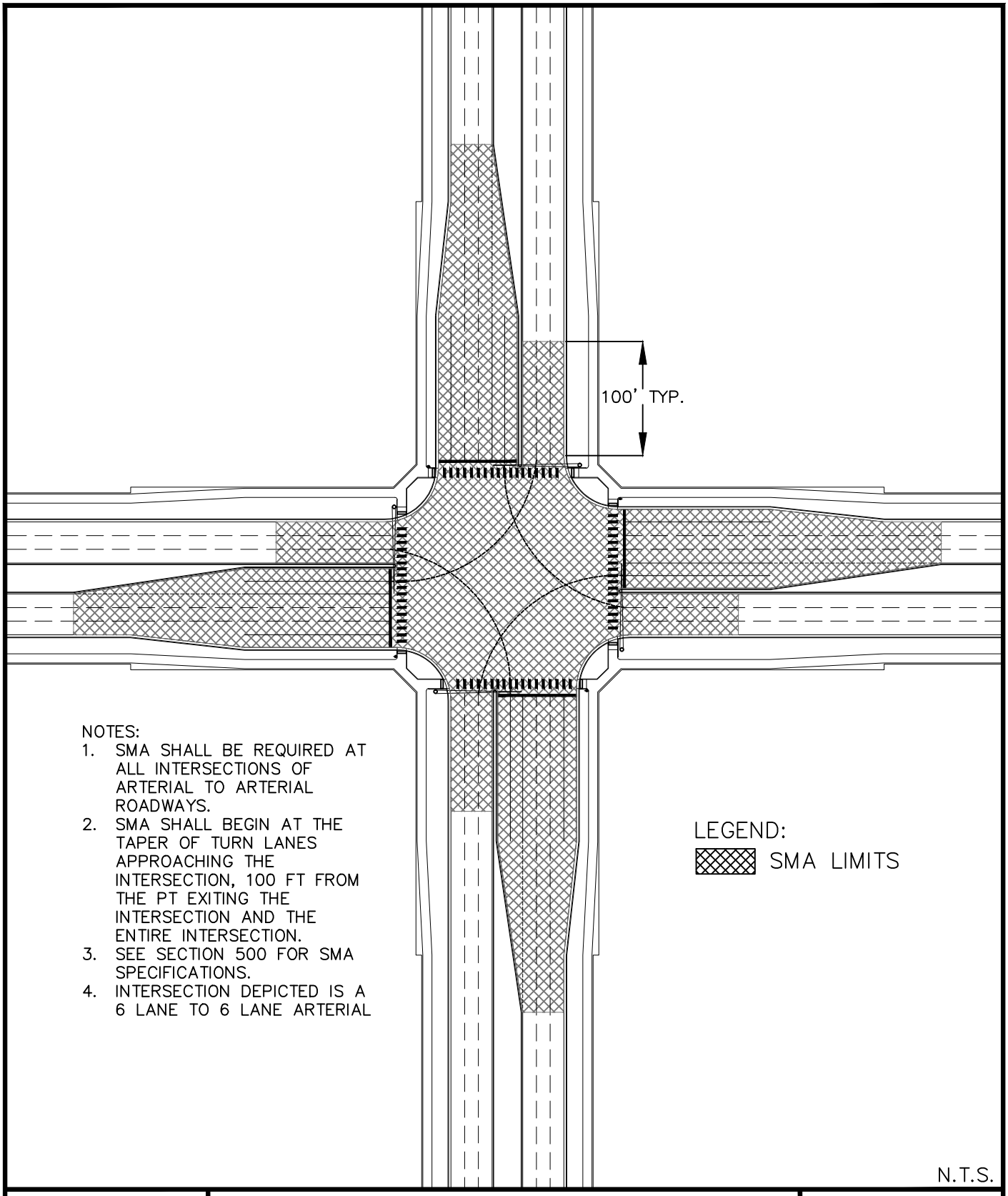
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

DIRECTIONAL SIDEWALK RAMP – DETACHED SIDEWALK

ISSUED: APRIL 2010
REVISED:

DRAWING NO. 500–15



NOTES:
1. SMA SHALL BE REQUIRED AT ALL INTERSECTIONS OF ARTERIAL TO ARTERIAL ROADWAYS.
2. SMA SHALL BEGIN AT THE TAPER OF TURN LANES APPROACHING THE INTERSECTION, 100 FT FROM THE PT EXITING THE INTERSECTION AND THE ENTIRE INTERSECTION.
3. SEE SECTION 500 FOR SMA SPECIFICATIONS.
4. INTERSECTION DEPICTED IS A 6 LANE TO 6 LANE ARTERIAL

LEGEND:
SMA LIMITS

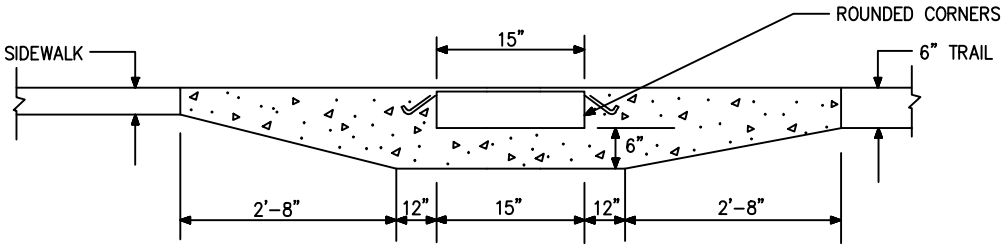
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

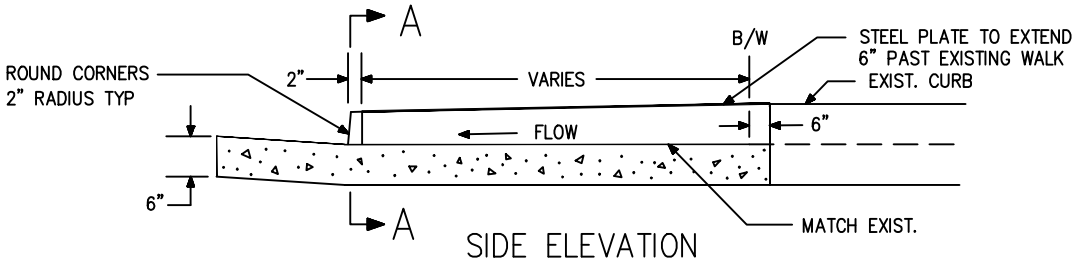
STONE MASTIC ASPHALT (SMA) TOP LIFTS

ISSUED:
APRIL 2010
REVISED:

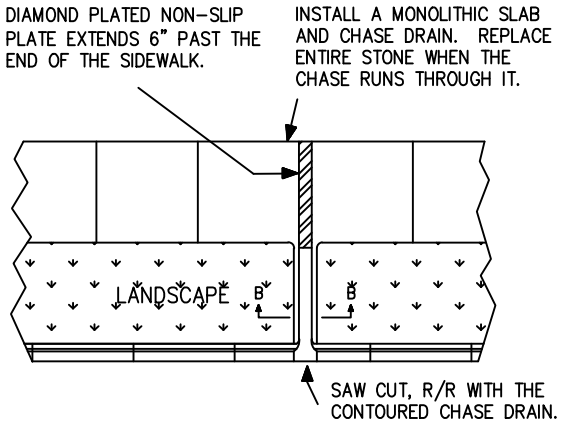
DRAWING NO.
500–16



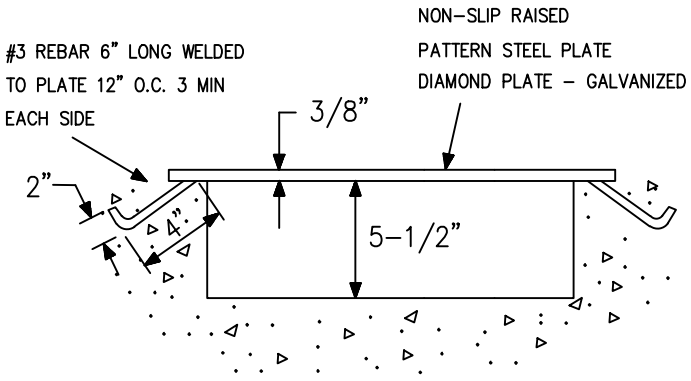
FRONT ELEVATION



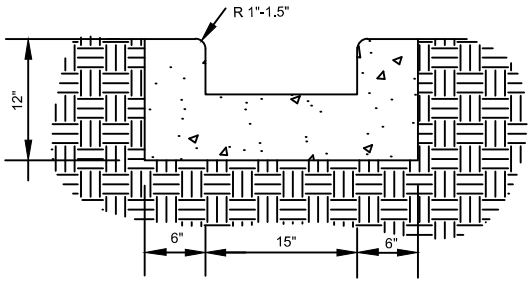
SIDE ELEVATION



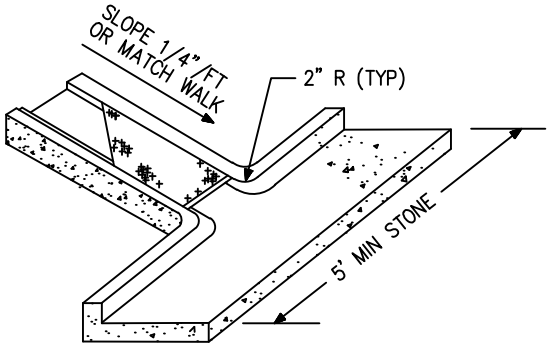
LANDSCAPE BUFFER
PLAN VIEW



SECTION A-A



LANDSCAPE BUFFER
SECTION B-B



NOTE:
CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE.
4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT

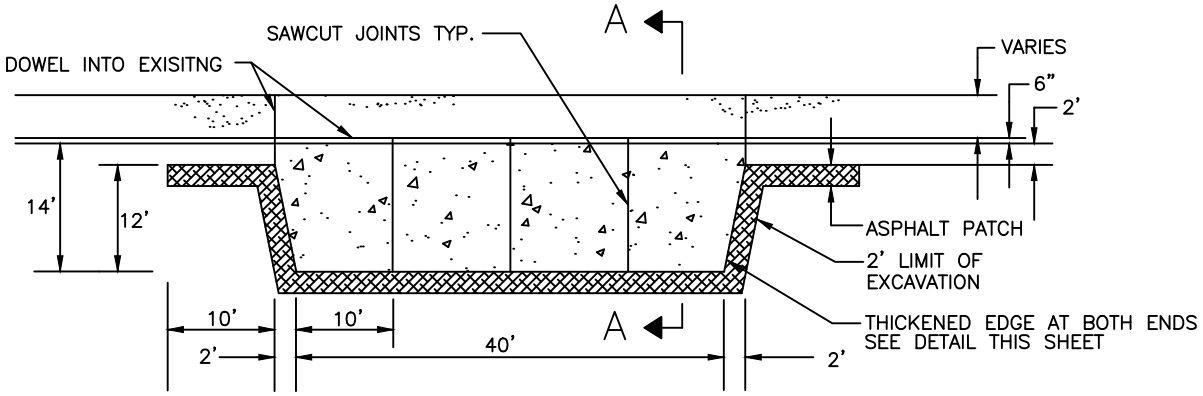
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

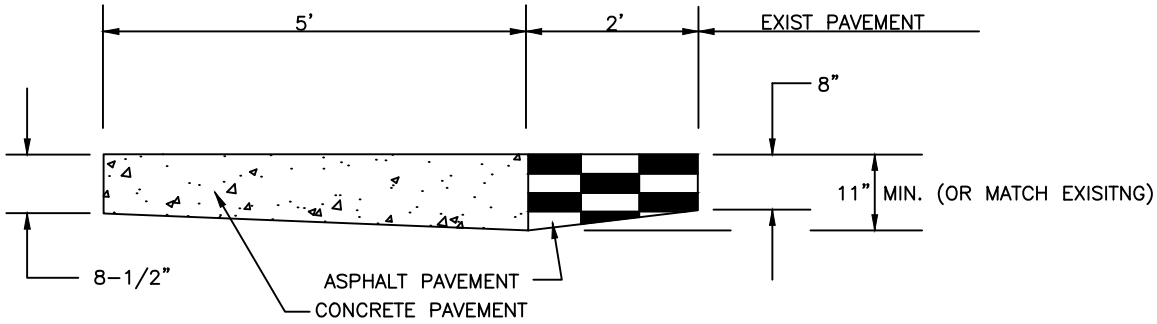
CONCRETE SIDEWALK CHASE DRAIN (FOR COMMERCIAL, COMMON AREAS, AND DETACHED)

ISSUED:
APRIL 1992
REVISED:
MAY 2010

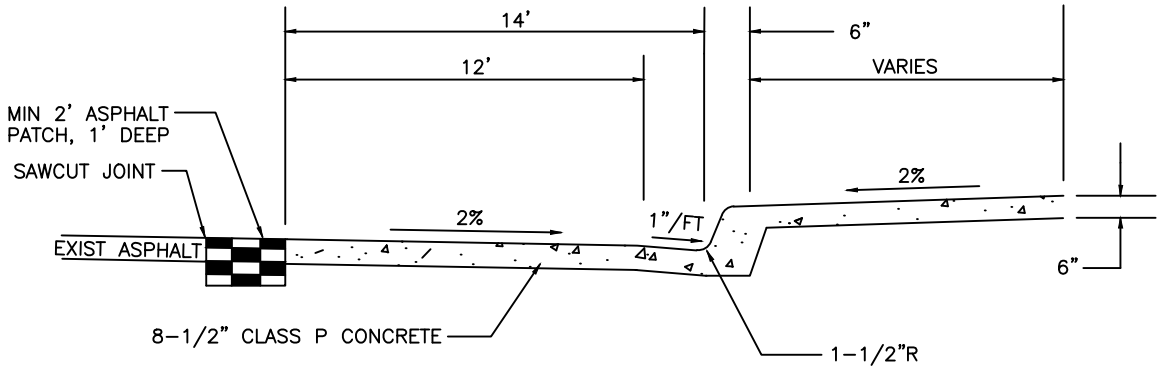
DRAWING NO.
500-17



PLAN



THICKENED EDGE



SECTION A-A

NOTE:
CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE.
4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CONCRETE BUS PAD

ISSUED:
MAY 1995
REVISED:
APRIL 2010

DRAWING NO.
500-18

Form 500-19

• Mixture Design Requirements for Hot Mix Asphalt Pavements (HMA)

Developer/Owner: _____ Paving Contractor: _____

Date: _____ Subdivision/Project Name: _____

- Project Special Provision Sheet for Hot Mix Asphalt Pavements (HMA)

Roadway Classification: _____
(examples: Local , Collector, Arterial, Parking Lot or actual name for Project)

Construction Application: ❑ Top Lift ❑ Intermediate Lift(s) ❑ Bottom Lift
❑ Patching ❑ Other _____

Aggregate Gradation:
- ❑ Grading SX (2.0" to 2.5" lifts)
- ❑ Grading S (2.5" to 3.5" lifts)
- ❑ Grading SG (3.5" to 5.0" lifts) - for lower lift(s) only, may need approval of surface texture by Agency
- ❑ SMA (2.5" to 3.5") - Top Lift Only
  The SMA gradation for this project shall be _____

RAP Quantity, Maximum: ❑ 0% ❑ 15% ❑ 20% ❑ 25%

Notes: A quality control plan for RAP will be required when RAP is used
Top lift Maximum RAP content allowed is 20%

Superpave Gyratory Mix Design Compaction Level usage and binder(s):

Design Level	Traffic Levels	PG Binder(s)	
❑ N_{design}=50	Low volume	❑ PG 58-28	❑ PG 64-22
❑ N_{design}=75	0 to <3 million ESALs	❑ PG 64-22	❑ PG 58-28
❑ N_{design}=100	3 million to <30 million ESALs	❑ PG 64-22	❑ PG 76-28

Notes:
- The binders are shown in order they should be considered.
- PG 76-28 polymer modified PG Binders are required in the top lift only on arterial roadways
- PG 58-28 Binder recommended for residential developments with less than 100,000 ESAL's

- Target Job Mix Optimum Binder Content for HMA gradings as close to 4.0% air voids as possible (3.5% to 4.5% air voids)
- Target Job Mix Optimum Binder content for SMA gradings at 3.0% to 4.0% air voids

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A completed Form 500-19 shall supplement the City of Thornton Standards and Specifications for the Design of Public and Private Improvements defining the project specific requirements of Hot Mix Asphalt Pavement (HMA) and Stone Matrix Asphalt (SMA). Refer to the Standards and Specifications Section 504 for details.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

HOT MIX ASPHALT (HMA) PAVEMENT MIX DESIGN

ISSUED: APRIL 2010
REVISED:

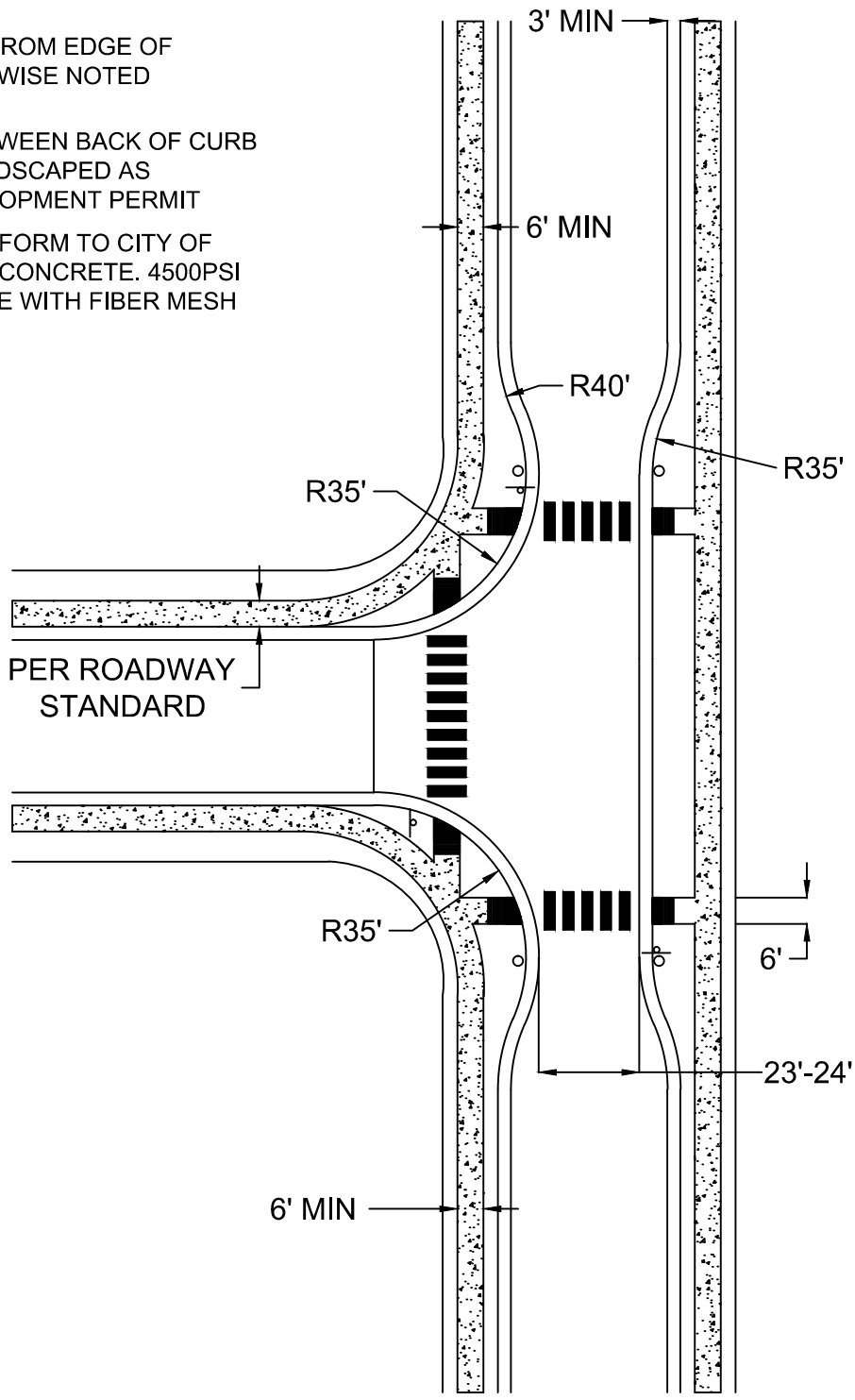
DRAWING NO. 500-19

NOTES:
1 RADIUSES ARE MEASURED TO FLOW LINE

2. MEASUREMENTS ARE FROM EDGE OF ASPHALT UNLESS OTHERWISE NOTED

3. MEDIAN AND AREA BETWEEN BACK OF CURB AND WALK SHALL BE LANDSCAPED AS APPROVED IN THE DEVELOPMENT PERMIT

4. CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT



N.T.S.

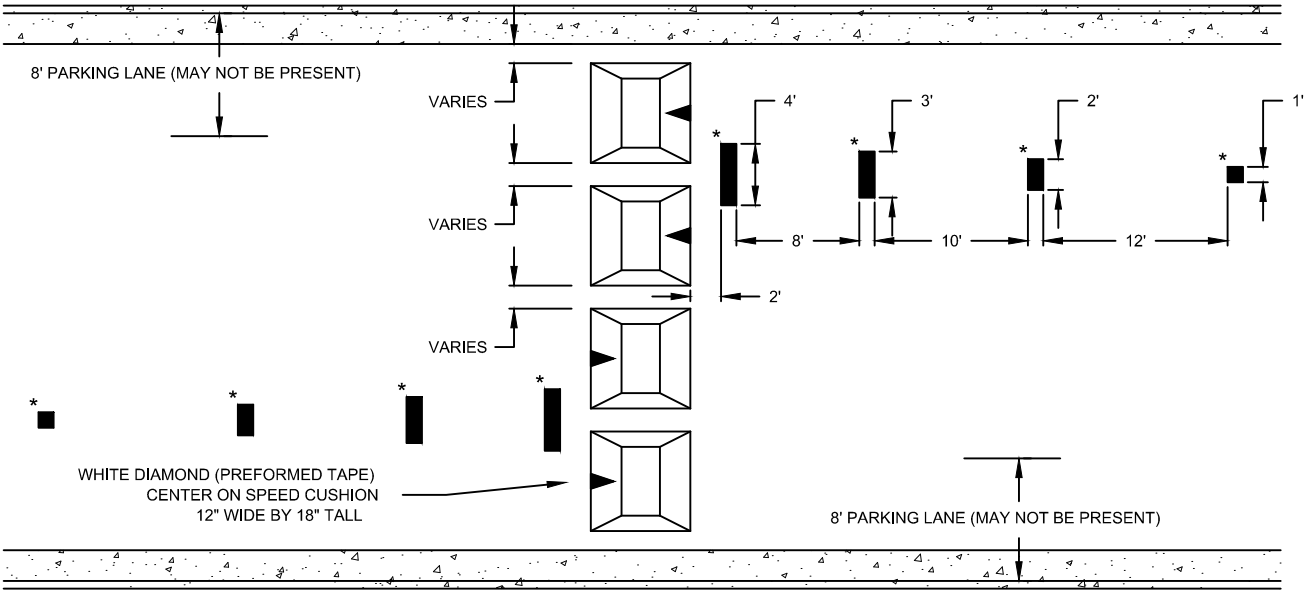
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

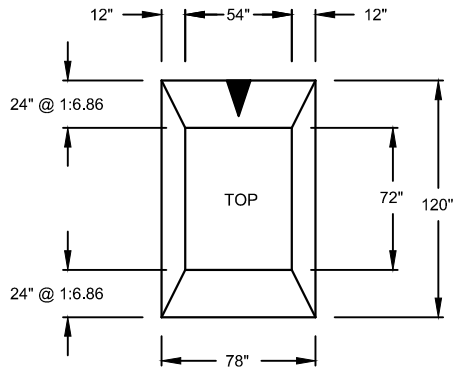
TRAFFIC CALMING
CURB EXT. @ T-INTERSECTION

ISSUED:
AUG 2012
REVISED:

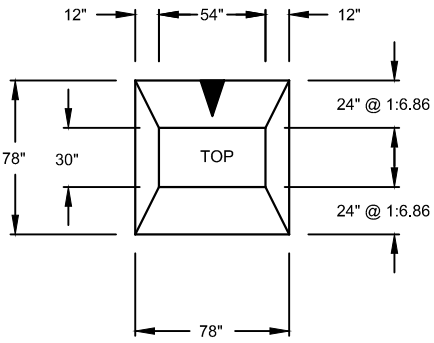
DRAWING NO.
500-20

* 12" WHITE STRIPE (PREFORMED PLASTIC TAPE)
CENTER ON SPACE BETWEEN SPEED CUSHIONS (4 CUSHION LOCATIONS)
CENTER ON OUTSIDE SPEED CUSHION (3 CUSHION LOCATIONS)





TYPICAL EXTENDED SPEED CUSHION
(3.5" HIGH)



TYPICAL SPEED CUSHION
(3.5" HIGH)

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SPEED CUSHION AND PAVEMENT MARKINGS LAYOUT

ISSUED:
AUG 2012
REVISED:

DRAWING NO.
500-21

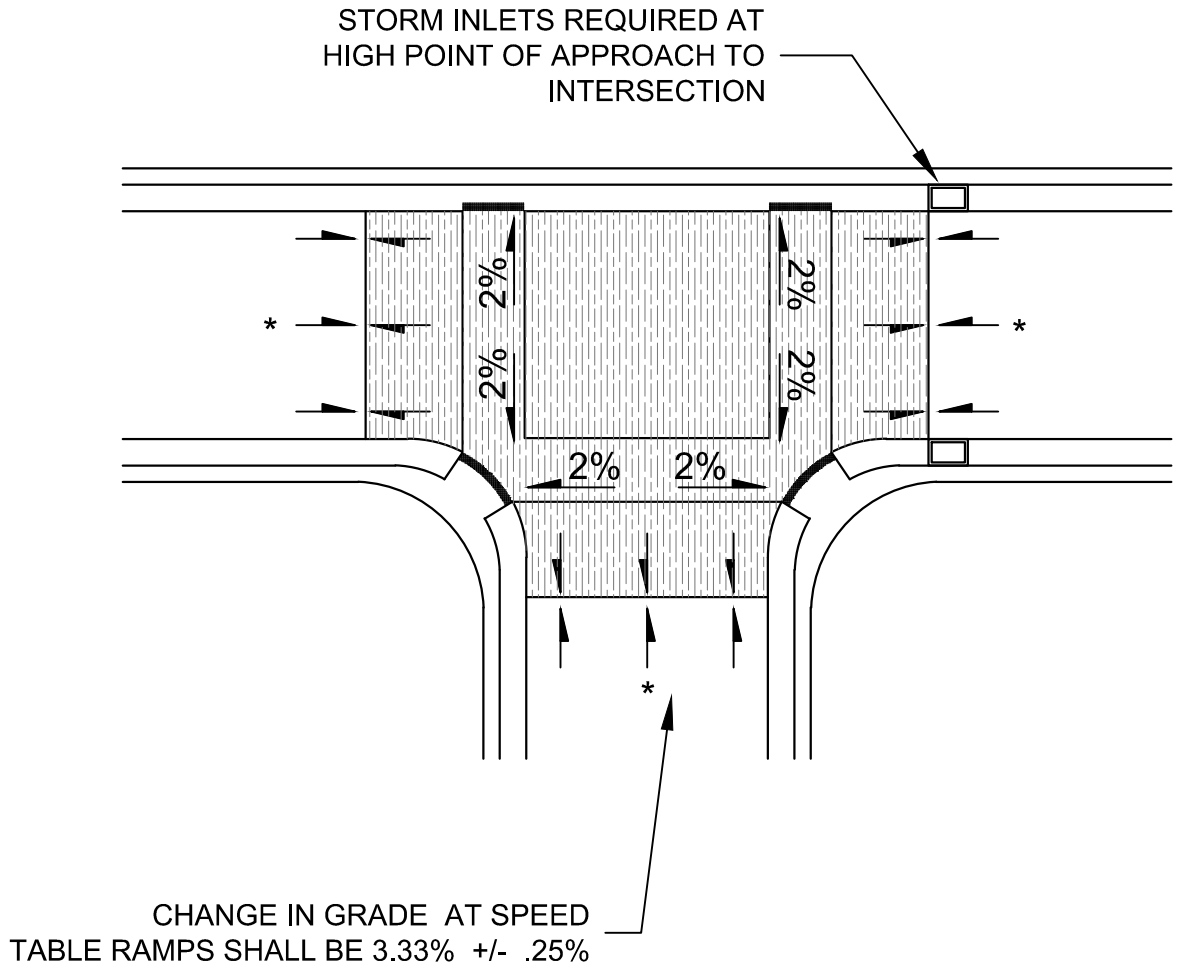
1. COLORADO PATTERN CONCRETE SHALL BE DAVIS FLAGSTAFF BROWN.

2. CONTRACTOR IS RESPONSIBLE FOR PROVIDING FINAL JOINTING AND REINFORCEMENT LAYOUT TO CITY FOR APPROVAL.

3. INLETS SHALL BE CONSTRUCTED WITH A 4" OPENING INSTEAD OF THE TYPICAL 6" OPENING DEPTH.

4. THE INSPECTION OF FORMS IS REQUIRED BY THE CITY PRIOR TO POURING / PLACEMENT OF CONCRETE.

5. CONCRETE SHALL CONFORM TO CITY OF THORNTON SECTION 600-CONCRETE. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT



N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TRAFFIC CALMING SPEED TABLE

ISSUED: AUG 2012
REVISED:

DRAWING NO. 500–22

SECTION 600 - CONCRETE WORK
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SECTION 600 - CONCRETE WORK

601 GENERAL PROVISIONS

This specification enumerates the requirements for the materials, storage, transportation, measuring, mixing, placing, and curing of Portland cement concrete. This specification applies to all Portland cement concrete used in sidewalks, driveways, approaches, patches, manholes, inlets, and other structures constructed in the City of Thornton. Specifications for Portland cement concrete pavement are in Section 500 of these Standards and Specifications. The contractor shall contact the Development Engineering Manager 24 hours in advance of concrete placement when the form work is ready to receive the concrete. Compaction test results shall verify the adequacy of all ground upon which concrete is to be placed.

602 MATERIALS

Concrete shall be composed of Portland cement, aggregate, and water, and shall be reinforced with steel bars, steel wire fabric or fibrous reinforcing where required. No admixture other than air-entraining agents shall be used without written permission of the Development Engineering Manager.

602.1 Cement

TABLE 600-1
ALLOWABLE CEMENT FOR USE ON CONCRETE STREETS

Type	Specification
Portland Cement, Type I, II, III Air-Entraining Portland Cement	ASTM C 150, AASHTO M 85 AASHTO M 134

A. Cement used in concrete work will be Portland cement conforming to the requirements of Table 600-1. In general, Type II or IIA shall be used in concrete which shall be in contact with the soil, unless otherwise allowed or directed by the Development Engineering Manager. Cement, which for any reason has become partially set or which contains lumps of caked cement, shall be rejected.

B. The Responsible Party shall be responsible for the proper storage of cement until it is used. No damaged cement shall be used in the work, and such cement shall be immediately removed from the site when so ordered by the Development Engineering Manager. When requested by the Development Engineering Manager, the Responsible Party shall, at his own cost and expense, furnish the Development Engineering Manager with a certificate from an acceptable testing laboratory for each batch of cement from which cement is taken for use in the work, stating that the cement meets the requirements of these Standards and Specifications for Portland cement.

602.2 Water

Water for concrete shall be clean and free from sand, oil, acid, alkali, organic matter, or other deleterious substances. Water from public supplies or water which has been proven to be suitable for drinking is satisfactory.

602.3 Admixtures

The Responsible Party shall use air-entraining admixtures for concrete that will have exposed surfaces. The Responsible Party may elect to use another admixture provided the admixture is specifically approved by the Development Engineering Manager. Admixtures to be used for plasticizing, densifying, or acceleration of hardening of concrete shall, when added to the mixture, produce a concrete of specified strength in seven (7) day and 28 day tests. Documented evidence of acceptability shall be required when new or unknown admixtures are proposed for use. Air-entraining admixtures shall conform to the requirements of ASTM C-260.

602.4 Fine Aggregate

Fine aggregate shall be composed of clean, hard, durable, uncoated particles of sand, free from injurious amounts of clay, dust, soft or flaky particles, loam, shale, alkali, organic matter, or other deleterious matter. Fine aggregate shall be well graded from coarse to fine and when tested by means of laboratory sieves shall meet the Concrete Aggregate Gradation Table 600-2 and shall also conform to AASHTO M6.

602.5 Coarse Aggregate

A. The coarse aggregate shall consist of broken stone or gravel composed of clean, hard, tough and durable stone and shall be free from soft, thin, elongated or laminated pieces, disintegrated stone, clay, loam, organic, or other deleterious matter.

B. Coarse aggregate shall conform to Number 357 or Number 467 course aggregate from the Concrete Aggregate Gradation Table 600-2, which shall also conform to AASHTO M43.

TABLE 600-2
CONCRETE AGGREGATE GRADATION TABLE
% PASSING DESIGNATED SIEVES AND NOMINAL SIZE DESIGNATION

	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
Sieve Size	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	100
1-1/2"	35-70	90-100	.....	.....	.....	100	.....	.....	95-100	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	0-5	95-100
#8	.....	.....	.....	0-5	0-10	0-5	0-5	.....	.....	50-100
#16	.....	.....	.....	.....	0-5	.....	.....	.....	.....	50-85
#50	.....	.....	.....	.....	.....	.....	.....	.....	.....	10-30
#100	.....	.....	.....	.....	.....	.....	.....	.....	.....	2-10

602.6 Fibrous Reinforcing

A. Fibrous reinforcing shall be used in Portland cement concrete used for curb, gutter, sidewalks, curb turn fillets, cross pans, and valley gutters.

B. The following shall be submitted to the Development Engineering Manager:

1. One (1) copy of manufacturer's printed product data, clearly marked, indicating proposed fibrous concrete reinforcement materials. Printed data should state one and one-half (1½) lbs of fiber to be added to each cubic yard of each type of concrete.

2. One (1) copy of manufacturer's printed batching and mixing instructions.

3. One (1) copy of a certificate prepared by the concrete supplier stating that the approved fibrous concrete reinforcement materials at the rate of one and one-half (1½) pounds per cubic yard were added to each batch of concrete delivered to the project site. Each certificate shall be accompanied by one (1) copy of each batch delivery ticket indicating amount of fibrous concrete reinforcement material added to each batch of concrete.

C. Fibrous concrete reinforcement shall consist of:

1. 100% virgin polypropylene fibrillated fibers specifically manufactured for use as concrete reinforcement, containing no reprocessed olefin materials. Fibrous concrete reinforcement shall be as manufactured by Fibermesh Company, Buckeye Ultra Fiber 500, or approved equal.

2. Physical characteristics:

a. Specific gravity = 0.905 grams per cubic centimeter.

b. Tensile strength: 70 to 110 psi.

c. Fibrous concrete reinforcement materials provided by this subsection shall produce concrete conforming to the requirements for each type and class of concrete required as indicated.

d. Construction methods:

i. Add fibrous concrete reinforcement to concrete materials at the time concrete is batched in amounts in accord with approved submittals for each type of concrete required.

ii. Mix batched concrete in strict accord with fibrous concrete reinforcement manufacturer's instructions and recommendations for uniform and complete dispersion.

e. Concrete placing and finishing: Place and finish concrete materials as specified in subsections 605 and 607.

603 MIXING

603.1 General

Concrete shall be thoroughly mixed in a batch mixer of an approved type and capacity for a period of not less than two (2) minutes after the materials, including the water, have been placed in the drum. During the period of mixing, the drum shall be operated at the speed specified by the manufacturer of the equipment. The entire contents of the mixer shall be discharged before recharge, and the mixer shall be cleaned frequently. The concrete shall be mixed only in such quantities that are required for immediate use. No retempering of concrete shall be permitted. Hand-mixed concrete shall not be permitted except by written approval of the Development Engineering Manager, and then in only small quantities or in case of an emergency.

603.2 Design of the Mix

A. Proportioning

Proportioning the "dry" constituents of concrete mixtures shall be accomplished by weighing. The Responsible Party shall provide adequate and accurate scales for this work. Scales shall be accurate within the allowable tolerances as prescribed by state law. The scales shall be certified by the measurement standards section of the Colorado Department of Agriculture at least once each year, each time the scales are relocated, and as often as the engineer may deem necessary. Scales shall be operated by weighers certified by the measurement standards section of the Colorado Department of Agriculture. The certified weigher shall perform the duties according to the Colorado Department of Agriculture's regulations. There shall be no variance permitted in the minimum cement factor (sacks per cubic yard) as specified for the calls of concrete. The total quantity of mixing-water per sack of cement, including free water in the aggregates, shall not exceed the maximum specified herein. The Responsible Party shall be responsible for developing the proper proportions of aggregates, cement and water that shall conform to the various requirements of these Standards and Specifications. Mix design shall be submitted to the City, along with at least two (2) sets of certified 28 day test results, for review and approval. No concrete shall be incorporated into the work until the proportions are approved by the Development Engineering Manager.

B. Classification

The classification shall conform to CDOT Standard Specifications Table 601-1 for concrete classes and mix requirements for Class D concrete at 28 days, except that Number 357 or Number 467 shall be used.

603.3 Ready-Mixed Concrete

A. The use of ready-mixed concrete in no way relieves the Responsible Party of the responsibility for proportion, mix, delivery, or placement of concrete; concrete must conform to the requirements of these Standards and Specifications, ASTM C-94, and AASHTO M 157 .

B. Concrete shall be continuously mixed or agitated from the time the water is added until the time of use and shall be completely discharged from the truck mixer or truck agitator within one and one-half (1½) hours after it comes in contact with the mixing water or with the aggregates. Retempered concrete shall not be allowed.

C. The City shall have free access to the mixing plant during times of operation. The organization supplying the concrete shall have sufficient plant and transportation facilities to assure continuous delivery of the concrete at the required rate. (The Responsible Party shall collect delivery, or batch, tickets from the driver for concrete used on the project and deliver them to the Development Engineering Manager). Batch tickets shall provide the following information:

1. Supplier's name and date.
2. Truck number.
3. Project number and location.
4. Concrete class designation.
5. Cubic yards batched.
6. Time batched.
7. DOH mix design number.
8. Type, brand, and amount of cement and fly ash.
9. Brand and amount of any admixture.
10. Weights of fine and coarse aggregates.
11. Moisture content of fine and coarse aggregates.
12. Gallons of batch water (including ice).
13. Gallons of water added by truck operator.

D. Provide the following titles with blank space to record information:

1. Discharge time.
2. Water-cement ratio.
3. Air content.
4. Slump.
5. Revolutions.

604 REINFORCING STEEL AND FORMS

604.1 Reinforcing Steel

A. Reinforcing steel shall conform to the requirements of the following specifications:

1.	Deformed and plain billet-steel bars for concrete reinforcement	AASHTO M 31
2.	Axle-steel deformed and plain bars for concrete reinforcement	AASHTO M 53
3.	Fabricated steel bar or rod mats for concrete reinforcement	AASHTO M 54
4.	Welded steel-wire fabric for concrete reinforcement	AASHTO M 5
5.	Welded deformed steel wire fabric	AASHTO M 221
6.	Epoxy coated rebar	AASHTO M 284

B. Unless otherwise designated, bars conforming to AASHTO M 31 and M 53 shall be furnished in Grade 60 for No. 5 bars and larger, and Grade 40 or 60 for bars smaller than No. 5., and all bars shall be epoxy coated. In AASHTO M 54, bar material conforming to AASHTO M 42 will not be permitted.

C. Reinforcement shall be carefully formed to the dimensions indicated on the plans by the cold bending method. Cold bends shall be made around a pin having a diameter of six (6) or more times the diameter of the reinforcing bars. Reinforcement shall not be bent and then straightened. Bars with kinks or bends not shown on the plans shall not be used. Precast mortar blocks, or other non metal supports not approved by ACI shall not be allowed to remain in the concrete placement.

D. Reinforcing steel shall be accurately placed and secured against displacement by using annealed iron wire of not less than No. 18 gauge, or by suitable clips at intersections. Where necessary, reinforcing steel shall be supported by metal chairs or spacers, precast mortar blocks, or metal hangers. Splicing of bars, except where shown on the plans, shall not be permitted without approval of the Development Engineering Manager.

E. Welded wire fabric for concrete reinforcement shall be of the gauge, spacing, dimensions, and form specified on the plans or detailed drawings and shall comply with "Specifications for Welded Steel Wire Fabric for Concrete Reinforcement" (ASTM A-741) or "Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement" (ASTM A-497).

F. Responsible Party shall submit to the City shop drawings of the reinforcement for approval. The Development Engineering Manager's approval of shop drawings and bar schedules shall not relieve the Responsible Party of fulfilling his responsibilities as outlined in the plans and specifications.

G. Unless otherwise shown on the plans, the minimum clear cover for reinforcing steel shall be the following, which is specified in ACI 30l, Section 5.5:

1. Bottom bars on soil bearing foundations and slabs: three (3) inches.

2. Bars adjacent to exposed surfaces or earth backfill:

   a. For bars more than three-fourths (¾) inch in diameter: two (2) inches.

   b. For bars three-fourths (¾) inch or less in diameter: one and one-half (1½) inches.

3. Interior Surfaces: slabs, walls, joints with one and three-eighths (1-3/8) inch diameter or smaller: three-fourths (¾) inch.

604.2 Forms

A. Whenever necessary, forms shall be used to confine the concrete and shape it to the required lines. Forms shall have sufficient strength to withstand, without deformation, the pressure resulting from

placement and vibration of the concrete. Forms shall be constructed so that the finished concrete shall conform to the shapes, lines, grades and dimensions indicated on the approved plans. Any form which is not clean and has not had the surface prepared with a commercial form oil that shall effectively prevent bonding and that will not stain or soften concrete surfaces shall not be used.

B. Plywood forms, plastic coated plywood forms, or steel forms shall be used for surfaces requiring forming which are exposed to view, whether inside or outside any structure. Surfaces against backfilled earth, interior surfaces of covered channels, or other places permanently obscured from view, may be formed with forms having sub-standard surfaces.

C. Forms shall not be disturbed until the concrete has hardened sufficiently to permit their removal without damaging the concrete or until the forms are not required to protect the concrete from mechanical damage. Minimum time before removal of forms after placing concrete shall be one (1) day for footings and two (2) days for other concrete except in curbs, gutters, sidewalks and pavements. The use of slip forms and concrete paving machines shall be allowed, with approval of the Development Engineering Manager.

605 PLACING CONCRETE

A. The subgrade shall be excavated or filled to the required grades and lines. Soft, yielding, or otherwise unsuitable material shall be removed and replaced with suitable material. Filled sections shall be compacted and compaction shall extend a minimum of one (1) foot outside the form lines.

B. The subgrade shall be compacted to the density shown on the plans and trimmed to provide a uniform surface at the correct elevation.

C. Before depositing concrete, debris shall be removed from the space to be occupied by the concrete and the forms, including any existing concrete surfaces, shall be thoroughly wetted. Concrete shall not be placed until forms and reinforcing steel have been inspected and approved by the Development Engineering Manager. Concrete shall be handled from the mixer to the place of final deposit as rapidly as possible by methods which prevent separation or loss of ingredients. The concrete shall be deposited in the forms as nearly as practicable in its final position to avoid re-handling. It shall be deposited in continuous layers, the thickness of which generally shall not exceed 12 inches. Concrete shall be placed in a manner that shall avoid segregation and shall not be dropped freely more than five (5) feet. If segregation occurs, the Development Engineering Manager may require the concrete to be removed and replaced at the Responsible Party's expense. Concrete shall be placed in one continuous operation, except where keyed construction joints are shown on the plans or as approved by the Development Engineering Manager. Delays in excess of 30 minutes may require removal and replacement of that pour, as determined by the Development Engineering Manager.

605.1 Vibrating

A. Concrete shall be thoroughly compacted and/or vibrated. Concrete shall be compacted by internal vibration using mechanical vibrating equipment, except that concrete in floor slabs, sidewalks, or curb and gutter, not poured against form linings, shall be either tamped or vibrated. Care shall be taken in vibrating the concrete to vibrate only long enough to bring a continuous film of mortar to the surface. Vibration shall stop before any segregation of the concrete occurs. Mechanical vibrators shall be an approved type as specified in ACI Publication 309, Chapter 5. Vibrators shall not be used to move or spread the concrete.

B. Any evidence of the lack of consolidation or over-consolidation shall be regarded as sufficient reason to require the removal of the section involved and its replacement with new concrete at the Responsible Party's expense. The Responsible Party shall be responsible for any defects in the quality and appearance of the completed work.

605.2 Workability

The consistency of concrete shall be kept uniform for each class of work and shall be checked by means of slump tests or Kelly ball tests. The workability of the concrete shall be varied as directed by the Development Engineering Manager. Concrete shall have a consistency such that it can be worked into corners and angles of the forms and around joints, dowels and tie-bars by the construction methods which are being used without excessive spading, segregation or undue accumulation of water or latent material on the surface. If, through accident, intention, or error in mixing, concrete fails to conform to the proportions of the approved mix design, such concrete shall not be incorporated in the work but shall be properly disposed of off the project site as waste material at the Responsible Party's expense. No water shall be added at the job site without permission of the Development Engineering Manager. If approval is obtained and water is added at the job site, slump tests shall be run and test cylinders cast following the addition of the water. Expenses incurred in excess of ordinary tests shall be borne by the Responsible Party.

605.3 Concrete Temperature

At the time of concrete placement, the mix temperature shall be between 50° F and 90° F. In cold weather, aggregates and water may be heated as part of the batching operation but they shall not be heated beyond a temperature of 150° F. Aggregates shall not be heated directly by gas flame or oil flame, or on sheet metal over direct flame. Materials containing frost or lumps of frozen material shall not be used in the mix, and their presence in the concrete shall be cause for rejection of that batch.

606 JOINTS

606.1 Materials

Joint materials, if permitted, shall conform to AASHTO, ASTM Specifications according to type as follows:

	AASHTO	ASTM
Concrete joint sealer, hot poured elastic or 888 Corning Cold or approved equivalent	M l73	D1190-74
Preformed expansion joint filler (Bituminous Type)	M 33	D994-71
Preformed sponge rubber and cork expansion joint fillers	M l53	D1752-67
Preformed expansion joint fillers -nonextruding and resilient bitumen	M 2l3	D1751-73

606.2 Spacing

A. Contraction Joints

Transverse joints shall be placed at maximum intervals of 10 feet to control random cracking; joints shall be formed, sawed, or tooled to a minimum depth of one-fourth (1/4) of the total thickness. If divider plates are used, the maximum depth of plates shall not be greater than one-half (½) depth at the finished surface and shall be no less than one (1) inch.

607 FINISHING AND CURING

A. Exposed faces of curbs and sidewalks shall be finished to true-line and grade as shown on the plans. Surface shall be floated to a smooth but not slippery finish. Sidewalk and curb shall be broomed or combed and edged, unless otherwise directed by the Development Engineering Manager. After completion of brooming and before concrete has taken its initial set, edges in contact with the forms shall be tooled with an edger having a three-eighths (3/8) inch radius. No dusting or topping of the surface or sprinkling with water to facilitate finishing shall be permitted.

B. Immediately following the removal of the forms, fins and irregular projections shall be removed from surfaces except from those which are not to be exposed or are not to be waterproofed. On surfaces, the cavities produced by form ties, honeycomb spots, broken corners or edges, and other defects, shall be thoroughly cleaned, moistened with water and carefully pointed and trued with a mortar consisting of cement and fine aggregate or removed and replaced at the direction of the Development Engineering Manager. The surface shall be left sound, of acceptable finish, even, and uniform in color. Mortar used in pointing shall not be more than 30 minutes old. Construction and expansion joints in the completed work shall be left carefully tooled and free of mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

C. Fresh concrete shall be protected from weather damage and mechanical injury during the curing periods. Curing processes described herein may be used at the option of the Development Engineering Manager. The selected curing process shall be started as soon as it can be done without injury to the concrete surface. The use of a membrane curing compound is required.

D. Membrane curing compound shall not be used when the concrete surface will be painted. The type of membrane curing compound chosen shall not permanently discolor the concrete surface. Where membrane curing compound is not used, the curing process shall be carefully adhered to as follows in subsection E below.

E. The following curing procedures may be used subject to the approval of the Development Engineering Manager:

1. Wet Burlap Curing

After completion of the finishing operations, the surface of the concrete shall be entirely covered with burlap mats. The mats used shall be in such length or width that as laid they will extend at least twice the thickness of the concrete beyond the edges of the slab or structure. They shall be placed so that the entire structure and all edges of the concrete, when forms are removed, are completely covered. This covering shall be placed as soon as the concrete has set sufficiently to prevent marring of the surface. After being placed, the mats shall be thoroughly saturated with water by spraying with a mist spray. The burlap shall be so placed and weighted down so it remains in contact with the surface covered, and the covering shall be maintained fully wetted and in position for seven (7) days after the concrete has been placed. If it becomes necessary to remove the burlap for any reason, the concrete shall not be exposed for a period of more than one-half (1/2) hour. This method of curing shall not be used when the outside air temperature is below 32° F unless heated enclosures are provided.

2. Plastic Sheet Curing

   As soon after the completion of the finishing operation, as the concrete has set sufficiently to prevent marring of the surface, the top surface and sides shall be entirely covered with plastic sheet materials. The plastic sheet, as prepared for use, shall have such dimensions that each unit as laid will extend beyond the edges of the concrete at least twice the thickness of the concrete. The units, as used, shall be lapped at least 12 inches, and the laps of plastic sheet shall be secure such that they do not open up or separate. The plastic shall be placed and weighted so it remains in contact with the surface covered, curing the entire curing period of seven (7) days.

3. Waterproof Paper Curing

   The procedures used for plastic sheet curing shall be used when waterproof paper is used in curing concrete.

4. Liquid Curing Membrane

   Immediately after the surface water has disappeared from the concrete surface, the liquid membrane curing compound (white pigmented) shall be sprayed under pressure to the concrete surface at a rate not less than one (1) gallon per 150 square feet with a spray nozzle, or nozzles, so that it covers the entire pavement with a uniform water-impermeable film. If the forms are removed within seven (7) days, the exposed sides and edges shall be sprayed in the above-described manner or the backfill completed immediately.

5. Insulation Pad

   Insulation pads or other thermal devices may be used to protect concrete in cold weather.

6. Wax Base and Resins

   Wax base and resin base solutions shall not be used if linseed oil protection is to be applied to the concrete surface. If linseed oil protection is to be utilized, the method of curing shall be either linseed oil base curing compound, wet burlap, plastic sheet, or waterproof paper curing.

608 PROTECTION

608.1 Cold Weather Concreting

A. During extreme weather conditions, placing of concrete shall be permitted only when the temperature of the concrete placed in the forms shall not be less than 60° F nor more than 90° F. To maintain this temperature range, the Responsible Party shall provide acceptable heating apparatus for heating the aggregates and the water. Concrete may be placed when the air temperature in the shade is 40° F, and rising. No concrete shall be placed, regardless of the present temperature, when the weather forecast promises freezing weather before final set of the concrete unless special means of heating and protection are used. Protection against freezing is the Responsible Party's responsibility regardless of the weather forecast or climatic conditions at the time of placing.

B. Small structures and slabs may be protected by completely covering fresh concrete with canvas to a depth that ensures protection. Material shall be secured to prevent displacement by the elements. Large structures or vertical walls shall be protected against freezing by enclosing the structure and heating with salamanders, heaters, or other devices capable of providing uniform and even heat throughout the structure.

C. Concrete placed in cold weather shall be protected from extreme temperatures as follows:

   1. A temperature of at least 50° F for the first 72 hours shall be maintained.

2. After the first 72 hours and until the concrete is seven (7) days old, it shall be protected from freezing temperatures.

3. Concrete adjacent to heaters or salamanders shall be insulated from direct heat of the unit which may dry it out prior to being properly cured.

4. Temperatures shall be measured by maximum and minimum thermometers furnished by the Responsible Party and installed adjacent to the concrete.

D. Concrete slabs shall not be placed, regardless of temperature conditions, if the supporting ground is frozen or contains frost. Use of salt or other additives to prevent concrete from freezing shall not be allowed. Concrete which has been frozen shall be completely removed and replaced as directed by, and to the satisfaction of, the Development Engineering Manager.

608.2 Hot Weather Concreting

Except by written authorization, concrete shall not be placed if the temperature of the plastic concrete cannot be maintained at below 90° F. The placement of concrete in hot weather shall comply with ACI 305.

609 MISCELLANEOUS

609.1 Repairs

A. After stripping of the forms, if any concrete is found to be not formed as shown on the drawings or is out of alignment or level, or shows a defective surface, it shall be in violation of the requirements set forth in these Standards and Specifications and shall be removed and replaced by the Responsible Party at his expense unless the Development Engineering Manager gives written permission to patch the defective area. In this case, patching shall be done as described in the following paragraphs. Defects that require replacement or repair are those that contain honeycomb, damage due to stripping of forms, loose pieces of concrete, bolt-holes, tie-rod holes, uneven or excessive ridges at form joints, and bulges due to movement of the forms. Ridges and bulges may be removed by grinding upon the approval of the Development Engineering Manager. Honeycombed and other defective concrete that does not affect the integrity of the structure shall be removed and replaced in a manner acceptable to the Development Engineering Manager.

B. Bolt-holes, tie-rod holes, and minor imperfections as approved by the Development Engineering Manager, shall be filled with dry-patching mortar composed of one (1) part Portland cement to two (2) parts of regular concrete sand (volume measurement) and only enough water so that after the ingredients are mixed thoroughly, the mortar shall stick together on being molded. Mortar repairs shall be placed in layers and thoroughly compacted by suitable tools. Care shall be taken in filling rod and bolt holes so that the entire depth of the hole is completely filled with compacted mortar. The mortar mix proportions described above are approximate.

C. Those areas with excessive deficiencies as determined by the Development Engineering Manager shall be removed and replaced at the Responsible Party's expense. All replacement as required by the Development Engineering Manager shall be full stone replacement, control joint to control joint, with no partial stone replacements allowed. Where repairs are made in existing sidewalks, all edges of the old sidewalk allowed to remain shall be sawcut to a minimum depth of two (2) inches. No rough edges shall be permitted where new construction joins the old section. Rebar doweling shall be required at all construction joints between new construction and the old section. Unless directed by the Development Engineering Manager, no section less than five (5) feet in length shall be placed or left in place. Where new sidewalk construction abuts existing sidewalks, the work shall be accomplished so that there is no abrupt change in grade between the old section and the new work. Concrete replacement adjacent to asphalt roads will require the asphalt be saw cut 18 inches away from the concrete edge to allow for proper forming and placement of concrete. Asphalt patch back will be required as directed by the Development Engineering Manager.

D. No addition to existing sidewalks or other flat work concrete shall be made less than four (4) feet in width.

E. Vertical surface discontinuities (i.e. vertical difference in level between two adjacent surfaces) shall be less than .25 inches.

609.2 Cleanup

The exposed surfaces of the concrete shall be thoroughly cleaned upon completion of the work, and the site shall be left in a neat and orderly condition.

609.3 Backfilling

A. When side forms are removed and the concrete has gained sufficient strength, the space adjoining the concrete shall be promptly backfilled with suitable material, properly compacted, and brought flush with the surface of the concrete and adjoining ground surface. In embankments, the backfill shall be level with the top of the concrete for at least two (2) feet and then sloped as shown on the drawings or as directed by the Development Engineering Manager.

B. When the area behind the walk is to be paved, a minimum of four (4) inches of asphaltic surfacing and six (6) inches of base course shall be used and shall be constructed in accordance with these Standards and Specifications. Existing pavement which is damaged during construction shall be repaired by the Responsible Party at his expense. Patching shall match existing asphalt or concrete and shall be the Responsible Party's responsibility.

609.4 Testing

A. General

1. The requirements of this section shall apply to testing services for concrete curb and gutter, sidewalk, pavement, slope paving, retaining walls, structures, and for miscellaneous concrete testing.

2. Concrete materials and operations shall be tested as directed by the Development Engineering Manager and as herein stipulated. The required testing services shall be performed by a testing agency approved by the Development Engineering Manager, and testing agencies shall meet the requirements of ASTM E329.

3. A representative of the testing agency shall inspect, sample, and test material and production of concrete as required by the Development Engineering Manager at the Responsible Party's expense. When it appears that any material furnished or work performed by the Responsible Party fails to fulfill specification requirements, the testing agency shall report such deficiency to the Development Engineering Manager and the Responsible Party.

4. The testing agency shall report test and inspection results to the Development Engineering Manager and Responsible Party immediately after they are performed. Test reports shall include the exact location of the work at which the batch represented by a test was deposited. The report of the strength test shall include detailed information on storage and curing of specimen prior to testing, the project number, and the location of the concrete (curb, manhole, inlet, sidewalk, paving, etc.). Test reports shall bear the seal and signature of a PE registered in the State of Colorado and competent in the field of concrete testing. Reports not properly certified shall not be accepted.

5. The testing agency or its representative is not authorized to revoke, alter, relax, enlarge or release any requirements of these Standards and Specifications, nor approve or accept any portion of the work.

B. Tests Provided by the Responsible Party

The following services shall be performed by the designated testing agency at the expense of the Responsible Party:

1. Conduct strength test of the concrete during construction in accordance with the following procedure: Secure composite samples in accordance with AASHTO Tl4l; mold and cure specimens from each sample in accordance with AASHTO T23. The maximum time between sampling and casting the cylinders or beams shall be 45 minutes. One (1) test series shall be taken per 50 cubic yards (or fraction thereof) of the concrete placed per day, or as directed by the Development Engineering Manager.

   a. Field cured test series: four (4) cylinders, one (1) to be broken at seven (7) days or as directed by the Development Engineering Manager.

   b. Lab cured test series: four (4) cylinders one (1) to be broken at seven (7) days; two (2) to be broken at 28 days. One (1) to be held for 56 day break should the 28 day breaks fail.

2. Determine slump of the concrete sample of each strength test whenever consistency of concrete appears to vary, or when directed by the Development Engineering Manager, in accordance with AASHTO Tll9.

3. Determine air content of the concrete sample for each strength test in accordance with either AASHTO Tl52 (pressure method), Tl96 (volumetric method), or Tl2l (gravimetric method).

4. Sample additional concrete at point of placement, and perform other testing or inspection service as required.

5. When required by the Development Engineering Manager, the Responsible Party shall provide concrete mix designs, the results of which shall be immediately reported to the Development Engineering Manager. When pumped concrete is to be used, a separate mix design shall be required. Mix designs shall be in accordance with ACI 2ll and 304, as applicable.

6. Additional testing and inspection required because of changes in materials or proportions.

7. When the work fails to pass inspection or previous tests fail to meet specifications, additional tests shall be taken as directed by the Development Engineering Manager.

8. Core samples shall be obtained and tested when samples of fresh concrete were not obtained and tested in accordance with the provisions of these Standards and Specifications. Obtaining and testing cores shall be in accordance with ASTM C42. Concrete in the area represented by a core test shall be considered adequate if the average strength of the cores is equal to at least 85% of the specified strength f^1c, and if no single core is less than 75% of the specified strength. Core holes shall be filled with low slump concrete or mortar.

9. Failure of the Responsible Party to furnish testing as herein described shall be sufficient cause for rejection of the work in question.

C. Responsibility and Duties of the Responsible Party

1. The Responsible Party shall provide the testing agency with the following:

   a. Any labor necessary to assist the designated testing agency in obtaining and handling samples at the project or from other sources of material.

   b. Provide and maintain for the sole use of the testing agency adequate facilities for safe storage and proper curing of concrete test specimens on the project site as required by AASHTO T23.

2. The use of testing services in no way relieves the Responsible Party of the responsibility to furnish material and construct in full compliance with these Standards and Specifications.

610 FLOWCRETE / FLOWFILL CONCRETE

610.1 Specifications

The following is the specification of the flowcrete/flowfill concrete as directed by the Development Engineering Manager:

Mix Proportions: (per cubic yard of concrete)		
Material	ASTM Specification	Weight
Cement	ASTM C-150	42 to 50 lbs
Sand	ASTM C-33	1845 to 1850 lbs
Aggregate	ASTM C-33	1700 to 1750 lbs
Air Entrainment	ASTM C-260	5.0 ounces
Water	ASTM C-94	39 gallons

DESIGN PHYSICAL PROPERTIES: Slump shall be six (6) to eight (8) inches

SECTION 700 - TRAFFIC TECHNICAL SPECIFICATIONS
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DETAIL DRAWINGS

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SECTION 700 - TRAFFIC TECHNICAL SPECIFICATIONS

701 General Provisions

A. These specifications for traffic signals, signs, and pavement markings supplement the roadway design specifications and shall govern the materials used for the installation of traffic control signals, signs, and pavement markings.

B. Work shall be done in accordance with these Standards and Specifications, the latest edition of the MUTCD, the latest revision of the Colorado Supplement thereto, and in conformity with the details as shown on the traffic signal plans.

701.1 Definitions

A. General

Whenever special engineering terms and words are used in these Standards and Specifications, or in other contract documents, the intent and meaning shall be as defined in the Traffic Engineering Handbook, ITE, latest edition and the Transportation Planning Handbook, ITE, latest edition.

701.2 Regulations and Codes

A. In addition to the requirements of the approved plans and these Standards and Specifications, items and workmanship shall conform to the requirements of the NEC; Rules for Overhead Electrical Line Construction of the Colorado Public Utilities Commission; standards of ASTM, ANSI, and any local ordinances which may apply.

B. Wherever reference is made to any of the standards mentioned above, the reference shall be construed to mean the NEC, order, or standard that is in effect on the date of plan approval by the City.

701.3 General Plan Notes - Traffic

The following notes shall be used on the traffic signal plans.

A. New Traffic Signal Installations

1. Conduit, Pole, Pull Boxes and Controller locations are approximate. Exact locations shall be marked by the Responsible Party and approved in the field by the City.

2. All existing utility locations are approximate. The Responsible Party shall field verify the exact location of all utilities before commencing work and agrees to be fully responsible for any damages which may occur by the Responsible Party's failure to exactly locate and preserve any and all underground utilities.

3. Except as modified in the plans, all work shall be in accordance with the City of Thornton's Standards and Specifications for the Design and Construction of Public and Private Improvements. The Responsible Party shall contact the Development Engineering Manager a minimum of 48 hours and a maximum of 96 hours prior to starting traffic signal construction.

4. The Responsible Party shall submit a traffic control plan for construction to the City with the permit application. A public right of way work permit will not be issued without an approved traffic control permit for traffic control during construction.

5. Upon completion of work, the Responsible Party shall submit record drawings, corrected plans and any additional data required by the City showing in detail all construction changes.

6. All signal heads shall be polycarbonate type and black in color.

7. All signal indications and luminaires shall be approved LED type.

8. Cabinet foundations shall be concrete.

9. All signal heads shall be wired separately form the signal head to hand hole above grade at base of signal pole with no overhead splices.

10. All new signal heads and all reset signal heads shall be positioned in the center of the lane.

11. Internally illuminated street name signs shall be approved LED type and mounted on the mast arm at a minimum of two (2)from the signal pole.

12. When the project is complete, two (2) keys for each controller cabinet and Police Panel shall be delivered to the Development Engineering Manager. The Instruction Manual for the controller shall be left inside the controller cabinet.

B. Modified Traffic Signal Installations

1. All salvaged signal equipment shall be delivered to the Infrastructure Maintenance Center, 12450 N. Washington Street.

2. If an existing traffic signal must be turned off, two (2) weeks minimum notice shall be given the City and arrangements made at the expense of the Responsible Party for police officers to direct traffic in the intersection.

C. Sign Installations

1. All traffic control signing shall conform to Sectiojn 704 of these Standards and Specifications

2. When sign poles are to be installed in an area that will be surrounded by concrete, an eight (8) inch diameter sleeve shall be installed to provide a space to install the sign pole base.

3. Mounting order of signs on sign pole from top to bottom: Dead End plaques, Street Name signs, other signs. Dead End plaques and Street Name signs shall be mounted using bolts only. All other signs shall be installed with a bolt, washer and nut for the top hole and a drive rivet for the bottom hole.

4. All signs shall be fabricated using 3M Diamond Grade retro-reflective sheeting, or approved equal. All signs shall have a 3M #1160 protective clear overlay (graffiti protection), or approved equal, applied to the face of the sign.

5. All Stop signs and Street Name signs shall be install as per Detail 700-12.

6. All salvaged signs shall be delivered to the Infrastructure Maintenance Center, 12450 N. Washington Street.

D. Pavement Marking Installations

1. All pavement markings shall be field marked and shall be approved in the field by the Development Engineering Manager before installation of pavement marking materials.

2. All material shall be installed as per the manufacturer's recommendations and City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements.

3. Paint shall not be used for permanent markings.

702 TRAFFIC SIGNAL STANDARDS

702.1 Conditions of Materials Furnished

A. Items furnished shall be new equipment and materials. The Responsible Party shall submit to the City a list of equipment and materials which is proposed to be installed for review and approval by the Development Engineering Manager prior to the Responsible Party ordering such materials. Submittals shall consist of product cut sheets and necessary supporting material. Each item shall be identified by the trade name, size, and catalog number.

B. 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, controller cabinet traffic control equipment furnished by the Responsible Party shall be compatible with existing equipment to be retained.

C. When the project is complete, two (2) keys for each controller cabinet and Police Panel shall be delivered to the Development Engineering Manager. The Instruction Manual for the controller shall be left inside the controller cabinet.

702.2 Required Documents

A. The Responsible Party shall have an IMSA Certified Traffic Signal Level II Technician on-site during the period of any splicing and/or termination of wiring for head and controller installation, and shall provide the Development Engineering Manager with a copy of the Technician's certification prior to the start of work.

B. Upon completion of the work, the Responsible Party shall submit as-built drawings or corrected plans and/or additional data required by the Development Engineering Manager to show in detail the

construction changes. This shall include but not be limited to: wiring, cable, location, depth of conduit and modifications to original cabinet wiring.

C. The Responsible Party shall submit two (2) sets of schematic wiring diagrams to the Development Engineering Manager 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.

D. Diagrams, plans and drawings shall be prepared using graphic symbols shown in ANSI Y32.2, "Graphic Symbols for Electrical and Electronic Diagrams."

E. One (1) copy of the controller cabinet diagram and the intersection and phase diagram, as approved by the Development Engineering Manager shall be placed in a heavy duty plastic envelope with side opening, and placed inside of each controller cabinet in the plan drawer prior to the initial acceptance of the project.

702.3 Maintaining Existing Traffic Signal Operations

A. Existing traffic signals shall be kept in effective operation for the benefit of the traveling public by the Responsible Party.

B. At intersections where power to signals must be turned off, the Responsible Party shall make arrangements to have a Thornton Police Officer control the intersection. The Responsible Party must request a police officer at least two (2) weeks prior to the time the officer is needed. Requests for Thornton Police Officers must be made through the Development Engineering Manager and coordinated with the Development Engineering Manager.

C. The above does not apply to intersections which are completely closed to traffic due to construction.

D. The Responsible Party shall maintain a minimum of two (2) three (3) section (red, yellow, green) traffic signal heads for each approach. 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. In the event that temporary signals are necessary to maintain the minimum signal display, the Responsible Party shall be responsible for furnishing materials, equipment, tools, and labor necessary to install and maintain the temporary signals. The Responsible Party shall furnish electrical energy for operation of a temporary signal.

E. Temporary span-wire traffic signal installations are not permitted unless specifically approved in writing by the Development Engineering Manager.

702.4 Field Tests of Equipment

A. Prior to completion of work, the Responsible Party shall make the following tests on traffic signal circuits, in the presence of the Development Engineering Manager and the controller representative, if a new controller is used (the Responsible Party shall notify the Development Engineering Manager a minimum of 48 hours prior to conducting the tests):

1. Each circuit shall be tested for continuity.

2. Each circuit shall be tested for grounds.

3. An insulation resistance test shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than the values specified in the provisions of the NEC.

B. 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.

C. Louvers, hoods, and signal heads shall be directed to provide maximum visibility.

D. Initial activation shall be between Monday and Thursday, between 9:00 a.m. and 2:00 p.m... Prior to activation, the equipment as shown on the plans shall be installed and operable. This includes, but is not limited to: pedestrian signals; pedestrian push buttons; vehicle detectors; system communications; and Opticom.

E. Flash and permanent activation shall have City Traffic Engineering and Operations personnel present.

F. The signal shall be run on flash cycle for a minimum of 24 hours prior to turn-on, with the exception of pre-existing signalized intersections After flash operations, a functional test shall be made which demonstrates that every part of the system functions as specified herein. The functional test for each traffic signal system shall consist of at least five (5) days of continuous satisfactory operation. If unsatisfactory

performance of the system develops, the conditions shall be corrected and the test shall be repeated until five (5) days of continuous, satisfactory operation is obtained.

G. Prior to the functional test, the Responsible Party will 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 Development Engineering Manager prior to the functional tests being performed.

H. Functional tests shall start on any working day except Friday, the day preceding a legal holiday, or a legal holiday. The City reserves the right to activate the test on any day of the calendar week.

I. During the test period, the City shall provide the electrical energy. Repair of any damage caused by public traffic is the responsibility of the Responsible Party. Other maintenance shall be the responsibility of the Responsible Party.

702.5 Activation of Traffic Signal Equipment

Activation of new or modified signal systems shall be made only after traffic signal circuits have been thoroughly tested as specified in Subsection 702.4 and the Development Engineering Manager concurs with the activation.

702.6 Traffic Signal, Lighting, and Communication Conduit

A. General

1. Underground utility information shown on the plans is for information only. The Responsible Party is responsible for field locating and verifying utility information before starting installation of underground conduit runs and traffic signal pole foundations.

2. Responsible Party shall cooperate, as directed by Development Engineering and/or the Development Engineering Manager, with any other Responsible Party under contract to the City or with the Utility Companies providing services to the City while installing underground conduit runs.

3. Electrical conduit shall be installed in accordance with the applicable requirements described in the latest revision of the CDOT Utility Manual, as amended.

4. Larger size conduit can be used, at the Responsible Party's option and own expense. 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 shall be permitted in any conduit run.

5. When specified, conduits shall be installed under existing pavement by jacking or drilling operations. Where plans show that existing pavement is to be removed, jacking the conduit shall not be required. Jacking or drilling pits shall be kept a minimum of two (2) feet clear of the edge of pavement whenever possible. Water shall not be permitted as an aid in jacking or drilling operations.

6. Conduits shall be of the rigid plastic PVC type conforming to the approved construction drawings and these Standards and Specifications. GRC type conduit shall only be used as indicated in the approved construction drawings and shall be in conformance with these Standards and Specifications. Conduit runs shown on the plans are tentative as to routing and may be changed as directed by the Development Engineering Manager 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 drawings, and necessary details and as-built drawings shall be submitted to the Development Engineering Manager.

7. Conduit installation shall include the installation of marking tape laid in the backfilled trench at a depth not more than eight (8) inches or less than four (4) inches below finished grade. Heavy gauge polyethylene film (0.004"0 tape, with legend "Caution Buried Electric Line Below", shall be used. Where tape length ends and conduit run continues, lapping of not less than six (6) inches shall be provided. No glue or adhesive shall be allowed to join separate tape sections.

8. Conduits shall have a one-eighth (1/8) inch nylon rope for future wire installation and 14 gauge copper stranded tracer wire. The sheathing for the tracer wire shall be purple in color. A minimum of two (2) feet of pull rope shall be doubled back into the conduit at each termination. A minimum of two (2) feet of slack tracer wire shall be left in each pull box and in the controller cabinet.

B. Nonmetallic Conduit (PVC)

1. Rigid PVC conduit shall be Schedule 40, Type 2 and shall be manufactured of high-impact PVC, and shall conform to industry standards and commercial standards No. CS-207-60. Schedule 80 may be used as an alternate. Each length of PVC conduit and the various PVC fittings (coupling, adapter, etc.) shall bear the label of UL or be approved by the Development Engineering Manager. The conduit shall be of the size or sizes shown on the plans or indicated in these specifications.

2. Rigid PVC conduit ends shall be squared and trimmed after cutting to remove rough edges. Connections shall be of solvent weld type except where PVC is to be connected to a steel conduit, in which case the coupling or adapter shall be threaded on the steel conduit side.

3. Solvent weld joints shall be made in accordance with the PVC manufacturer's recommendations. Rigid PVC conduit shall only be used for underground installations; conduit used above ground shall be galvanized rigid steel.

C. Galvanized Rigid Conduit Steel GRC

1. 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 and exterior of a six (6) inch sample cut from a center of a standard length of a conduit, when tested in accordance with the applicable portion of ASTM Designation A239, shall not show a fixed deposit of copper after four (4) - one (1) 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 UL and shall conform to appropriate articles of the NEC.

2. 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 shall butt or come together for the full circumference. Slip joints or running thread shall not be permitted for coupling conduit. When a standard coupling cannot be used, weatherproofed threaded three (3) piece union shall be used. Three (3) piece unions must be threaded; non-threaded couplings shall not be accepted.

3. The threads on conduits shall be well-painted with a good quality lead or rust-preventive paint before couplings are made up. Couplings shall be tightened until the ends of the conduits are brought together so that a good electrical connection shall 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 a good quality asphalt bituminous or other paint suitable for the purpose.

D. Installation Methods

1. Conduit sizes and locations shall be as shown on the plans. Conduit shall be stubbed and capped for future use where shown on the plans or where specified in these specifications.

2. 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.

3. Conduits terminating in poles, cabinets or pedestal bases shall extend a maximum of three (3) inches and a minimum of two (2) inches above the foundation vertically, and shall be sloped toward hand holes in poles or base opening where transformer bases are used. Conduit entering pull boxes shall terminate a minimum of two (2) inches and a maximum of three (3) inches above the bottom of the box.

4. Conduit ends shall be accomplished by 90 degree elbow with a minimum radius of 48 inches. Where two (2) or more conduits meet, 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 of wire.

5. Conduits required to be terminated, stubbed and plugged shall be as shown on the plans and as directed by the Development Engineering Manager. Conduit ends shall be capped with standard conduit caps. The location of ends of conduit for future electrical circuits under curbs, gutters, sidewalks, or structures shall be marked by a "Y" at least three (3) inches high, cut into the face of the curb, gutter or structure directly above the conduit.

6. Metal type conduit ends 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. Non-metallic type conduit ends shall be capped with a standard PVC cap until conductors are in place.

7. Conduit under railroad tracks shall not be less than 42 inches below the bottom of the ties and/or as specified by railroad code. It shall be the responsibility of the Responsible Party to obtain clearance

from the railroad company prior to performing any work within the boundaries of the railroad ROW. The minimum size of conduit to be used shall be as shown on the plans.

8. 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.

702.7 Pull Boxes

A. General

1. Pull box locations shall be depicted on the approved plans. These shall be located in the field by the Responsible Party and approved by the Development Engineering Manager prior to installation. Pull boxes for traffic signal conduit shall not be spaced more than 150 feet apart from each other.

2. It shall be the option of the Responsible Party, to install additional pull boxes desired to facilitate its work, at the expense of the Responsible Party.

3. Pull boxes used for loop detectors or sampling stations shall be a minimum of 12 inches wide by 16 inches long by 12 inches deep. Pull boxes used at junctions of roadway conduit crossing and at the controller cabinet shall be a minimum of 20 inches long by 33 inches wide by 15 inches deep. Pull boxes used for traffic signal communication interconnect shall be a minimum of 24 inches long by 36 inches wide by 24 inches deep. Pull boxes at the controller cabinet shall be a minimum of 30 inches long by 48 inches wide by 24 inches deep. Use of two (2) pull boxes in place of the larger one shall not be permitted.

4. Pull boxes shall be or equal to the `Composolite' by Quazite. Enclosure and covers shall be concrete gray color and rated for no less than 8,000 lbs over a 10 inch by 10 inch area and tested to a temperature of -50° F. Material compressive strength shall be no less than 11,000 psi. Pull boxes shall have lids with the words "Traffic Signal" printed on them and be gray in color. Lids for pull boxes sized 30 inches long by 48 inches wide by 24 inches deep or larger shall consist of two pieces capable of being removed from the pull box independently. The configuration of the two-piece lid shall be such that access to the pull box is unobstructed when both pieces are removed.

5. Pull Box-Special shall be installed in street and shall be a water valve stem type pull box made of cast-iron or steel. The pull box shall have the capability of accepting riser rings for future overlays. The lid shall have the word "Traffic" cast into lid.

B. Installation

1. Pull boxes shown in the vicinity of curbs and gutters shall be placed adjacent to the back of the curb. Pull boxes adjacent to light standards shall be placed along the side of foundations as shown on the plans.

2. The cover of the pull box shall be installed level with the finish grade. The bottom of pull boxes shall rest on firm ground with 12 inches of three-fourths (3/4) inch to two (2) inch fractured rock below pull box for drainage. Pull boxes installed in a sidewalk shall be tied into the sidewalk to prevent the boxes from being pushed down below the top of the sidewalk.

3. Pull boxes installed in dirt or landscaped areas shall have a 12 inch wide by six inch thick concrete collar placed around the top, level with the cover of the pull box and finish grade. All concrete collars shall be Portland cement concrete conforming to the applicable requirements for Class B as referenced in the SSRBC, latest revision.

702.8 Standard Type Poles

A. Traffic signal poles and mast arms shall be structurally engineered by the manufacturer in the United States to carry the proposed weight load as to signal heads with five (5) inch backplates, mounting hardware and traffic control and street name signs; The poles and mast arms shall be structurally engineered in accordance with the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals for a 90 mph wind velocity. AASHTO Fatigue Category II shall be used in design. The minimum design life for the poles and mast arms shall be 50 years. A minimum gust effect factor, G, of 1.14 shall be used in design. A speed of 55 mph shall be used to calculate truck-induced gust loads..

B. Poles shall be furnished with anchor bolts, nuts and washers; pole caps; door covers; anchor bolt nut covers; rebar cages in conformance with these Standards and Specifications (except 10 foot poles). Mast arm traffic signal poles shall be one of the following, or approved equivalent:

Valmont Poles - Drawing DB00991, Rev. B, Dated February 27, 2012, (City)

Union Metal Corporation (Design Number 50700 B1011)

C. Roadway clearance at end of signal mast arm shall be 21 feet from roadway with side slope of two (2) to three (3) percent to the mast arm/pole connection.

D. Traffic signal poles and mast arms shall be of like manufacture. The pole types shown on the plans are for illustrative purposes only and are not to be construed as representative of one manufacturer. Workmanship and finish shall be equal to the best general practice of metal fabrication shops.

1. Standard Poles

   a. Pole shafts shall be straight, with a permissive variation not to exceed one (1) inch measured at the midpoint of a 30 foot or longer pole, and not to exceed three fourths (3/4) inch measured, at the midpoint of a pole shorter than 30 feet.

   b. Standard poles with mast arms shall have a two hand holes. One hand hole shall be at the bottom of the pole, 180 degrees from the mast arm mounting location at a height of 1.5 feet from the ground surface to the center of the hand hole. The other hand hole shall be located directly opposite and in line with the mast arm mounting location.
   c. 10 foot and 15 foot signal poles shall be capable of supporting a signal head using a standard pole top mount and two (2) pedestrian signal heads using side of pole mount.

2. Signal Mast Arms

   Traffic signal mast arms shall be furnished with end caps. Mast arms shall not have tenons unless a written request is approved in advance by the Development Engineering Manager. If, while being installed, an arm is determined to be shortened, the Responsible Party must fabricate and install a new end cap.

3. Luminaire Mast Arms

   Luminaire mast arms shall be of the single arching type, and straight, angled or ornamental types shall be acceptable. These mast arms are to be standard 15 foot arms unless it is a double mast arm pole, then the luminaire mast arms shall be 12 feet.

4. Pole Foundations

   a. Foundations shall be Portland cement concrete conforming to the applicable requirements of Class BZ, as referenced in the CDOT SSRBC. (Foundation dimensions shall be determined by the Responsible Party's design engineer and reviewed by the Development Engineering Manager.)

   b. The bottom of concrete foundations shall rest on firm ground. Foundations shall be poured monolithically where practicable. For poles or pedestal, the top four (4) inches shall be poured after the pole or pedestal is in proper position. The exposed portions of the foundation shall be formed to present a neat appearance.

   c. Tops of foundations, except as noted on the plans, shall be finished to curb or sidewalk grade, or as ordered. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in design position and to design height, and shall be held in place by means of a template until the concrete sets.

   d. Both forms and ground, which will be in contact with the concrete shall be thoroughly moistened before placing concrete.

   e. Where obstructions prevent construction of a planned foundation, the Responsible Party shall construct an effective foundation as directed by the Development Engineering Manager.

   f. Mast arm poles shall be installed with the proper rake as recommended by the manufacturers of the poles so as to assure a substantially vertical set when the specified signal and lighting equipment is installed.

   g. Anchor bolts provided by the manufacturer of the pole shall conform to Subsection 715.02 of the CDOT SSRBC, and shall be provided with two (2) washers and two (2) nuts each. 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 shall be permitted only when approved by the Development Engineering Manager.

h. The excavation required for the installation of pole foundations shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping, utilities and other improvements. Excavation shall be performed immediately before the installation of the concrete foundation. The material from the excavation shall be placed in a position that shall not cause damage or obstruction to vehicular and pedestrian traffic, or interfere with surface drainage.

i. Foundation holes that have been excavated, and will not be filled with concrete immediately, shall be covered with a solid surface covering and barricaded until concrete is poured. Foundation holes shall not be drilled more than 24 hours prior to placement of concrete.

702.9 Protective Coatings for Signal Poles with Mast Arms and Pedestal Poles

A. Scope

The specification is designed for the use of Valmont triglycidyl isocyanurate (TGIC) or super durable polyester powder (Valmont part number 250257 for mocha brown or 349235 for beige) or approved equivalent in conjunction with Valmont dark gray high build epoxy powder (Valmont part number 347380) or approved equivalent for the protection and finish of the tapered and non-tapered colored steel poles. Interior surfaces shall be prime painted by dip or spray.

B. General

In order to be acceptable, poles and component parts furnished on this project by a manufacturer, or their authorized representative, shall be in accordance with the terms and requirements as set forth herein. Other comparable coating systems that comply with these specifications may be acceptable, subject to the approval of the Development Engineering Manager. The Responsible Party shall be required to furnish the City with a notarized certificate of compliance from the pole manufacturer that guarantees that the coating system used is in conformance with these Standards and Specifications and is free of defective workmanship.

C. Surface Preparation for Exterior Protective Coating Systems

Exterior surfaces of shaft and arm(s), and component parts, shall be abrasive blasted in accordance with coating manufacturer's recommendations. Rolled-in mill scale, impurities, and non-metallics shall be removed. The lower interior portions of the shaft, from the base plate bottom to the top of the hand hole opening, shall receive the same treatment. Rough and sharp edges shall be rounded off. Weld splatter, flux and slag around the base plate, hand hole, arm connections and other areas of welding shall be removed. Drilling of holes and welding of tenons or hubs shall be done prior to abrasive blasting.

D. Requirement of Interior Protective Primer System

The interior surface of the pole shaft shall be thoroughly cleaned, dried, and free of mill scale, rust, oil, grease, and dirt, or other contaminants before interior primer is applied. Primer shall conform with Federal Specification TTP-645, yellow or red oxide. Minimum dry film thickness shall be two and one-half (2-1/2) mils.

E. Requirement of Exterior Protective Coating System

1. After abrasive blast, exterior steel surfaces shall hot dip galvanized in accordance with ASTM A123. All threaded holes shall be plugged prior to galvanizing. All holes shall be free of excess galvanizing. Galvanized steel surfaces shall be kept indoors and free from moisture and other foreign materials prior to prime painting. Prior to powder coating, poles, mast arms, and luminaire arms shall be brushblast to a uniform dull appearance from of any shine and preheat. Mechanically galvanized parts do not require brushblast.

2. After exterior steel surfaces have been galvanized, an epoxy prime coat consisting of Valmont dark gray high build epoxy powder (part number 347380) or approved equivalent shall be applied. A minimum dry film thickness for the high build epoxy powder of five (5) mils shall be required for the bottom eight (8) feet of the pole. A minimum dry film thickness of three (3) mils shall be required for the remaining surfaces of the pole above eight (8) feet and mast arms and luminaire arms. Metal cure temperature shall be 300 degrees Fahrenheit.

3. The color topcoat shall consist of two (2) coats of Valmont triglycidyl isocyanurate (TGIC) or super durable polyester powder (part number 250257 for mocha brown or 349235 for beige) or approved equal) at a minimum of one and one-half (1.5) mils dry film thickness for a total minimum dry film thickness of three (3) mils. The total exterior coating system shall consist of a minimum of eight (8) milsdry film thickness for the bottom eight (8) feet of the pole and a minimum dry film thickness of six (6) mils for the remaining surfaces of the pole above eight (8) feet and mast arms and luminaire arms.

The coating shall form a satin finish with lasting color, resistant to fumes, splash and spillage of acids and alkalis.

4. The primer and topcoat for exterior application shall be supplied by the same coating manufacturer to ensure a compatible protective coating system resistant to corrosion, abrasion and impact.

5. Color for finish topcoat shall conform to City requirements. Color shall meet Federal Standard 595C Colors (January 2008). Color number 10075, satin finish, “Mocha Brown”, or Color 20227, semi-gloss finish, “Beige”. Beige shall only be used in the area defined in the detail sheet at the end of this section.

F. Application

The prime coat and color topcoat shall be strictly applied according to manufacturer's recommendation. The lower interior portion of the shaft, from the bottom of the base plate to the top of the hand hole opening, shall receive the same application treatment. Surfaces shall be kept free of moisture, oil, grease and other organic matter until coated. Failure to do so will prevent proper adhesion and shall require the abrasive blast procedure to be repeated. Solvent wiping is not satisfactory as contamination may be spread and not be removed. Prior to applying top coat, repair any surface imperfections such as sags or runs by light sanding to obtain a uniform surface. Apply prime paint as necessary to any voids or areas having less than the required thickness. Powder application shall be with electrostatic spray equipment

G. Drying and Curing Time

1. Drying time for the application of each primer coat and color topcoat application shall be per the coating manufacturer’s specifications.

2. Curing time after final color topcoat and prior to packaging, loading and shipment shall be per the coating manufacturer’s specifications to ensure complete dry-through time.

H. Wrapping and Packaging

Upon completion of the coating system, and prior to shipment, poles and arms shall have protective wrapping with two (2) inch minimum overlap applied at contact points with cushioned dunnage during transport. This wrapping shall be cushioned material, be a minimum one-eighth (1/8) of an inch thick and 24 inches wide, be applied at contact points, and extend a minimum of 18 inches on either side of dunnage locations at poles and arms. Minimum thickness of wrap shall be three-eighths (3/8) of an inch at contact points. Component parts shall be individually wrapped with heavy kraft paper and boxed for shipment.

I. Handling and Shipment

Poles shall be handled in a manner that will preserve the overall appearance and prevent damage to the coating. The use of chains or cables for loading, unloading, shipping or installing is prohibited. Only three-fourths (3/4) of an inch diameter or larger nonabrasive nylon rope or equivalent nylon belting may be used. Adequate hold-downs and appropriate blocking shall be utilized for shipping to prevent load movement and damage to the outer coating in transit. No handling shall be allowed until "dry-through" condition has been achieved with the coating.

J. Delivery, Installation, and Acceptance of Poles

Extra care shall be taken to not damage the coating. Upon arrival of the poles at the delivery point, neither chains nor cables shall be used for either unloading or installation of poles.

K. Procedure for Field Touch-Up

The Responsible Party shall utilize a pole manufacturer who will furnish extra primer and color coat paint to satisfy the needs of field touch-up requirements, in the event of minor physical damage to the coating from handling or transit. Damaged area shall be clean and dry before repair application. Field touch-up shall follow the directions of the pole manufacturer or an authorized representative in order to guarantee manufacturer's warranty.

L. Warranty

1. A minimum three (3) year warranty (at no additional cost) shall be provided for the exterior protective coating system.

2. The coating manufacturer shall warrant the coating to not be defectively manufactured and that the coating will prevent cracking, checking, blistering, flaking, peeling, or excessive chalking of the

painted surface or excessive corrosion of the base metal on which the exterior protective coating system is applied for three years from date of application.

3. The warranty shall not apply under conditions such as construction, physical or mechanical abuse, or falling objects and under conditions of normal wear and tear such as welding, civil disturbance, defacing, vandalism, fire, explosion, or catastrophe.

702.10 Conductors and Cables

A. Installation and Identification

1. Conductors shall be permanently identified as to function. Identification shall be placed on each conductor, or each group of conductors comprising a signal phase, in each pull box and near the end of terminated conductors.

2. Identification shall be by bands fastened to the conductors in such a manner that they will not move along the conductors.

3. Cables and conductors not shown on the plans as imbedded loop detector shall be installed in conduit unless installed in poles, pedestals or mast arms.

B. Applicable Codes

1. Grounds and bonding wire, straps, and electrodes shall conform to NEC Article 250.

2. Wiring and splices shall conform to appropriate article of the NEC. Wiring within cabinets, hand holes, etc., shall be neatly arranged and shall be laced within cabinets.

3. Conductors shall be stranded, tinned copper wire, rated at 600 volts and individually insulated with heat stabilized polyethylene. Conductors and cables shall conform to specifications 19-1 of the IMSA.

C. Bonding and Grounding

1. Metallic cable sheaths, conduit, metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. Bonding and grounding jumpers shall be a bare copper wire or copper strap of the same cross sectional area, No. 8 American Wire Gauge (AWG). Sheath for detectors shall be grounded in the control cabinet only. The other end of the sheath shall be taped and left ungrounded.

2. Bonding of poles and pedestals shall be by means of connecting to the ground rod a bonding strap attached to an anchor bolt or a three-sixteenths (3/16) inch or larger brass or bronze bolt installed in the lower portion of the shaft.

3. A ground electrode shall be installed at each control box. Each ground electrode shall be one-piece copper-weld rod of five-eighths (5/8) of an inch diameter and eight (8) feet in length, driven to a depth of at least eight (8) feet below the surface of the ground (top of rod flush with ground or top of cabinet base).

4. The ground terminal of controller shall be connected to the ground rod with a No. 8 AWG bare copper wire with a ground rod clamp approved by the Development Engineering Manager.

D. Wire Splices

Splices in underground systems shall be hermetically sealed. Splices shall be waterproofed. Splices shall be made in the hand holes or cabinet. No splices shall be allowed in pull boxes or conduit unless authorized in writing by the Development Engineering Manager. The splice method shall be approved by the Development Engineering Manager.

E. Installation Method

1. Sufficient signal light conductors shall be provided to perform the functional operation of signal system. 19 conductor cable shall be run to each signal pole. Seven (7) conductor cable shall be run from the handhole of each signal pole to each signal head. A minimum of three (3) spare conductors per through phase shall be provided throughout the signal light circuit. Additional conductors for service, interconnect, etc., shall be provided as noted on the plans.

2. Signal light conductors shall conform to the Red-Yellow-Green color sequencing with different colored tracers for each phase provided.

3. All signal light cable conductors shall have individual terminal lugs for connection to terminal strips in cabinet.

4. When conductors and cables are pulled into the conduit, the ends of these conductors and cables shall be taped to exclude moisture and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped to exclude moisture.

5. Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit.

6. One-eighth (1/8) inch nylon pull rope and tracer wire shall be installed in new conduit and existing conduit where a cable is added or an existing cable is replaced. At least two (2) feet of pull rope shall be doubled back into the conduit at each termination.

7. Five (5) feet of slack shall be left for each conductor at each support pole and two (2) feet of slack at each pull box containing cable connections.

8. At least two (2) feet of slack for both power feed and loop wire is to be provided in each pull box so that testing and splicing can be done outside the pull box.

9. Splicing of cable shall not be permitted in the conduit or outside of pull boxes, standards, or at the hand hole location in pedestals unless authorized by the Development Engineering Manager.

10. Multi-conductor cable shall be spliced and insulated to provide a water-tight joint to prevent absorption of moisture by the cable.

F. Meter

The Responsible Party shall install a meter housing as required for the project. The Responsible Party shall coordinate with the relevant electrical service provider on the source and connection of the power feed, the installation of the meter in the meter housing, and the connection of the power feed to the meter.

703 DETECTION – SIGNAL HEAD – CONTROLLER CABINET

703.1 General

A. Video detection shall be used for vehicle detection unless other methods are approved by the Development Engineering Manager.

B. Traffic signal equipment shall be manufactured in the United States using domestic materials and be designed to operate from a 115 volt 60 cycle single phase source.

C. Traffic signal equipment shall be designed to operate between an ambient temperature of -30° F to +165° F, with relative humidity up to 95%.

D. The video detection system shall consist of one (1) video camera, a video detection processor (VDP), which mounts in a standard detector rack, a detector rack mounted extension module (EM), a detector rack mounted remote communications module (RCM), a pointing device, and a four channel color video monitor mounted inside the controller cabinet. The video camera shall be Iteris Vantage or approved equal. The VDP and EM shall be Iteris Vantage Edge 2 or approved equal. The RCM shall be Iteris Vantage EdgeConnect or approved equal.

E. The software shall detect vehicles in multiple lanes using only the video image. Detection zones shall be defined using only an on-board video menu and a point device to place the zones on a video image. Up to 24 detection zones per camera shall be available. A separate computer shall not be required to program the detection zones. Traffic counting ability shall be part of the system.

703.2 Installation

A. The coaxial cable to be used between the camera and the VDP in the traffic cabinet shall be Belden 8281 or a 75 ohm, precision video cable with 20 gauge solid bare copper conductor (9.9 ohms/M), solid polyethylene insulating dielectric, 98% (min) tinned copper double-braided shield, and black polyethylene outer covering. The signal attenuation shall not exceed 0.78 dB per 100 feet at 10 MHz. Nominal outside diameter is 0.304 inches. The coax cable shall be a continuous unbroken run from the camera to the VDP. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. 75-Ohm BNC plug connectors should be used at both the Camera and Cabinet ends. The coaxial cable, BNC connector, and crimping tool shall be approved by the supplier of the video detection system, and the manufacturer's instructions must be followed to ensure proper connection.

B. The power cabling shall be 16 AWG three (3) conductor SJOW type cable. The cabling shall comply with the NEC, as well as local electrical codes.

C. The video detection system shall be installed and adjusted by supplier factory certified installers and as recommended by the supplier and documented in installation materials provided by the supplier. The preferred location is on the traffic signal mast arm. If mounted on the traffic signal mast arm, the bracket shall be a PELCO #AB-0170-74 (with stainless steel straps, not cables), or approved equal, 74 inches in length. Mounting on the luminaire requires approval of the Development Engineering Manager.

703.3 Loop Detectors

A. General

1. Loop detectors shall be installed in the configuration shown on the plans. Actual layout shall be determined by the Development Engineering Manager. A complete installation consists of a conductor loop or group of loops installed in saw cuts in the roadway, lead-in Beldon cable and a sensor unit with power supply installed in the traffic signal controller cabinet.

2. Low voltage signal circuits shall have no more than one (1) splice in each detector sensing circuit.

3. Cable sheath for detectors shall be grounded in control cabinet only; the other end of the sheath shall be taped and ungrounded.

4. Loops shall be made using duct-type wire, 14THHN copper stranded inside a one-half (1/2) inch O.D. Polyethylene jacket or a one-half (1/2) inch O.D. PVC jacket.

5. Loop Detector amplifiers shall be two (2) channel plug-in type, which incorporates digital output timing functions. Amplifiers shall have both pulse and presence for each channel to be set by thumb wheel switching only. Amplifiers shall have sequential scanning for elimination of cross talk.

B. Installation Method

1. The saw cut shall be made one-half (1/2) inch wide and minimum of three (3) inches deep. The slot shall be straight and shall not vary more than one-half (1/2) inch when checked with a 10 foot straightedge.

2. Saw cuts shall be blown free of standing water and debris with compressed air. The cut shall be dry prior to placement of wire.

3. After saw cut is cleaned of debris, the wire shall be placed in the loop by pushing it into the slot with a blunt non-metallic object. A screwdriver or other sharp tool shall not be used. Care shall be used to avoid abrading or damaging the insulation.

4. One (1) continuous length of wire shall be used for each loop from the pull box around the loop with the specified number of turns and back to the pull box. There shall be three (3) twists per foot in the loop wire when pulling the wire through the conduit into the pull box.

5. After the loops are properly seated, they shall be tested for continuity and proper loop inductance. The loop slots shall then be sealed with a high grade sealant. Sealant shall be a one part formula only (3M Sealant or approved equivalent) made specifically for sealing traffic signal loops. This sealant shall remain permanently flexible and be non-shrinking to assure maximum protection after installation.

6. The loop detector wires shall be spliced to the shielded lead-in cable in the pull box and pulled into the controller cabinet via the shortest possible distance using existing conduit. A minimum of three (3) feet of slack shall be provided in the controller cabinet for attachment to the detector amplifier. Each detector cable shall be clearly labeled in the cabinet identifying phase relationship and approach leg.

7. A minimum one and one-half (1-1/2) inch conduit shall be placed under the curb and into a pull box to accommodate detector loop wires. Conduit shall have a drain "T and Weep Hole" at the lowest point of the run under the curb to facilitate drainage. Conduit may be "pushed" or trench-laid depending on conditions at project site, and upon approval from the Development Engineering Manager. Special traffic type loop pull boxes in the roadway shall be installed at the locations shown on the traffic signal plans.

C. Detector Lead-In

1. Detector lead-in cable shall consist of two (2) No. 14 AWG copper conductors with each conductor insulated with high molecular weight, heat stabilized, colored polyethylene. The conductors shall be a twisted pair (Beldon 8720) and shall be protected with a shield of tinned copper-brass or aluminum-polyester. A No. 16 AWG minimum, stranded tinned copper ground wire shall be provided. The cable shall be provided with a chrome vinyl outer jacket with a minimum thickness of 37 mils, suitable for use in conduit or for direct burial when used in conjunction with magnetic or magnetometer detectors.

2. Sampling station detection shall be through separate lead-ins for each lane of detection. Sampling stations shall not consist of loops tied together and run into the controller on a single lead-in pair.

D. Alternative Round Loop Detector Configuration

1. As an alternative to the six (6) foot by 40 foot rectangular shaped loop detectors, three (3)-six (6) foot round loop detector configurations may be proposed by the Responsible Party.

2. A plan of the alternative loop detector configurations and pull box locations shall be prepared by the Responsible Party for approval by the Development Engineering Manager prior to installation. If proposed, the six (6) foot round traffic loop detector cable shall conform to the following specifications:

3. The Responsible Party shall core drill a round traffic signal loop to be six (6) feet in diameter by one-half (1/2) inch width by three (3) inches in depth. A saw cut shall be provided to the appropriate pull box within 50 feet. The saw cut shall be one-fourth (1/4) inch in width by three and one-half (3.5) inches in depth.

4. Cuts shall be washed clean. Water and slurry shall be vacuumed out leaving a clean and dry loop area.

5. A preformed loop wire made of Detecta-Duct Traffic Signal loop wire or approved equivalent shall be stacked in the cuts and secured from footing. Cuts shall be sealed with a high grade sealant. Sealant shall be one part formula only made specifically for sealing traffic signal loops.

6. A preformed loop shall consist of three (3) - six (6) foot diameter turns of loop wire, laid one loop on top of the other and glued so each loop remains in place. The tails in the loop that run to the pull box shall be approximately 50 feet.

703.4 Push Button Stations

A. Pedestrian push buttons shall be of the direct push button contact type. The push buttons shall operate on a voltage not to exceed 18V AC. The assembly shall be of tamper-proof design and equipped with a push button instruction sign. Button frames shall be painted black and ADA approved. Push buttons shall be Polara Bulldog part number BDLM2 or approved equal.

B. The assembly shall be weatherproof and constructed so it shall be impossible to receive any electrical shock under any weather conditions.

C. The pedestrian push button instruction sign shall include informational text as shown in the Detail 700-24

D. Sign dimensions shall conform to mounting frames as shown in the Detail 700-24.

703.5 Signal Heads

A. 12 inch signal heads shall be polycarbonate and shall come complete with mounting opening plugs, washers, and gaskets for mounting. Heads shall be highway signal black in color (both faces and housings). Visors shall be polycarbonate and shall be highway black for outside and flat black inside. LED arrows shall not be the outline type.

B. General Standards

The signal housing and LED faces shall conform to the Institute of Transportation Engineers most recent standards. LED on-board circuitry must meet FCC Title 47, CFR Subparts B, Section 15.107, 109 regulations concerning emission of electronic noise. Certificate of Compliance with ITE standards shall be provided upon delivery of material.

C. Physical

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.

D. LED Signal Lens Module

The lens may be uniformly tinted to enhance ON/OFF contrasts in a manner not to affect luminous intensity or chromaticity. The lens shall be easily replaceable in the field without the need of any special tools or any adhesives in the event of vandalism or vehicle impact. The lens shall be keyed to the housing to assure proper orientation. The lens material shall be Ultraviolet (UV) stabilized polycarbonate to withstand direct sunlight exposure for a minimum of five (5) years without exhibiting evidence of deterioration.

E. Lamp Construction

1. The LED signal shall be a self-contained device not requiring on-site assembly and be capable of withstanding mechanical shock and vibration.

2. Signal faces installed prior to final activation of the system shall be covered with orange bags to clearly indicate that the signal is not operational. 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.

3. Polycarbonate type vehicular or pedestrian signal heads shall be colored Federal Highway (black) for standard installation.

4. Signal hardware to be furnished shall be of standard design and manufacture. No special fittings and/or components shall be used or furnished which are not shelf type items by the manufacturer and/or vendor.

5. Vehicle signal faces and pedestrian signal faces shall be of the adjustable, vertical type as shown on the plans. They shall provide light indication in one direction only and shall be adjustable through 360° about a vertical axis.

6. Unless otherwise shown on the approved plans, traffic signal faces shall be 12-inch LED and shall contain three (3) sections arranged vertically; red--top; yellow--center; green--bottom.

7. All Vehicle signal faces shall be focused to allow maximum visibility to approaching motorists. Signal heads installed at any one intersection shall be of the same make and type, unless otherwise approved by the Development Engineering Manager.

703.6 Pedestrian Signal Heads

Pedestrian signal heads shall be polycarbonate or 18 inch clamshell mounting type, (Portland Orange and Lunar White). Units shall be highway black in color. Units shall come complete with a combination cut out and/or honeycombed visor, to prevent sun washout. Units are to be LED, with a Handman and Countdown display.

703.7 Mounting Hardware

A. Mast Arm Mounts

Signal head placement as shown on the plans are representative only. Mast arm signal head mounts shall be of an Sky Bracket mount or approved equal. Each head shall be mounted with a separate mount. Horizontal clustering of two (2) arrowed heads next to a three (3) section standard head shall be permitted on one Sky Bracket type signal mast arm mount or approved equal.

B. Side of Pole and Top of Pole Mounts

One-way side and top mounts shall be either bronze or malleable iron 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 bronze or malleable iron, 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.

703.8 Backplates

A. Backplates shall be furnished and installed on vehicular signal heads. No background light shall show between the backplates and the signal face or between sections of the signal head.

B. Backplates shall be either one piece or sectional. Sectional backplates shall be riveted together. No screws shall be allowed for putting backplates together.

C. Backplates shall be five (5) inches in width unless otherwise approved by the Development Engineering Manager.

D. Backplates shall be louvered to allow air flow and yet not permit background light to be visible to the motorist.

E. Backplates shall be aluminum painted flat black.

F. Backplates shall be attached to the signal head using the appropriate screws and one-fourth (¼) inch zinc plated flat washers.

703.9 Emergency Vehicle Pre-empt Detection

Opticom No. 722 (Detector) (Global Traffic Technologies) units or approved equal shall be used for detection purposes, consisting of a single channel bi-directional assembly.

703.10 Controller Specifications

170E Controller Model HC-11 system module with a minimum of 64K EPROM and 32K ZRAM. Controller shall operate the Wapiti (W4IKS Rev. 18p) software program. Controller shall have four ACIA ports.

703.11 Cabinet Specifications

A. General

1. A 333SD-ITS Cabinet with uninterrupted power supply shall be used at intersections and other locations as determined by the Development Engineering Manager.

2. Cabinets shall have the following items included in addition to the items specified for each cabinet.

3. The cabinet shall be natural aluminum with no anti-graffiti coating and no powder coated finish.

4. A means of selecting the active red monitor channel shall be provided on the rear of the monitor panel. Selection shall be accomplished by means of a two (2) position jumper (shunt) with the center position wired to a red monitor input and select of 115V AC to the right and red load switch output to the left. Moving the jumper to the right will provide continuous red input and override, while moving a jumper to the left will attach the monitor channel to the corresponding load switch output.

5. This jumper assembly shall be accessible while the intersection is in operation. Means shall be provided to prevent shock to personnel operating jumper selection devices.

6. Red monitoring disable control shall be provided within the red monitor cable assembly. Pin six on TB02 shall connect to a 24V DC relay coil. This relay is designated RM control relay. The normally closed contacts shall provide 115V AC to the red monitor select line and pin 17 on the monitor cable. When a logic ground is applied to TB02-6 the RM relay shall energize and open the cable. The relay power will be derived from the cabinet 24V DC cabinet power supply.

7. Electrical characteristics of the device that will be used for series transient protection on the 332 and 336S cabinet system shall include tests run using a Velonex 587 surge generator and Tektronix oscilloscope type 2430 or equivalent hardware. Using ANSI/IEEE 062 41-1980 waveforms for normal mode and common mode ring wave and impulse tests.

8. Each unit shall comply with the following:

a. Clamping level 400V peak normal mode and 500V peak common mode. Trace photos and other test related information will be available upon request.

b. EMI/EFI noise rejection derived via standardized 50 ohm insertion loss tests shall have amplitude of at least –20db over a minimum spectrum from 50 KHZ with a –40db being the most desirable.

c. Diagnostics indicators shall clearly display the status of the suppression circuit. The indication shall warn of the loss of protection.

d. Transient energy suppression shall be in excess of 250 Joules.

e. Rated voltage is 120V AC with rated output current minimum 10 amperes single phase operation.

9. All of the above components provided on the project, excluding the signal monitor unit, shall be on the Colorado and California Qualified Products listing.

10. The cabinet drawings shall be non-fading prints using xerography method. No blue line drawings shall be acceptable.

11. The Responsible Party, shall provide the Development Engineering Manager, a computer printout of the complete environmental testing results.

12. Serial connections shall use a standard RJ – type quick lock connection.

13. The power distribution assembly shall have over current indicators added to the four (4) gang 15 ampere signal circuit breaker. When the current in the monitored circuit exceeds 13 amperes for 160 milliseconds or greater, the circuit shall be latched open, the indicator shall be on, and can only be reset by a mechanical reset button.

14. One (1) Set of anchor bolts.

B. The cabinet shall include the following:

QUANTITY	ITEM
	Internal Fans – 2 for the 333SD-ITS, 1 for the 336S and 303 Cabinets
	Internal (front/back) fluorescent lamps - 4 for the 333SD-ITS, 2 for the 336S, 1 for the 303 Cabinets
4	Model 430” Transfer Relays
2	Model 204 2-Circuit Flasher (cube type, 25 AMP output)
12 maximum	Model 200 Load Switches w/Input & Output LEDs (cube type, 25 AMP)
3 maximum	Model 242 DC Isolators
*	Model 222 Loop Amplifiers or Video Detection Cards
1	Model 210E Monitor with absence of red monitoring
	New York 330 Pull-out Drawer Assembly – 2 for the 333SD-ITS, 1 for the 336S, and 0 for the 303 Cabinets
1	Transient Voltage Surge Suppression System
2	Split Input files – 333SD-ITS Cabinets only
1	External Whelen 2015 Yellow Beacon (not on 336S or 303 cabinet)
1	Output File (not in the 303 Cabinet) with terminal strips (not Phoenix connectors)
8	Flash Program Blocks – 6 in the 303 Cabinet
2	Model 762 Opticom discriminators or approved equal

* As required per plans.

1. 333SD-ITS Cabinet shall consist of the following in addition to Section 703.11A:

a. The controller cabinet shall be a four (4) door Model 333SD-ITS as specified. The 333SD-ITS cabinet shall include a base extension assembly. The input file shall meet the requirements of the split input file. Unless otherwise specified in the contract, the cabinet shall include the following:

i. Cabinet dimensions: 54” X 43” X 26” D

ii. All four doors shall have Corbin #2 locks installed.

iii. A minimum of 12 selections are required; eight (8) phase selections and four (4) overlap selections shall be provided with jumper selections.

iv. Split input file shall be an SF 170 that will also operate in the 332/336S cabinets.

v. The Split Input File shall use a split 22 pin connector (2 rows of 22 pins) which provide for 44 unique contacts, rather than the 22 double contacts as provided by the former input file. This design shall interface electrically with the older 2 and 4 channel devices available under the 170 and NEMA TSI specification as well as the newer 2 and 4 channel devices as specified in the TS2 NEMA specification.

vi. The input file shall be divided into two (2) partitions. The first partition shall include the first eight (8) slots from the left; the second partition shall include the next six (6) slots. All 14 slots shall be able to be tied to one common communication drop if desired.

vii. The serial/ITL Transmit and receive pairs shall be wired across the back panel. TXO, DXO, Ground0 serve the first eight (8) slots. TX1, DX1, and Ground1 serve the next six (6) slots. Back plane addressing is automatically assigned in the rear of the input file, such that:

(1) Slot 1 = Address 0
(2) Slot 2 = Address 1 . . . . . Slot 8 = Address 7 (all three (3) line low)
(3) Addressing from the front of any input device shall override the back plane addressing.

b. The left side of the 333SD-ITS cabinet assembly shall have shelves assembled to the EIA rack assembly to house additional equipment such as, but not limited to, Video Detection, Standby Uninterrupted Power supply, and communication equipment.

c. Surge suppression for the field wiring shall be installed on the back of the output file.

d. The contractor shall install a beacon on the cabinet to provide visual alert should an uninterrupted power supply become active. The beacon shall be a twenty-four (24) 24 volt Whelen 2015HP yellow beacon, or approved equal, and shall be located in the top center of the cabinet. The beacon shall be wired to the cabinet and the uninterrupted power supply using eighteen (18) gauge wire. An outdoor silicone caulk bead shall be applied between the beacon and the cabinet to prevent water intrusion

C. A 336S Cabinet Assembly shall not be permitted. Contact the Development Engineering Manager for 336S Cabinet specifications.

D. 303/8 Traffic Signal Control Cabinet shall not be permitted. Contact the Development Engineering Manager for 303/8 Traffic Signal Control Cabinet specifications.

703.12 Communication Interface

A. General

1. Communication interface will consist of fiber or radio or a combination of each. This work shall consist of furnishing, installing, and testing all required fiber optic cable and radio equipment. Fiber optic cable shall include backbone cable, lateral cable, and patch cords running from the environmental distribution type enclosure to the optical data link, and are explained in detail in these Standards and Specifications. The cable shall be an accepted product of the United States Department of Agriculture Rural Electrification Administration (REA) as meeting the requirements of 7CFR1755.900. The cable shall be new, unused, and of current design and manufacture. The Responsible Party shall provide the Development Engineering Manager with two (2) copies of the cable manufacturer's installation instructions. Backbone 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 pull lengths shall not be exceeded. Cable ends shall be spliced and/or stored in pull boxes as indicated in the plans or as directed. Only fibers indicated in the plans need to be spliced or terminated in controller cabinets or pull boxes. All other fibers shall be sealed in a manner recommended by the manufacturer.

2. No cutting or splicing of the interconnect cable will be allowed unless shown in the plans or otherwise authorized by the Development Engineering Manager.

B. Radio

1. Radio communication shall be accomplished using an ENCOM 5200 Radio or approved equal. The Responsible Party shall supply and install all required antennae, harnesses, connectors, and lightning suppression. Antennae wiring shall be LMR-400 DB low loss flexible coaxial communications cable or approved equal, unless otherwise specified in the plans or by the Development Engineering Manager. Antennae of the directional type shall be pointed as shown on the plans or directed by the Development Engineering Manager. At radio/fiber or fiber/radio master locations the Responsible Party shall supply and install a Traffic Fiber Systems FO-512 interface unit and a Traffic Fiber Systems FO-400 fiber modem or approved equals with appropriate connectors and harnesses.

2. The Responsible Party is responsible for supplying and installing a working system that is compatible with the Thornton Traffic Signal System.

C. Fiber

1. Fiber shall be the number of strands indicated on the plans.

2. Backbone cable shall consist of loose tube non-armored outdoor cable containing the required number of 12-fiber single mode ("SM") tubes. Backbone cable for installation in conduit shall meet the applicable portions of IMSA Specification 60-2 or approved equal. Lateral fiber optic cable shall be dielectric, loose tube, non-armored outdoor cable (UV resistant and flame retardant outer jacket) suitable for duct installation complying with the following specification for fiber optic cable, Siecor FREEDM/LST cable or approved equal. In addition the cable shall meet the applicable portions of IMSA specification 60-2 or approved equal. Lateral cable shall consist of six (6) single mode fibers or as indicated on the plans. Odd length cables and reel ends are acceptable for lateral cables provided they are of sufficient length to connect backbone and controller cabinet in continuous runs. Hereinafter single mode fiber may be abbreviated as "SM".

3. Fiber Characteristics

   All fibers in the cable must be usable fibers and meet these Standards and Specifications. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.

   a. The SM fiber utilized in the cable specified herein shall conform to the following specifications:

      i. Typical Core Diameter 8.3 micrometer.

      ii. Cladding Diameter 125 +/- 1.0 micrometer.

      iii. Core to Cladding Offset $\leq$ 0.6 micrometer.

      iv. Cladding Non-Circularity $\leq$ 1.0%. (Defined as [1 - (min. Cladding dia. + max. Cladding dia.)] x 100.

      v. Coating Diameter 245 +/- 10 micrometer.

      vi. Colored Fiber Diameter nominal 250 micrometer.

      vii. Attenuation Uniformity – No point discontinuity > 0.10 dB at either 1310nm or 1550 nm.

      viii. Attenuation at the Water Peak – The attenuation at 1383 +/- 3nm shall not exceed 2.1 dB/km.

      ix. Cutoff Wavelength – The cabled fiber cutoff wavelength shall be $\leq$ 1250 nm.

      x. Mode-Field Diameter (Petermann II): 9.30 +/- 0.50 micrometer at 1310nm; 10.50 +/- 1.00 micrometer at 1550nm.

      xi. Zero Dispersion Wavelength $\leq$ 1321.5nm and $\geq$ 1301.5nm.

      xii. Zero Dispersion Slope (S_o): $\leq$ 0.092 ps/(nm^2/km).

   b. The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer. Coating shall be mechanically strippable without damaging fiber.

4. Fiber Specification Parameters

   All fibers in the cable shall meet the requirements of this specification.

   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," the average change in attenuation at extreme operational temperatures (-40°C to +70°C) shall not exceed 0.05 dB/km at 1550 nm. The magnitude of 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 shall be $\leq$ 3.3 ps/(nm km) for 1285 nm through 1330 nm and $\leq$ 18 ps/(nm km) at 1550 nm.

5. Specifications for Outdoor Cables

a. Optical fibers shall be placed inside a loose buffer tube. The fibers shall not adhere to the inside of the buffer tube.

b. Each fiber shall be distinguishable from the others with distinct and recognizable colors in accordance with EIA/TIA-598, Optical Fiber Cable Color Coding, latest revision.

c. Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with EIA/TIA-598, Optical Fiber Cable Color Coding, latest revision.

d. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or the gel filling material. Colors shall not cause fibers to stick together.

e. Buffer tubes shall be of a dual-layer construction with the inner layer made of polycarbonate and the outer layer made of polyester.

f. Fillers may be included in the cable core to lend symmetry to the cable cross-section.

g. 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.

h. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogeneous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "SZ" stranding process.

i. The cable core interstices shall be filled with a water-blocking compound. The compound shall be a thixotropic gel containing a Super Absorbent Polymer (SAP) material. The gel shall be non-nutritive to fungus, electrically non-conductive and homogeneous. The gel shall be free from dirt and foreign matter and shall be readily removable using nontoxic solvents.

j. Binders shall be applied with sufficient tension to secure buffer tubes to central member without crushing the buffer tubes. Binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound) and dielectric with low shrinkage.

k. Cable shall contain at least one ripcord under the sheath for easy sheath removal.

l. Tensile strength shall be provided by high tensile strength aramid yarns and/or fiberglass yarns. The high tensile strength aramid and/or fiberglass yarns shall be helically stranded evenly around the cable core.

m. 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.

n. The jacket or sheath shall be free of holes, splits and blisters. The cable jacket shall contain no metal elements and shall be of a consistent thickness. Cable jackets shall be marked with sequential meter or foot markings, year of manufacture, and a telecommunications handset symbol, as required by Section 350G of the National Electric Safety Code. The actual length of the cable shall be within zero (0) to one (1)% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be approximately two and one half (2.5) mm.

o. The maximum pulling tension shall be 2,700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

p. Shipping, storage, and operating temperature range of the cable shall be -40° C to +70° C. The installation temperature range of the cable shall be the same as the shipping, storage, and operating temperature.

6. General Cable Performance Specifications

The un-aged cable shall withstand water penetration when tested with a one (1) meter static head or equivalent continuous pressure applied at one end of a one (1) meter length of filled cable for 24 hours. No water shall leak through the open cable end. When a one (1) meter static head or equivalent continuous pressure is applied at one end of a one (1) meter length of aged cable for one

(1) 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".

a. 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 80^{o} C. If material flow is detected, the weight of any compound that drips from the sample shall be less than 0.05 g.

b. The cable shall withstand a minimum compressive load of 220 N/cm 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.

c. 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 attenuation greater than 0.1 dB at 1500 nm (single mode). The average increase in attenuation for the fibers shall be $\leq$ 0.20 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 plus/minus 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. The repeatability of the measurement system is typically 0.05 dB or less. The cable jacket shall not exhibit evidence of 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," cable shall withstand 25 impact cycles. Magnitude of the attenuation change shall be within repeatability of measurement system for 90% of test fibers. The remaining 10% of the fibers shall not experience attenuation change greater than 0.1 dB at 1550 nm. The repeatability of measurement system is typically 0.05 dB or less. 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 a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N applied for one (1) hour (using Test Condition II of the procedure). In addition, cable sample, while subjected to a minimum load of 2660 N, shall be able to withstand twist of 360° in a length of less than 3 m. Magnitude of attenuation change shall be within repeatability of the measurement system for 90% of the test fibers. Remaining 10% of the fibers shall not experience an attenuation change > than 0.1 dB at 1550nm. Repeatability of the measurement system is typically 0.05 dB or less. The cable shall not experience a measurable increase in attenuation when subjected to the rated residual tensile load of 890 N.

g. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2m will withstand 10 cycles of mechanical twisting. Magnitude of attenuation change will be within the limit of repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers will not experience an attenuation change > 0.1 dB at 1550 nm. The repeatability of the measurement system is typically 0.05 dB or less. The cable jacket will exhibit no cracking or splitting when observed under 5x magnification following completion of the test.

h. When tested in accordance with the proposed FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse $\geq$ 105 kA. The test current used shall be damped oscillatory with a maximum time-to-peak value of 15 microseconds (which corresponds to a minimum frequency of 16.7 kHz). The time to half-value of the waveform envelope ($t_{1/2}$) shall be 40-70 microseconds. In addition to the analysis criterion set forth on 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.

7. Quality Assurance Provisions

All optical fibers shall be proof tested by the fiber manufacture at a minimum load of 100 kpsi. All optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.

8. Packaging

   The completed cable shall be packaged for shipment on non-returnable wooden reels. Top and bottom ends of the cable shall be available for testing. Both ends of the cable shall be sealed to prevent the ingress of moisture. Each reel shall have a weatherproof reel tag attached identifying the reel and cable. Each cable shall be accompanied by a cable data sheet that contains significant information on the cable.

9. Miscellaneous

   The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

   a. The Responsible Party shall terminate all fibers on the patch panel provided by the Responsible Party in the controller cabinets indicated on the plans.

   b. The Responsible Party shall terminate backbone fibers on the contractor-provided patch panel as shown on the plans. Number of bulkheads on individual patch panels shall be as shown in the plans or as otherwise specified herein.

   c. Cable shall be installed using appropriate strain relief in the cabinet (through cable ties) at a minimum of three (3) locations.

   d. Prior to installation, the Responsible Party shall submit a schematic interconnect diagram to the Development Engineering Manager 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 Development Engineering Manager.

   e. The same color coded pairs of fibers and/or wires shall be used throughout the entire project.

   f. At the terminal points the jackets shall be stripped and the ends taped. Gel filling compound shall be removed using filled cable cleaner.

   g. Cable shall be installed in new conduit or existing conduit as depicted in the plans. The Responsible Party shall be required to leave a minimum of 50 feet coiled and laced slack lateral cable in each traffic signal controller cabinet; 50 feet coiled and laced slack cable in pull boxes where the lateral cable is spliced; 50 feet coiled and laced slack backbone cable in pull boxes where the backbone is broken out; and 50 feet coiled and laced slack backbone cable at all other pull box locations called out in the plans. The fiber optic cable shall be neatly coiled and clearly tagged and labeled at such pull boxes and at all other locations where it is exposed.

   h. For all fiber optic cables, each fiber shall be checked with an OTDR and full traces documenting fiber performance shall be provided to the Development Engineering Manager within 30 days of test. 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 shall be supplied to the Development Engineering Manager prior to completion of the project.

   i. Cable shall be transported to the site using cable reel trailers. Care shall be taken at all times to avoid scraping, denting, or otherwise damaging the cable before, during, and after installation.

   j. Sufficient slack shall be pulled to allow cable cutting and connection to communications equipment.

   k. Cable shall be installed in conduit or duct in accordance with the contract drawings. Conduit and duct ends shall have all rough edges smoothed to prevent scraping the cable. A stiff bristle brush shall be pulled through each section of conduit before pulling cable. A manufacturer recommended lubricant shall be applied to the cable to reduce friction between the cable and duct or conduit. Where fiber optic cables are to be installed in inner duct, the Responsible Party shall secure each section of inner duct to prevent it from being pulled with the cables.

   l. A cable grip shall be attached to the cables so that no direct force is applied to the optical fiber. The cable grip shall have a ball-bearing swivel to prevent the cable from twisting during pulling. Cable rollers and feeders and winch cable blocks shall be used to guide the cable freely into the duct and at maintenance hole locations. The Responsible Party shall ensure that the tensile load on the cable does not exceed the manufacturer's recommended maximum. Mechanical aids and pulling cables or ropes shall be used as required.

m. Personnel equipped with two (2) way radios shall be stationed at each maintenance hole, cabinet, pedestal, communications box, and junction box through which the cable is to be pulled to observe and lubricate the cable.

n. Where mechanical pulling is required (i.e. all runs greater than 150 feet), a dynamometer shall be used to record installation tension and a tension limiting device shall be used to prevent exceeding the maximum pulling tension as defined by the cable manufacturer. The maximum pulling tension shall be recorded for each run of cable. The cable shall be taken up at intermediate pulling points with an intermediate cable take-up device as approved by the Development Engineering Manager to prevent over-tension on the cable. Cable pulls shall be continuous and steady between pull points and shall not be interrupted until the entire run of cable has been pulled.

o. The Responsible Party shall be responsible for ensuring the cable length is sufficient to allow for connection between the communications equipment and the splice enclosures (if applicable) including provision for slack, vertical runs, cable necessary for splicing, wastage and cable to allow for the removal of the splice enclosure for future splicing.

p. Where backbone or lateral cable runs are left to be "dead ended," a minimum of 100 feet of cable shall be left coiled in the final cabinet, manhole, or pull box, unless otherwise called for in the plans.

10. Splices and Splice Closures

Splices are not allowed without the written authorization of the Development Engineering Manager. If splices are authorized, each such splice shall occur in a new pull box to be installed by the Responsible Party or an existing manhole or pull box already installed along the route. All splices shall be enclosed within a splice closure, Siecor Catalog SCN-CAN or approved equal.

a. Following successful splicing, said splice closure shall be placed inside the described pull box or manhole. The Responsible Party shall accomplish the work using splicing tools and hardware recommended by the cable manufacturer. The average splice loss shall not exceed 0.2 dB for any given span.

11. Testing

Cable reels shall be tested for attenuation prior to installation. The Responsible Party shall measure attenuation of at least 10% of the total fibers randomly selected on each reel. Where the 10% quantity equates to more than one fiber, the fibers tested shall be located in different buffer tubes. Attenuation shall meet or exceed the specified performance requirements. If cable is furnished by the Responsible Party, the Responsible Party shall ensure that specifications for fiber optic cable have been met prior to installation.

12. Buffer Tube Fan-Out

The Responsible Party shall terminate the loose-tube lateral cable at the controller using a buffer tube fan-out kit, Siecor Catalog FAN-BT or approved equal. Fanned-out cables shall be terminated at the controller telemetry panel or in the termination enclosure furnished by the Responsible Party. The fan-out kit shall be placed inside the cabinet rack-mounted termination enclosure. The number of fibers to be landed and terminated shall be as shown in the plans.

13. Termination Enclosure

The Responsible Party shall furnish and install a cabinet rack-mounted termination enclosure for storage of the fan-out kit and broken-out fibers. This enclosure shall be sized as called out in the plans. Optional guard and dust proofing components shall be included. The Responsible Party shall furnish and install all connectors, adaptors, jumpers, and/or pigtails required to establish the final connection to the controller. The Responsible Party shall furnish and install a rack-mounted termination enclosure for storage of the fan-out kit and broken out fibers at the IMC or other City facility as indicated in the plans. This enclosure shall be sized as called out in the plans.

14. Fiber Optic Patch Cord (Pigtail) Cables

Fiber optic patch cord cables shall consist of SM fibers housed individually in protective jackets. Both ends of the cable shall be connected. Fiber optic patch cord cable shall be suitable for operation over a temperature range of -30° C to +60° C.

a. Fiber optic patch cords shall be fiber optic jumper cable, duplex, ceramic ferrule, yellow-jacketed (for SM) 8.3/125nm or orange-jacketed (for multimode) 62.5/125nm, adaptable to ST style connectors.

b. Fiber optic patch cord cables shall be a minimum of six (6) feet in length suitably long enough to be connected between the interconnect panel and the communications equipment (i.e. the fiber optic transceivers). Patch cord couplings shall be compatible with termination points.

c. Appropriate strain relief in the cabinet (through cable ties) shall be installed at a minimum of three (3) locations. Sufficient slack shall be left to allow relocation of the equipment anywhere within the existing cabinet. The attenuation of a fiber optic patch cord cable after installation, not including the connector loss, shall not exceed 0.1dB measured at 1310nm and 1550nm.

15. Connectors

The connector shall have a ceramic ferrule with a nickel-plated nut and body. The connector shall be an ST style compatible field mounted connector. The connector shall be compatible with a physical contact finish.

a. All connectors shall be polished to a physical contact finish such that the return loss per mate pair of connectors is less than -25dB.

b. The return loss when the connector is mated with previously installed connectors shall be less than -18dB. The connector insertion loss shall not be greater than 0.20dB (typical). The connector loss shall not vary more than 0.20dB after 1000 repeated matings. The tensile strength shall withstand an axial load of 20lb with less than 0.20dB change.

c. Index matching fluids or gels shall not be used. The connectors shall be compatible with the optical fiber surrounding jacket and shall be installed on one end of the optical fiber in accordance with the manufacturer's recommended materials, equipment, and practices. The connector shall be suitable for the intended environment and shall meet the following environmental conditions:

Operating Temperature: -40° C to +80° C
Storage Temperature: -40° C to +85° C

d. The connector loss shall not vary more than 0.20 dB over the operating temperature range. Connectors shall be protected by a suitably installed waterproof protection cap.

D. Conductor Cable

1. Five (5) feet of slack shall be left for each conductor at each support pole and two (2) feet of slack at each pull box containing cable connections.

2. See Section 702.11 – Conductors and Cables for additional conductor specifications.

E. Fiber Optic Modems

1. Fiber optic modems shall be a Traffic Fiber Systems FO-400, or approved equal. The modem shall be capable of meeting the following requirements:

a. The modem shall be compatible with, and installed in, the Model 170E controller. It shall be capable of operating in full duplex mode, using asynchronous RS-232 data link protocols up to a 19.2k baud rate. RS-232 signals shall be converted to light and transmitted from modem to modem until the light is reconverted to RS-232 electrical signals directed to a particular controller. Modems shall operate in a daisy-chained communications mode.

b. Modem shall be a printed circuit board assembly fitting in the 400 modem slot of the controller. On the assembly there shall be an edge connector which shall mate with the internal connector on the controller mother board. On this assembly, there shall be two (2) pairs of optical emitters and detectors labeled pair "1" and pair "2", designed to attach to standard ST connectors. There shall be two (1) LEDs provided, one labeled "T" for transmit and one labeled "R" for receive. These LEDs shall illuminate when the fiber optic modem is either receiving or transmitting at the local site. There shall be a slide switch labeled "M" for master operation and "L" for local operation. In the master position, electrical data signals entering the fiber optic modem via the edge connector shall be transmitted as optical signals in a parallel mode from each of the two emitters. Optical signals received by the two detectors shall be converted to electrical signals and sent in parallel to the controller via the edge connector. In the local mode of operation, optical signals received by detector 1 shall be converted to electrical signals and sent to the 170E controller via the edge connector. These same signals shall be regenerated and transmitted by emitter 2 to the next adjacent fiber optic modem downstream. Optical signals received by detector 2 shall be regenerated and transmitted to emitter 1 to the next adjacent

fiber optic modem upstream. Electrical signals received by emitter 1 from the controller shall be transmitted to the next adjacent fiber optic modem upstream.

c. The fiber optic modem shall derive +12VDC for its operating power from the controller connector pins “C” and “D.” Logic ground shall be on pins “A” and “B,” DATA IN on pin “M” and DATA OUT on pin “P.” To enable the ACIA, Request to Send pin “N” shall be jumpered to +12VDC pin “D”.

d. An RJ11/4 jack J1 shall be available on the assembly. J1, in conjunction with slide switch S2, shall be used to interface an external data link, allowing fiber optic communications in 4 directions at either a master or local controller.

2. One (1) modem is required at the intersection locations specified in the plans, to be installed in accordance with the manufacturer’s recommendations.

F. Fiber-to-Radio Modems

1. Fiber-to-radio modems shall be a Traffic Fiber Systems FO-512,, or approved equal. The modem shall be capable of meeting the following requirements:

a. The modem shall act as a stand alone interface for connecting fiber optic cables to RS232 ports and shall be capable of operating in full duplex, multi-drop/point-to-point, dual mode (master/local switch selectable) communications.

b. The modems printed circuit board shall be housed in a two (2) piece aluminum case. The front of the unit shall have 6 LED’s labeled R1 (Receive 1), T1 (Transmit 1), P (Power-On), A (Anti-Stream), T2 (Transmit 2), and R2 (Receive 2). Two (2) pairs of optical emitters and detectors shall also be on the front and labeled E1 and E2 (Emitters) and D1 and D2 (Detectors). The emitters and detectors shall be designed to attach to standard ST connectors. The back of the unit shall have a connector (JI-primary port) for an interface cable, a RJII (J2-secondary port), a power receptacle, and a local/master switch (S1).

c. The modem shall derive +12VDC for operating power from the power receptacle (J3), interface (J1), or the internal battery.

2. One (1) modem is required at the intersection locations specified in the signal plans, to be installed in accordance with the manufacturer’s recommendations.

G. Internal Ethernet Communications Modules

Internal Ethernet Communications Modules shall be used to enable the 170 controller to communicate over an Ethernet system. The modules shall be designed to plug into the modem slot of the 170 controller. Communication to the controller is through the RS232 serial port lines while the RJ-45 connector shall support the Ethernet interface. The modules shall meet the following specifications:

1. 170 Controller Interface:

Mode	Asynchronous RS232, modem slot compatible
Data Rates	1200 to 38.4 kbps
Characters	7 or 8 data bits
Parity	odd, even, none
Stop bits	1 or 2
Power	+12 volts @ 125 mA Max and -12 volts @ 25 mA Max
Indicators	Red Tx and Rx LEDs

2. Ethernet Device Interface:

Data Rates	300 to 230 kbps
Characters	7 or 8 data bits
Parity	odd, even, none
Stop Bits	1 or 2
Power	3.3 volts @ 210mA Max
Ethernet	10Base-T or 100Base-T Auto Sensing
Protocols	TCPIP, ARP, UDP, ICMP, Telnet, TFTP, DHCP, HTTP, SNMP
Connectors	RJ-45
Indicators	10Base-T or 100Base-T on RJ-45
Memory	256K bytes SRAM and 512K bytes Flash

H. Ethernet Field Switches

Ethernet field switches shall be used to facilitate communication between Internal Ethernet Communications Modules and an Ethernet system. The field ethernet switches shall be GarrettCom Magnum 6KQ industrial field switches or approved equal with eight (8) copper 10/100 RJ-45 Ethernet ports and eight (8) 100 Base FX(SM) fiber ports (four transmit and four receive).
At Ethernet/fiber or fiber/Ethernet locations, the Responsible Party shall supply an Internal Ethernet Communications Module, and an Ethernet Field Switch or approved equals with all necessary connectors and harnesses.

I. Ethernet Telemetry

1. Ethernet Telemetry shall consist of a 900 MHZ unlicensed Spread Spectrum Radio modem used to enable the 170 controller to communicate over an Ethernet system. The radio modem shall be Encom Wireless CommPak IP or approved equal.

2. Software shall be included to allow the Development Engineering Manager to configure the radios on an as-needed basis. All data shall be encrypted.

3. The radios are to be equipped with an external jack allowing the use of a directional yagi or omni-directional antenna.

4. Omni-directional and directional yagi antennas shall be furnished and installed per the Spread Spectrum Radio system manufacturer's recommendations for antenna, make, model, and installation.

5. The Responsible Party shall field test all radios and yagi antennas and provide compliance testing and approval verification to the Development Engineering Manager. The Responsible Party must provide a fully functional radio communication system for the project.

6. The Responsible Party shall test signal reception at all intersections to verify end-to-end communications system performance prior to physical installation. The Responsible Party shall notify the Development Engineering Manager of the intended implementation plan based on the findings of the initial reception test.

J. Rack Assembly

Rack assemblies shall be used at the central traffic signal system location for installation of fiber optic modems at the central location. The rack assembly shall be a Traffic Fiber Systems R400/16 or approved equal. The rack assembly shall be capable of being installed in a 19" EIA defined rail system. The rack assembly shall have 16 slots for installation of fiber optic modems. The rear panel of the assembly shall be wired with sixteen (16) DB25 female communication connectors for each of the sixteen slots. The power connection for the rack assembly shall be a four position terminal block that provides a means to attach +12VDC, -12VDC, and common wiring.

At the central traffic signal system location, the Responsible Party shall install a rack assembly with all necessary connectors and harnesses.

703.13 Uninterrupted Power Supply (Continuous Power System)

A. The Uninterrupted Power System (UPS) is a true on-line power conditioner and battery backup or uninterruptible power system designed for transportation and traffic applications. The UPS shall be capable of operating up to its rated power level in extreme environments with existing equipment on the street today including any and all signal heads (i.e., Incandescent, LED, Neon, etc.) The UPS shall be a complete Clary SP1000SR or approved equal. The amber beacon shall be illuminated at any time the permanent power supply is interrupted to the cabinet, and the signal is operating on the battery backup.

B. Battery System

1. The battery shall be comprised of extreme temperature, deep cycle, Absorbed Glass Material/Valve Regulated Lead Acid (AGM/VRLA) batteries that have been field proven and tested by the U.S. Military.

2. The battery system shall consist of one or more strings (typically 4 or 6 batteries per string) of extreme temperature, deep cycle AGM/VRLA batteries such as Clary Outpost™ batteries or equivalent.

3. Batteries shall be certified to operate at extreme temperatures from -40º C to +74º C.

4. The batteries shall be provided with appropriate interconnect wiring and a corrosion resistant mounting trays and/or brackets appropriate for the cabinet into which they will be installed.

5. The interconnect cable shall be protected with abrasion resistant nylon sheathing.

6. The interconnect cable shall connect to the base module via a quick-release circular connector.

7. For safety and proper operation purposes, the circular battery connector shall have interlocking pins to prevent turn-on if batteries are not connected and to shut off the UPS should the batteries be disconnected.

8. Battery construction shall include heavy-duty, inter-cell connections for low-impedance between cells, and heavy-duty plates to withstand shock and vibration.

9. The top cover shall use tongue and groove construction and shall be epoxied to the battery case for maximum strength and durability.

10. An optional lifting handle shall be available on most battery models.

703.14 Illuminated Overhead Signage

A. The internally illuminated signs shall be "Naim-Series-Inter Mark ll signs manufactured by Nu-Art Lighting, Fullerton, California, or standard (96" L x 19" H x 9.375" D) signs manufactured by Southern Manufacturing, Orlando, Florida, or approved equal. Some manufacturers fabricate standard sizes of those signs required on the plans. Signs on any single project or at any specific location shall be from the same manufacturer or fabricator. Signs shall be eight (8) feet in length.

B. The face of the panel shall be "Lexan" or an approved type of sufficient thickness to permit minimum deflection, as certified by the manufacturer. All faces shall be of the same material.

C. Colors shall be standard approved colors for highway signs. The colors shall be white, green, blue, and red applied on the interior sign face. Green shall be Pantone 3435c Emerald Green (3M 3630-126). The City of Thornton logo shall be Pantone 300 Intense Blue (3M 3630-127). Blue for highway shields shall be Pantone 294 Bristol Blue (3M 3630-097). Red shall be Pantone 485 (3M 3630-33). Color tint shall show as intended and be consistent regardless of whether the sign is lit or unlit.

D. Capitalization of text on the internally illuminated sign shall be in compliance with the MUTCD, latest revision.

E. The sign layout shall include all necessary text and logos on one or both sides of the sign assembly as indicated on the plans.

F. The illumination source shall be light emitting diode (LED) and shall be from the same manufacturer or fabricator of the internally illuminated sign. The interval illumination shall provide a uniform lighting on the sign message and background. The light produced by the LEDs shall not alter the colors or background on the sign faces.

G. Each sign shall have a plug in type photo cell. Photo-electric controls are required and shall be of the "hail-resistant" type, and meet the requirements of Section 706.2.4.

H. The front sign panel of the case shall be hinged, either by a continuous hinge or extruded interlocking hinge, to provide access to the lamps. A weather-tight gasket shall be provided all around the sign face to exclude dust and moisture. The latching devices shall be either screw type or latch type to provide a secure attachment of the sign face to the case. Exterior hardware, hinges, etc., shall be painted in accordance with Section 702.9.

I. The sign case shall be securely attached to the support structure. Close coordination shall be maintained between the sign fabricator and support fabricator to assure attachment devices are properly placed. Brackets shall be PELCO SP 5559 assembly or approved equal.

J. An appropriately rated, in-line fuse shall be installed at the base of the pole where the sign feed connects to the power feed.

K. An insulating grommet shall be installed where the illuminated street name sign wiring enters the signal pole.

L. One galvanized ½-inch eyebolt with washer and nut shall be installed adjacent to each mounting bracket for installation of safety cable. An outdoor silicone caulk bead shall be applied at the entrance of the eyebolt into the sign to prevent water intrusion.

704 TRAFFIC SIGNING STANDARDS

704.1 General

The City shall review and approve what type of controls and where they shall be installed based on standard City practices and the MUTCD. These controls shall include traffic control signs, street name signs, delineators, fiber markers, permanent barricades, and pavement markings.

A. Materials

Sign panels shall conform to City requirements for material composition and reflective sheeting. Items used in the fabrication, manufacturing, and installation of traffic control signing in the City shall be manufactured in the United States with domestic materials and parts. Domestic materials and parts are those which are melted, cast, formed, shaped, drawn, extruded, forged, fabricated, or otherwise processed in the United States using raw materials produced in the United States.

B. Sign Sizes

Sign sizes shall conform to the MUTCD sizes for conventional roads unless otherwise approved in writing by the Development Engineering Manager.

704.2 Signing Layouts

Sign staking shall be done by the Responsible Party and inspected by the City prior to installation.

704.3 Variance Requirements

The Responsible Party shall obtain a City traffic control permit prior to installation of any signs. This permit shall constitute City authorization for the Responsible Party to install official traffic controls on public ROW. Responsible Parties installing traffic controls within the City shall be annually licensed through the City to do work in the City.

A. Inspection

After installation, the signing Responsible Party shall notify the Development Engineering Manager. The Development Engineering Manager shall then inspect installations and notify the Responsible Party of any correction needed. A second inspection shall be made by the Development Engineering Manager at the time of the final walk-through of public ROW improvements. The Responsible Party shall correct signing problems.

B. Relocation

The Responsible Party is responsible for the removal and relocation of existing traffic signs on public ROW affected by the approved project.

704.4 Sign Fabrication

A. Standard control and street name signs shall be fabricated on .080/50-52 H 38 anodized aluminum blanks with standard radius corners.

B. Traffic control signs and street name signs shall be fabricated using 3M Company diamond grade retro-reflective sheeting or approved equivalent. Sign facings shall be covered with 3M #1160 protective overlay or approved equivalent.

C. Traffic control sign faces shall be screened in conformance with methods prescribed by 3M Company using 3M inks or approved equivalent. No substitutions shall be allowed unless approved by the Development Engineering Manager prior to fabrication in writing.

D. Standard signs, except street name signs, shall be fabricated to conform exactly to the detailed drawings of standard highway signs as shown and detailed in the latest Standard Highway Signs Manual as published by the U.S. Department of Transportation/Federal Highway Administration.

E. School, bicycle crossing, and pedestrian crossing signs shall be strong fluorescent yellow green. All warning signs shall be fluorescent yellow.

F. Street name signs shall be fabricated in accordance with these Standards and Specifications. The City shall furnish a sample of the City logo decals to be installed on street name signs.

G. Street name letter sizes shall be as follows:

Street Speed Limit	Street Name Number/Letter Size	Supplementary Number/Letter Size
25 & Under	4”	2”
30 – 35	6”	3”
40 & Above	8”	4”

H. Capitalization of letters shall be in compliance with the MUTCD, latest revision.

I. Signs shall be fabricated with new materials. No used or reconditioned sign blanks or outdated sheeting and/or precut letters or numbers shall be used.

704.5 Sign Installation

A. Signs shall be installed in conformance with the latest edition of the MUTCD and Revisions. Signs shall be mounted on either the approved City breakaway supports, or banded to street light poles.

B. Signs mounted to street light poles shall have the sign support banded to pole with two (2) one-half (1/2) inch stainless steel “band-it" straps.

C. Mounting of signs to breakaway supports shall be accomplished by the following: Street signs must use five-sixteenths (5/16) inch nut and bolt. No rivets are allowed. Stop signs or equivalent must use five-sixteenths (5/16) inch nut bolt arrangement with a one and one-half (1½) inch washer to be used on top hole only, rivet to be used on bottom hole only.

D. Assembly of the breakaway supports to the anchor shall be by using a corner bolt or a drive rivet, or by using a V-lock base.

E. The Responsible Party shall, prior to installing sign support bases, contact utility agencies providing services, to locate buried services and to avoid damage when the base is installed. This shall include contacting the Utility Notification Center of Colorado.

F. Support bases shall be installed with a stabilizer fin to prevent the support from turning, and/or easy removal by vandals. The stabilizer fin shall provide 360 degree stabilization.

G. Single sign installations shall be on "TELESPAR" 16F 12 or equal, 10 foot support assemblies.

H. Multiple sign installations shall be on "TELESPAR" 16F 10 or equal, 12 foot support assemblies.

I. Sign support bases for standard sign installations shall be a "V-Lock" base, installed so that one (1) inch plus or minus one-half (1/2) inch protrudes above ground level.

J. Sign supports for standard sign installations shall be installed so that a minimum of six (6) inches is inside of support base and the sign height conforms to the MUTCD.

K. Sign supports shall be straight in alignment with the road and vertically straight from top and bottom. Bending of the support to achieve the vertical alignment shall not be permitted unless approved by the Development Engineering Manager.

L. Delineator posts and fiber markers for interconnect conduit marking shall be Safe-Hit 48-inch flexible guide posts or approved equal, white in color with a three (3) inch x nine (9) inch high intensity reflective strip, to be installed with an 18 inch soil anchor. Delineators installed on traffic calming projects shall be of the Safe – Hit type one (1) foot tall with a three (3) inch by nine (9) inch band of reflective material at the top of pole.

M. Permanent Type III Barricades installed shall meet all requirements of the MUTCD. All barricades shall be constructed using eight (8) inch by eight (8) foot by .010/50-52/H 38 anodized aluminum blanks with standard radius corners. The orange on white facing shall be 3M high intensity grade or equivalent.

N. Permanent Type III Barricades shall be supported using "TELESPAR" No. 20F 10 or equal, six (6) foot support assemblies. All barricade supports shall have the same finish as standard sign supports, except the final outer finish shall be White Federal Standard No. 595A Powder Resin No. 17875, or an approved equivalent.

O. Barricade support bases shall be the same as standard sign support bases.

P. Barricade supports shall be installed six and three-fourths (6-3/4) inches from the edge of the panels to the center of the support.

Q. Sign supports for standard sign installations shall meet or exceed the following specifications:

1. Tubing seam shall be welded in such a manner that the weld or flash shall not interfere with the telescoping of the tubing.

2. Support tubing size shall be one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) inch, U.S.S. 12 gauge, with a weight of 2.06 pounds per lineal foot.

3. The length of each post shall be as specified and have a permissible length tolerance of plus or minus one-fourth (¼) inch.

4. The finished post shall be straight and shall have a smooth uniform finish.

5. It must be possible to telescope a one and one-half (1-½) inch by one and one-half (1-½) inch O.D. post into a one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) inch O.D. post.

6. It must be possible to telescope a one and three-fourths (1 3/4) inch by one and three-fourths (1 3/4) inch O.D. post into a two (2) inch by two (2) inch O.D. post.

7. The outside tolerance at sides and corners shall be as follows:

    a. For one and one-half (1-½) inch by one and one-half (1-½) inch O.D. plus or minus six one-thousandths (.006) inch

    b. For one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) O.D. plus or minus eight one-thousandths (.008) inch

    c. For two (2) inch by two (2) O.D. plus or minus eight one-thousandths (.008) inch

8. The wall thickness shall fall between a plus .011 inch and a minus .008 inch of U.S.S. 12 gauge.

9. The maximum twist permissible in three (3) foot lengths for a standard one and three-fourths (1-3/4) inches by one and three-fourths (1-3/4) inch sign support is .062 inch.

10. The maximum tolerance in squareness for one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) inch supports is plus or minus .010 inch.

11. A maximum tolerance in straightness of one-sixteenth (1/16) of an inch in three (3) feet is permissible.

12. Supports shall be given a double outer finish. The first outer finish is galvanized and the second outer finish Mocha-Brown Federal Standard 595B No. 10075 polyester powder finish. The following specifications for the finishes shall be met:

    a. Each square steel tube support shall be hot dipped galvanized, ASTM A-525 coating, designation G90, or given a triple coated protection by in-line application of hot dip galvanized zinc per AASHTO M-120 followed by a chromate conversion coating.

    b. Sign supports shall receive a final outer finish of polyester. The polyester (thermoset) powder finish to be used shall provide a tough outside, weather resistant, highly mar-resistant coating able to withstand high impacts without chipping or cracking. Polyester required properties are:

        i. Tensile strength of 7500 psi

        ii. Impact resistance to not less than 160 pounds

        iii. Hardness of 87 shore D Durometer

        iv. Flexibility of 180° bend over one-fourth (¼) inch diameter mandrel without cracking or loss of adhesion.

    c. Dielectric strength of 1000 v/mil at 10 mils

    d. Color of the outer finish shall be Mocha-Brown Federal Standard 595B Powder Resin No. 10075, or an approved equal, as determined by the Development Engineering Manager.

    e. Application of final outer finish shall be accomplished by the following process:

        i. Pretreating is required to remove grease, rust, and dirt and then a thin coat of iron or zinc phosphate shall be applied. This pretreatment is required to provide maximum adhesion and long term corrosion protection.

ii. The powdered resins shall be applied to the cold support tubing through an electrostatic gun. The support shall then be baked in order to fuse the finish to the surface.

iii. The outer finish shall have a minimum thickness of two (2) mils.

704.6 Sign Maintenance

It is the responsibility of the Responsible Party to maintain required signs after installation until the City has officially granted the initial acceptance of the adjacent ROW improvements. Signs installed under this standard shall be maintained during the development construction period in two manners.

A. Signs damaged which do not constitute an immediate hazard to the public shall be repaired by the Responsible Party within a reasonable time, not to exceed 10 working days after Responsible Party has been notified.

B. Signs damaged, which constitute an immediate hazard to the public, shall be repaired or replaced by City personnel. The Responsible Party shall be responsible for the cost of repairs and/or replacement.

704.7 Fire Lane Designations

A. General

Street signs and pavement marking specifications included with construction plans shall show the location of fire lane signs on all streets and areas designated by the Thornton Fire Department. Installation shall be in accordance with these Standards and Specifications.

B. Sign Installation

1. All signs shall be installed in strict conformance with the latest edition and revisions of the MUTCD.

2. Signs shall read “NO PARKING FIRE LANE” and may include directional arrows at the bottom of the sign, as shown in the detail at the end of this section.

3. Signs shall be mounted to a metal post, wall, or other approved device or surface. The height of the bottom of the sign shall no be less than seven (7) feet above the concrete curb, walkway, road surface, or landscaping. Signs mounted on buildings or other walls shall be installed not less than five (5) feet above the ground.

4. Signs shall be spaced at 100 to 200 foot intervals, depending on the road layout or configuration of the area being designated, so that it is obvious that parking is prohibited.

C. Inspection

Completed fire lane sign installations shall be reviewed/inspected by the Development Engineering Manager and Fire Department.

705 PAVEMENT MARKINGS

705.1 General

A. The Responsible Party shall furnish pavement marking plans for each approved project to the Development Engineering Manager. The Development Engineering Manager shall review and approve the Responsible Party’s pavement marking plans. Pavement marking plans shall include but are not limited to the designation of locations where crosswalks, exclusive right-turn lanes, exclusive left-turn lanes, edge lines, stop bars, white skip lines, solid double yellow lines, and yellow skips to be installed.

B. The Responsible Party shall be responsible for the removal of any existing pavement markings necessary to install new markings for the approved development.

C. It is the intent of these Standards and Specifications to describe the requirements for retro-reflective pavement marking thermoplastic (preformed) to be used on roadway surfaces within the City, to provide for the submission of samples, to describe the laboratory and service test procedure which must be used to rate the materials proposed for marking new city roads, and to describe the requirements for the actual field installation of proposed pavement markings. Alternative markings for temporary installations are also listed as traffic line paints, hot extruded thermoplastics and detour grade tapes, and shall be approved by the Development Engineering Manager.

D. Pavement Marking Layout – The Responsible Party will layout in the field pavement marking locations prior to installation. Before installation, the lines must be approved by the Development Engineering Manager.

E. Permanent pavement markings installed on new asphalt shall be inlaid and installed within four (4) hours of placement of the final lift of asphalt pavement. Pavement markings on existing and new concrete pavement shall be recessed in a one fourth (¼) inch groove not to exceed one half (½) inch wider nor two (2) inches longer than the tape being laid and shall be glued with an epoxy binder. Permanent pavement markings on existing asphalt shall have an epoxy binder applied and be tape.

705.2 Preformed Plastic Pavement Markings and Legends

A. General

1. The prefabricated markings described shall consist of white or yellow pigmented plastic films with reflective glass spheres uniformly distributed throughout their entire cross-sectional area, and shall be capable of being affixed to bituminous or Portland cement concrete pavements by either a pressure sensitive pre-coated adhesive or liquid contact cement. The markings shall be provided in a complete form that shall facilitate rapid application and protect the markings in shipment and storage. The manufacturer shall identify proper solvents and/or adhesives to be applied at the time of application, the equipment necessary for proper application, and recommendations for application that shall assure an effective performance life. The marking film shall have resealing characteristics such that it shall fuse with itself and with previously applied marking materials of the same composition under normal conditions of use.

2. Prefabricated legends and symbols shall conform to the applicable shapes and sizes as outlined in the MUTCD.

B. Classification

The markings shall be highly durable retroreflective pliant polymer materials designed for longitudinal and word/symbol markings subjected to high traffic volumes and severe wear conditions, such as shear action from crossover, or encroachment on typical longitudinal configurations such as edge lines, barrier lines and lane lines.

C. Symbols, legends, long lines, stop bars, and crosswalks shall be 3M Series 270 ES or approved equal. For concrete pavement, long lines, and skips shall be 3M Series 380I-5ES or approved equal.

705.3 Marking Paint

Marking paint generally will not be approved for permanent markings. The use of pure acrylic high solids for hot application and quick dry to paint centerlines and edgelines on roads, crosswalks, stop zones, parking lots, storage zones, aisles, etc. as approved by the Development Engineering Manager shall contain no lead and comply with the EPA's voluntary 30/50 program, and meet the performance standards of federal specifications TT-P-1952. Prior to application, surfaces must be thoroughly dry and free from dirt, loose paint, oil, grease, and other contaminants. Paint may be thinned if necessary up to two (2)%, thin per manufacturer's recommendation. The paint shall be applied at air, surface, and product temperature above 50° F or per manufacturer's specifications.

% solids by weight	77.5 +/- 3%
Viscosity	80 - 90 K.U.
Sheen	Flat
Wet film per coat	14 – 16 mils
Dry film per coat	8.4 – 9.6 mils
Application rate	1 gal / 100 sf
Unit weight	14 lbs / gal

705.4 Thermoplastic Marking

A. Shall be in conformance with CDOT SSRBC Section 713.12.

B. Application

1. The pavement marking shall be applied to the pavement either to the right or left of the application unit, dependent upon roadway lane being used. The unit shall not occupy more than one lane of roadway while operating.

2. The finished lines shall have well defined edges and be free of waviness. Tolerance shall be one (1) inch longitudinally and one fourth (¼) inch transversely. The minimum thickness of thermoplastic line shall be three thirty-secondths (3/32) inch at the edges, not less than one eighth (1/8) inch at the center. Measurements shall be taken as an average throughout any 10 foot section of the line. The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall bond itself to the old

line in such a manner that no splitting or separation takes place. All of the equipment necessary to the preheating and application of the material shall be so designed that the temperature of the material can be controlled within the limits necessary to its pourability for good application.

3. The marking material as specified shall be installed at the manufacturer's recommended temperature.

4. At the time of installation of thermoplastic materials, the pavement shall be clean, dry, and free of laitance, oil, dirt, grease, paint, or other foreign contaminants. Pavement and ambient temperatures shall be at least 50° F.

5. An epoxy resin primer shall be applied to concrete surfaces prior to the application of the thermoplastic pavement marking. The epoxy resin primer shall be installed per the thermoplastic manufacturer recommendations.

6. The marking material shall not be applied until the epoxy resin primer reaches the tacky stage. An infrared heating device may be employed to shorten the curing time of the epoxy.

7. If the Development Engineering Manager determines that a new asphalt surface has become soiled, prior to placement of the pavement markings, a pavement primer will be required and preformed plastic pavement markings shall be applied as approved.

8. The epoxy resin primer material may be accepted at the job site on the basis of a manufacturer's certification, or a sample may be sent to the laboratory for testing, in which case three (3) weeks shall be allowed between sampling and intended use.

705.5 Reflectorized Glass Beads

A. General

1. This specification is intended to cover free-flowing, water-proofed, reflectorizing glass beads for drop-on type application on highway traffic paint and thermoplastic for the production of a reflective surface improving night visibility of the painted markings without altering daytime visibility. The beads shall conform to the following specifications:

a. A blended material consisting of spheres containing refractive indices of 1.50 and 1.65 and conforming to the following specifications:

i. Manufactured from high grade optical crown glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

ii. Colorless, clean and transparent.

B. Material

The reflectorizing glass beads shall conform to the following:

1. Refracture Index - When testing by the liquid immersion method at 77° F, 70% of the spheres shall have an average index of not less than 1.50, and 30% shall have an average index of not less than 1.65.

1.50 Index Glass Beads

U.S. Standard Sieve Number	% Passing by Weight
20	95 - 100
30	75 - 95
50	9 - 32
80	0 - 15

1.65 Index Glass Beads

U.S. Standard Sieve Number	% Passing by Weight
50	100
80	90 - 100
100	75 - 90
200	0 - 5

706 STREET LIGHTING

706.1 Street Lighting

Street lighting shall conform to Detail 700-21. In the Washington Street Corridor Area, shown in the details, the color shall be as specified on Details 700-5 and 700-22. For colors of poles, coordinate with the City Development Department.

706.2 Street Light Luminaires

A. Luminaires shall meet the following general requirements:

1. Luminaires shall be as specified for each type in the Luminaire Material Specification table.
2. Luminaires shall have an external label per ANSI C136.15.
3. Luminaires shall have an internal label per ANSI C136.22.
4. Luminaires shall have maximum nominal luminaire input wattage as specified for each luminaire type in the Luminaire Material Specification table.
5. Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
6. Luminaires shall start and operate in -30°C to +40°C ambient.
7. Fully assembled luminaires shall be electrically tested before shipment from factory.
8. Effective Projected Area (EPA) and weight of the luminaires shall not exceed the values indicated in the Luminaire Material Specification table.
9. Luminaires shall be designed for ease of component replacement and end-of-life disassembly.
10. Luminaires shall be rated for the ANSI C136.31 Vibration Level indicated in the Luminaire Material Specification table.
11. LED light source(s) and driver(s) shall be RoHS compliant.
12. Luminaires shall be rated for a minimum operational life of 80,000 hours at an average operating time.
13. Lumen maintenance shall not decrease by more than 30 percent over the minimum operational life.
14. A minimum of 70 percent of original lumen output shall be maintained for operational life in excess of 80,000 hours.
15. Lumen maintenance shall be determined using criteria identified in LM-80, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources, latest revision and TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources, latest revision.
16. The driver shall:
    a. Have a rated driver case temperature shall be suitable for operation in the luminaire operating in the ambient temperatures indicated above.
    b. Accept the voltage or voltage range indicated in the Luminaire Material Specification table at 50/60 Hz, and shall operate normally for input voltage fluctuations of plus or minus 10 percent.
    c. Have a minimum Power Factor (PF) of 0.90 at full input power and across the specified voltage range.
    d. Have a UL Class I rating.
    e. Have a UL outdoor, damp, location rating in compliance with International Electrotechnical Commission IP-66.
    f. Be UL, cUL recognized.
    g. Have a 1.5 maximum current crest factor.

h. Have a Class A sound rating.

i. Have a life expectancy of 80,000 hours.

j. Provide constant light output over the life of the fixture.

k. Be solid state (electronic) type.

l. Be modular and removable without the use of special tools or disassembly of the luminaire.

17. Electromagnetic Interference

    a. Luminaires shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across the specified voltage range.

    b. Luminaires shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.

18. Luminaires shall be listed for wet locations by OSHA Nationally Recognized Testing Laboratories and have an International Electrotechnical Commission IP-66 rating.

19. Luminaire Housing

    a. The luminaire housing shall have a corrosion resistant finish providing protection against high concentrations of liquid and salt spray.

    b. The finish shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.

20. Thermal Management

    a. Mechanical design of any protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.

    b. Moving parts shall be clearly indicated in submittals, be consistent with product testing, and shall be subject to review by the Owner.

    c. Liquids shall not be used.

21. Backlight, Uplight, and Glare (BUG) Ratings

    a. BUG ratings shall be as specified for each luminaire in the Luminaire Material Specification Table.

    b. Calculation of BUG Ratings shall be for initial (worse-case) values, i.e., Light Loss Factor (LLF) = 1.0.

    c. If luminaires are tilted upward for calculations in photometric analysis, BUG ratings shall be calculated for the same angle(s) of tilt.

22. The vertical angle of cobra head luminaires shall be adjustable and the luminaire shall have a bubble level or gauge to assist in installing the fixture vertically plump.

23. Minimum color rendering index (CRI) shall be 70.

24. Nominal Correlated Color Temperature (CCT) shall be 4000K. Allowable LM-79 chromaticity values shall be a measured CCT of 3710 to 4260K and a measured Duv of -0.005 to 0.007.

25. All wiring and grounding, terminal blocks from incoming AC lines, photo-electric control receptacle (if applicable), latching, hinging, and ingress protection shall be in accordance with ANSI C136.37.

26. All internal components shall be assembled and pre-wired using modular electrical connections.

27. No special tools shall be required for maintenance of the luminaire.

28. Luminaires shall contain no mercury.

29. At a minimum, the manufacturer or local sales representative shall provide installation and troubleshooting support via telephone and/or email.

Luminaire Material Specification Table

LED Luminaire Performance Criteria				
Luminaire Type		Post Top Decorative (Lantern)	Cobra Head (Type I)	Cobra Head (Type II)
Input Power	Max. Nominal Luminaire Input Power	70 W	130 W	200 W
High Pressure Sodium Wattage	Equivalent High Pressure Sodium Wattage	100 W	250 W	400 W
Typical Mounting Height		23 feet	32 feet	
IES Type		Type III		
Nominal CCT	Related Correlated Color Temperature	4000K		
Photopic Downward Luminaire Output	Minimum *Maintained* Luminaire Output Below Horizontal	3256 lm		
BUG Rating	Max. Nominal Backlight-Uplight-Glare Ratings	B1-U1-G1		
Voltage	Nominal Luminaire Input Voltage	100 – 277V (+10/-10%)		
Finish	Luminaire Housing Finish Color	Black	Gray	
Weight	Maximum Luminaire Weight	60 lb	60 lb	
EPA	Maximum Effective Projected Area	3.0 ft^2	2.0 ft^2	
Mounting	Mounting Method	Post Top	Side-arm	
	Tenon Nominal Pipe Size	3 inches	2 inches	
Vibration	ANSI Test Level	☑ Level 1 (normal) ☐ Level 2 (bridge/overpass)		

B. Submittals shall be required for each luminaire type. Submittals shall include:

1. Luminaire cut sheets
2. LED light source cut sheets (LED packages, modules, arrays)
3. LED driver(s) cut sheets (drivers and power supplies, if applicable)
4. Surge protection device cut sheets
5. Installation and maintenance instructions
6. Illuminating Engineering Society (IES) LM-79 luminaire photometric report. The "product families" method may be utilized for the LM-79 report if test data is lacking for a particular product configuration. The LM-79 report shall include:

   a. Name of test laboratory (must be accredited by National Voluntary Laboratory Accreditation Program (NVLAP) for the IES LM-79 test procedure or must be qualified, verified, and recognized through the U.S. Department of Energy's CALiPER program).

   b. Report number

   c. Report date

   d. Complete luminaire catalog number

      Provide clarification if catalog number in test report does not match catalog number of luminaire submitted (clarify if discrepancy does not affect performance)

   e. Description of luminaire, LED light source, and LED driver(s)

f. Colorimetry

7. Computer generated point-by-point photometric analysis of maintained photopic light levels as per the Luminaire Material Specification table.

8. Calculations and supporting test data per LM-80.

9. Calculations and supporting test data per TM-21.

10. Written product warranty

11. Buy American documentation

a. Manufacturers listed on the current NEMA Listing of Companies Offering Outdoor Luminaires Manufactured in U.S.A. for Recovery Act Projects need only provide a copy of the document.

b. Other manufacturers shall submit documentation as per the Department of Energy Guidance on Documenting Compliance with the Recovery Act Buy American Provisions.

12. At the request of the Development Engineering Manager, a test sample of each proposed luminaire shall be provided to the City at no cost for review, testing, and evaluation.

C. A minimum five (5) year warranty shall be provided for each luminaire, covering maintained integrity and functionality of:

1. Luminaire housing, wiring, and connections

2. LED light source(s)

Negligible light output from more than 10 percent of the LED packages constitutes luminaire failure.

3. LED driver(s)

D. The photo-electric control (photocell) shall be a standard NEMA three (3) pole locking type. The photo-electric control shall meet the following general requirements:

1. Photo-electric controls shall be rated for a nominal input voltage of 120 – 277V.

2. Photo-electric controls shall have built-in metal oxide varistor (MOV) surge protection.

3. Photo-electric controls shall be time delayed for a minimum of fifteen (15) seconds.

4. Photo-electric controls shall be UL tested for a minimum of five thousand (5,000) cycles (approximately 13.7 years) at one thousand (1,000) watt minimum tungsten and one thousand eight hundred (1,800) volt-amp minimum ballast loads.

5. Photo-electric controls shall meet UL Standard 773 requirements.

6. Photo-electric controls shall be in compliance with ANSI C136.10.

706.3 Arterial and Collector Poles and Luminaire Arms

A. Poles for single luminaire arm and double luminaire arm arterial and collector street lighting shall be tapered tenon top steel poles galvanized per ASTM A123, latest revision or tapered tenon top seamless alloy aluminum poles. The poles and mast arms shall be of American steel or aluminum and shall be engineered by a manufacturer in the United States in accordance with the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals for a 100 mph wind velocity and minimum design life of 25 years. Poles shall be designed to carry the typical proposed weight as to luminaires, sign, banners, and mounting hardware. Banners are typically made of vinyl material two (2) feet in width and eight (8) feet in height, mounted via top and bottom arms at a height of fifteen (15) to twenty (20) feet from ground surface to bottom of the banner. Signs are typically made of 0.080/50-52 H 38 anodized aluminum material thirty-six (36) inches in width and forty-eight (48) inches in height, mounted via a top bolt and bottom rivet at a minimum height of seven (7) feet from ground surface to bottom of the sign. A complete set of Professional Engineer stamped structural engineering drawings and specifications for pole and mast arms shall be provided.

B. Arterial and collector street light poles shall be thirty (30) feet in height from ground surface to base of tenon. The tenon at the top of the pole shall have a three (3) inch outside diameter. Each pole shall have a hand hole located a minimum of one foot to a maximum of one foot and six inches (1’ – 6”) from the

ground surface to the center of the hand hole. The hand hole shall be a minimum of four (4) inches wide and a minimum of five (5) inches in height.

C. The anchor base for each pole shall be slotted for one inch diameter anchor bolts. The bolt circle for the anchor base shall be sized to be compatible with a twenty-four (24) inch diameter concrete foundation without overlap of the foundation.

D. Luminaire arms shall be arching arms ten (10) feet in length. Steel arms shall be galvanized per ASTM A123, latest revision. Aluminum arms shall be seamless alloy aluminum. Truss arms shall not be used. The arching arm shall have a rise of two (2) feet. Attachment of the luminaire arm to the pole shall be via a slip fitting designed to mount to a three (3) inch outside diameter top mount tenon on top of the pole. Attachment of the luminaire to the luminaire arm shall be via a slip fitting designed to mount to a two (2) inch outside diameter side-arm tenon and the end of the luminaire arm.

E. All poles shall be plumb when installation is complete.

F. The use of steel poles and luminaire arms or aluminum poles and luminaire arms shall be as specified in the plans or at the direction of the Development Engineering Manager.

G. All necessary hardware and attachments shall be bagged and secured within each pole.

706.4 Residential and Trail Poles

A. Poles for residential or trail lighting shall be tapered fiberglass direct buried poles, black in color (natural finish) The poles shall be engineered in accordance with the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals for a 100 mph wind velocity and minimum design life of 25 years. Poles shall be designed to carry the typical proposed weight as to luminaires and mounting hardware. The pole shaft length shall be 28 feet. Luminaire mounting height shall be 23 feet above ground surface. Each pole shall have a hand hole located a minimum of one (1) foot to a maximum of five (5) feet from the ground surface to the center of the hand hole. The hand hole shall be a minimum of three (3) inches wide and a minimum of five (5) inches in height.

B. Mounting of the luminaire to the fibergalls pole shall be via a slip fitting designed to mount to a three (3) inch outside diameter top mount tenon on top of the pole.

C. Holes for installation of fiberglass poles shall be made by hand or using a power augur. The diameter of the hole shall be approximately three (3) times the ground line diameter per pole manufacturer's specifications. Once the pole is installed, backfill material suitable for the soil's conditions and per pole manufacturer's recommendation shall be applied and firmly tamped every six (6) inches.

D. All poles shall be plumb when installation is complete.

E. All necessary hardware and attachments shall be bagged and secured within each pole.

706.5 Street Light Pole Foundations

A. Arterial and collector pole shall have concrete foundations twenty-four (24) inches in diameter and forty-eight (48) inches in height. Concrete for the foundation shall be Class BZ per Colorado Department of Transportation SSRBC, latest revision.

B. Four (4) steel anchor bolts conforming to ASTM F1554 Grade 55 shall be installed in the foundation. The foundation bolt circle shall be per manufacturer's specification for the light pole. The anchor bolts shall be L-shaped anchor bolts one (1) inch in diameter, thirty-six (36) inches in length, with a four (4) inch hook.

C. Reinforcing steel for the foundation shall be seven (7) horizontal #4 rebar hoops at +/- six (6) inch vertical spacing and eight (8) vertical #4 rebar evenly spaced. The hoops shall have a minimum twelve (12) inch overlap. The bottom hoop shall be three (3) inches from the bottom of the foundation. A minimum one and one-half (1-1/2) inch clearance shall be provided between the hoops and the outer surface of the foundation. Two (2) #4 rebar stirrups shall be placed at +/- six (6) inches around the anchor bolts.

D. Three 3-inch rigid conduits shall be installed down the center of the foundation, exiting the foundation a minimum of twenty-four (24) inches below ground surface. Each conduit exist shall be positioned a minimum of ninety degrees from the adjacent conduit exit. One additional one-half (1/2) inch conduit shall be run through the foundation for installation of ground wire.

E. All necessary nuts, nut covers, and washers shall be supplied with the arterial and collector poles and shall be steel, galvanized per ASTM A153, latest revision. Anchor bolts shall be galvanized per ASTM A153 to a minimum of twelve (12) inches on the threaded end.

F. The top of the pole foundation shall be flush with ground level.

G. A professional structural engineer shall certify that the foundation will be adequate for the pole proposed by the Responsible Party. If it is determined that an alternate foundation design is required, it shall be provided by the Responsible Party's professional structural engineer.

H. Foundations shall not be required for direct buried fiberglass poles.

706.6 Breakaway Support

A. All arterial and collector street light poles shall use a breakaway support unless otherwise specified in the plans or at the direction of the Development Engineering Manager.

B. Breakaway supports shall be frangible cast aluminum transformer bases designed in accordance with the 2009 edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

706.7 Street Light Pole Grounding

A. A ground rod shall be installed adjacent to each arterial and collector pole. Each ground rod shall be one-piece copper-weld rod of 5/8-inch diameter and eight (8) feet in length, driven to a depth of at least eight (8) feet below the surface of the ground. The ground rod shall be a minimum of six (6") inches away from the foundation. The top of the ground rod shall be a minimum of four (4) inches below the ground surface.

B. A ground rod shall not be required for direct buried fiberglass poles.

C. A ground plate shall be located at the back of the hand hole of each arterial and collector pole. Ground wire shall be #4 copper wire run through a one-half (1/2) inch conduit in the foundation to the grounding plate. Ground wire shall not be exposed.

D. In addition to the ground rod and wire for arterial and collector poles, a complete grounding system shall be provided for the entire lighting installation. Grounding shall consist of all necessary ground cables, conduits, ground rods, wires or straps, and ground fittings as required by the NEC and in conformance with the plans.

706.8 Street Light Wiring

A. Wiring size and type for the street lighting circuit shall be as specified by the design engineer and in the plans.

B. Lighting conduit shall be as specified in Section 702.6 Traffic Signal, Lighting, and Communication Conduit.

C. One 20 amp in-line fuse shall be used per luminaire, located at the hand hole of each pole.

706.9 Arterial and Collector Pole Painting

A. General

Arterial and collector poles and luminaire arms shall not be painted unless otherwise specified in the plans or at the direction of the Development Engineering Manager. In order to be acceptable, painted poles and luminaire arms furnished by the Responsible Party shall be in accordance with the terms and requirements set forth herein. Other comparable coating systems that comply with these specifications may be acceptable, subject to approval by the Development Engineering Manager. The Responsible Party shall be required to furnish the Development Engineering Manager with a notarized certificate of compliance from the pole and luminaire arm manufacturer that guarantees that t Capitalization of letters shall be in compliance with the MUTCD, latest revision.
he coating system used is in compliance with these specifications and is free of defective workmanship.

B. Steel Pole and Luminaire Arm Painting

If painting is specified steel poles and luminaire arms, all exterior surfaces of steel poles and luminaire arms shall be primed and painted mocha-brown or beige, in accordance with Section 702.9 Protective Coatings for Signal Poles with Mast Arms and Pedestal Poles.

C. Aluminum Pole and Luminaire Arm Painting

Unpainted aluminum poles and luminaire arms shall have a clear natural anodized finish. If painting is specified for aluminum poles and luminaire arms, the requirements of this specification shall be met.

Wrapping and packaging, handling and shipment, delivery and acceptance of poles, field touch-up, and warranty shall be in accordance with Section 702.9 H, I, J, K, and L.

1. Surface Preparation for Aluminum Exterior Coating System

   a. Exterior surfaces of poles shall be abrasive blasted in accordance with coating manufacturer's recommendations.

   b. Luminaire arms and component parts shall be chemically cleaned with a suitable water based cleaner or solvent in accordance with coating manufacturer's recommendations.

2. Requirement of Aluminum Exterior Coating System

   a. A primer coat is not required for above ground aluminum poles and luminaire arms. An epoxy primer shall be used on any pole surface embedded directly into soil.

   b. The color topcoat shall consist of two (2) coats of triglycidyl isocyanurate (TGIC) Hybrid or super durable polyester powder at a minimum of one and one-half (1.5) mils dry film thickness for a total minimum dry film thickness of three (3) mils. The color topcoat shall meet the following requirements:

      i. Have a pencil hardness of 1H.
      ii. Have a minimum impact resistance of eighty (80) inch pounds.
      iii. Have a minimum adhesion level of three (3).
      iv. Have minimum salt spray resistance of 250 hours.

   c. Color for finish topcoat shall conform to City requirements. Color shall meet Federal Standard 595C Colors (January 2008). Color number 10075 satin finish "Mocha Brown" or Color 20227 semi-gloss finish "Beige" shall be used as specified in the plans or at the direction of the Development Engineering Manager.

3. Application of Aluminum Exterior Coating System

   a. The color topcoat shall be strictly applied according to manufacturer's recommendation.

   b. Surfaces shall be kept free of moisture, oil, grease and other organic matter until coated. Failure to do so will prevent proper adhesion and shall require the abrasive blast or chemical cleaning procedures to be repeated.

   c. Powder application shall be with electrostatic spray equipment.

4. Aluminum Exterior Coating System Drying and Curing

   a. The color topcoat shall be cured in a convection oven according to the specific cure temperature and cycle required by the power manufacturer to ensure complete dry-through time.

706.10 Street Light Pole Submittals

Submittals shall be required for each type of street light pole and mast arm (if applicable). Submittals shall include:

A. Street light pole cut sheets

B. Street light luminaire arm cut sheets (if applicable)

C. Interior (if applicable) and exterior protective coating system cut sheets, specifications, and documentation

D. Written product warranties

707 SCHOOL ZONE FLASHING LIGHTS

A. General

1. SZFL's shall be installed on new 15 foot pedestrian poles. Each SZFL assembly shall consist of:

   a. Three (3) black 12 inch polycarbonate signal heads with tunnel visors and yellow LED faces.

b. Three (3) Pelco upper and lower arm assemblies model number SE-3215 or approved equal. All mounting hardware to be black in color.

c. One (1) S5-1 School Speed sign. Sign to be 24 inches by 48 inches with diamond grade sheeting and 3M #1160 protective overlay. The sign shall be black lettering on a white background. The background for the word "SCHOOL" shall be fluorescent yellow.

d. One (1) R2-6 Fines Higher sign. Sign to be 24 inches by 10 inches with diamond grade sheeting and 3M #1160 protective overlay. The sign shall be black lettering and border on a white background.

2. Each AC-powered SZFL assembly shall also include one (1) Pelco cabinet, model number SE-1004 with Eltec NTC-17E clock, 204 flashers, and mounting hardware. All devices shall be mounted on a back plate and fully wired for operation. The cabinet shall be mounted to the side of a pedestrian pole. Mounting hardware for the cabinet shall be compatible with a four (4) inch diameter pedestrian pole.

3. Each solar-powered SZFL assembly shall also include one (1) Eltec solar panel with mounting hardware and one (1) Eltec battery cabinet with mounting hardware, prewired and equipped with an Eltec NTC-17E clock, FS-2 flasher, Prostar controller, and AGM sealed deep cycle batteries. The number of batteries, the wattage of the Prostar controller, size of the solar panel shall be per manufacturer's recommendation to power three (3) twelve (12) inch yellow signal faces. The solar panel and battery cabinet shall be mounted to the side of a pedestrian pole. Mounting hardware for the solar panel and battery cabinet shall be compatible with a four (4) inch diameter pedestrian pole.

4. The use of solar-powered SZFL assemblies shall only be approved specifically in writing by the Development Engineering Manager.

In United Power territory, the Responsible Party shall install a meter housing as required in the plans for the each AC-powered SZFL assembly or group of AC-powered SZFL assemblies. The Responsible Party shall coordinate with Xcel Energy or United Power on the source and connection of the power feed, the installation of the meter in the meter housing, and the connection of the power feed to the meter.

6. All work shall be done in accordance with these specifications, the latest revision of the MUTCD published by the Federal Highway Administration and the latest Colorado supplement thereto, the SSRBC. The actual location for the SZFL assembly will be determined by the Development Engineering Manager at the time of construction.

B. Installation

1. Installation shall be in accordance with the plans, the manufacturer's recommendations, the MUTCD, and these Standards and Specifications.

2. Devices shall be covered until final activation.

3. Existing speed limit signs shall not be removed until final activation.

708 GLOBAL POSITIONING SYSTEM

A. North American Datum 83 (NAD83) Colorado State Plane Central Zone coordinate system (grid) units in feet shall be provided for all roadway devices within the project limits. This shall include traffic signal controller cabinets, sign posts, pull boxes, and street light poles. The elevation datum shall be based upon the North American Vertical Datum 1988 (NAVD 88).

B. The GPS data collected shall be provided to the City in an AutoCAD drawing format using model space.

C. The AutoCAD drawings shall include a note describing how the coordinates were established along with the primary control points that were used.

D. The AutoCAD information shall be incorporated into the asbuilts for the project.

E. The horizontal and vertical positional accuracy of the data collected shall be within a tolerance of $\pm$ 0.3 feet.

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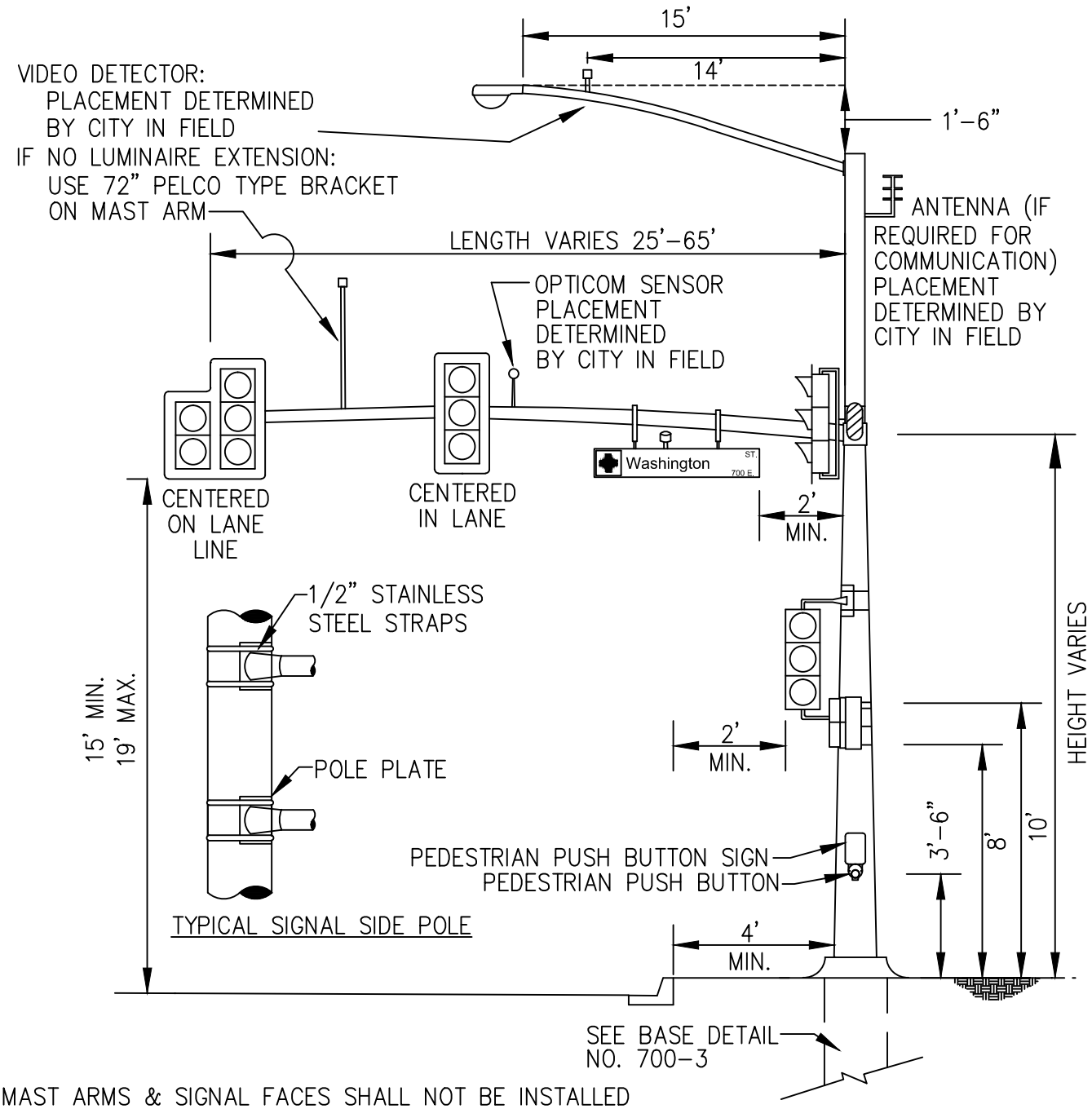
LUMINAIRE EXTENSION, ARM & WIRING TO BE INSTALLED BY CONTRACTOR

LUMINAIRE LIGHT, HOUSING, BULB, ETC., TO BE INSTALLED BY XCEL OR UNITED POWER



MAST ARMS & SIGNAL FACES SHALL NOT BE INSTALLED UNTIL FIVE (5) DAYS OR LESS PRIOR TO ACTIVATION UNLESS APPROVED BY THE TRAFFIC ENGINEER.

N.T.S.

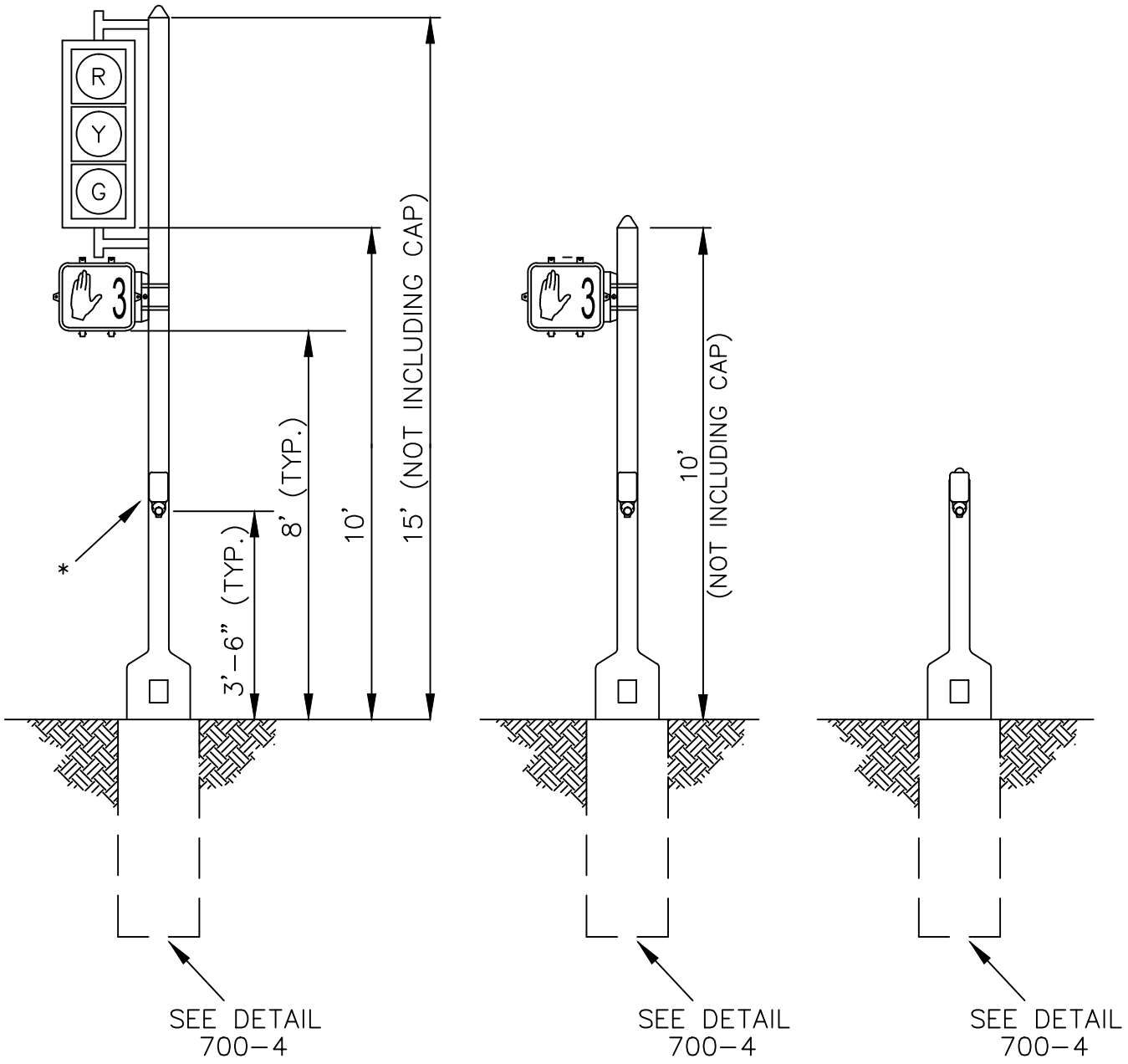
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL SIGNAL INSTALLATION

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700–1

* PEDESTRIAN PUSH BUTTON (TYPICAL)
(PUSH BUTTON AND SIGN TO
BE ORIENTED AS DIRECTED
BY THE TRAFFIC ENGINEER)



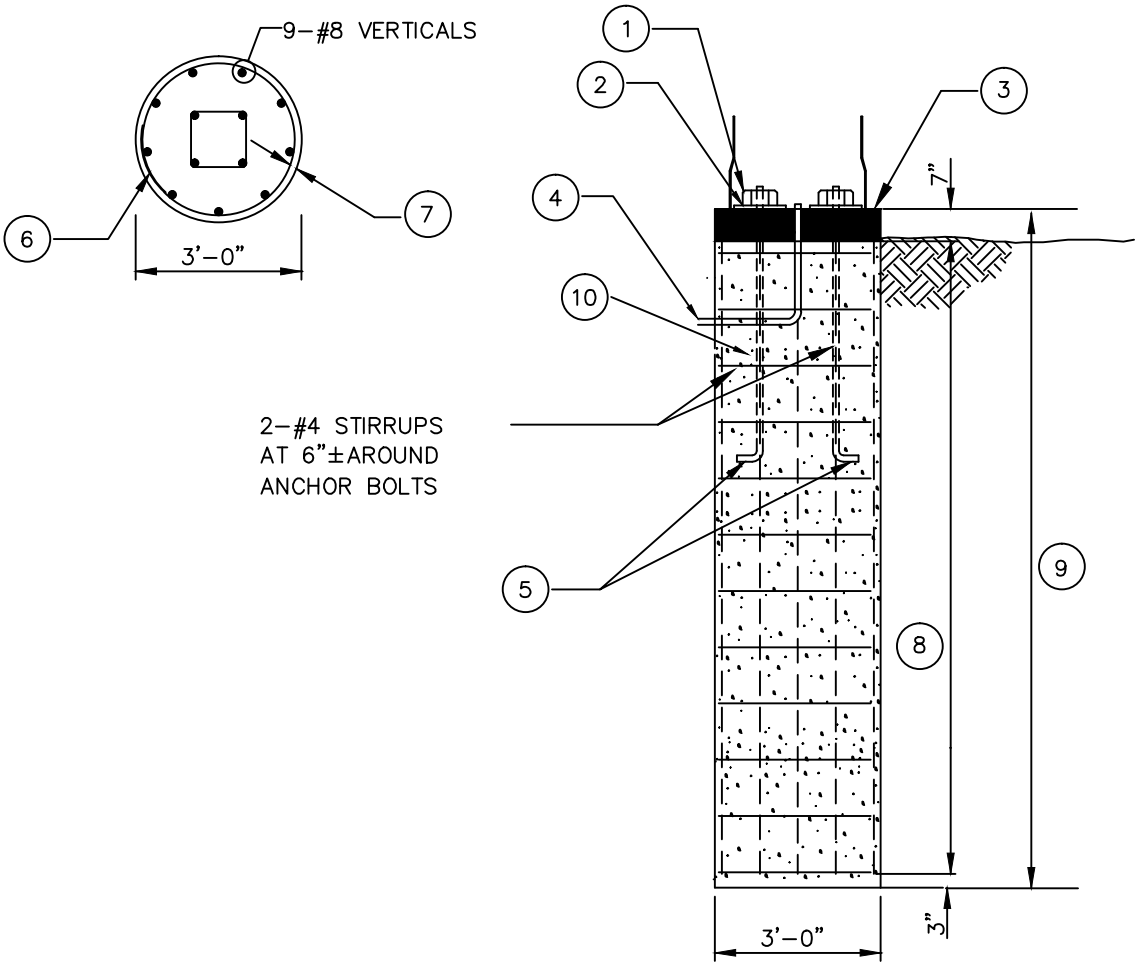
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL PEDESTRIAN POLE INSTALLATION

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-2



FOOTING NOTES

1. HEX NUTS
2. SQUARE NUTS
3. 4"–7" MIN. NON–SHRINKABLE GROUT OVER ROUGH FOUNDATION
4. RIGID CONDUIT (24" MIN. DEPTH, 30" MIN. DEPTH UNDER ROADWAY) CONDUIT STUB FROM PULL BOX TO POLE SHALL BE 3" DIA.
5. INSTALL ANCHOR BOLTS (FURNISHED WITH POLE) PER MANUFACTURER'S TEMPLATE PRINT (FURNISHED WITH ORDER)
6. MINIMUM OVERLAP 12"
7. 1–1/2" CLEARANCE FOR HOOPS
8. 15 – #4 HOOPS AT +/– 12" FOR 15' FTG.
   12 – #4 HOOPS AT +/– 12" FOR 12' FTG.
9. USE 15' FOOTING FOR POLES WITH MAST ARMS 45' IN LENGTH OR LONGER.
   USE 12' FOOTING FOR POLES WITH MAST ARMS LESS THAN 45' IN LENGTH.
10. ALL INSTALLATIONS TO BE PROPERLY GROUNDED.

CAISSON DESIGNS REQUIRE THAT THE CAISSON BE FOUNDED IN COMPACT SAND, CLAY, OR SANDY CLAY. IF BY VISUAL INSPECTION OF THE HOLE OTHER MATERIAL IS PRESENT, THE CAISSON DESIGN SHALL BE MODIFIED AS DETERMINED BY THE RESPONSIBLE PARTY'S ENGINEER.

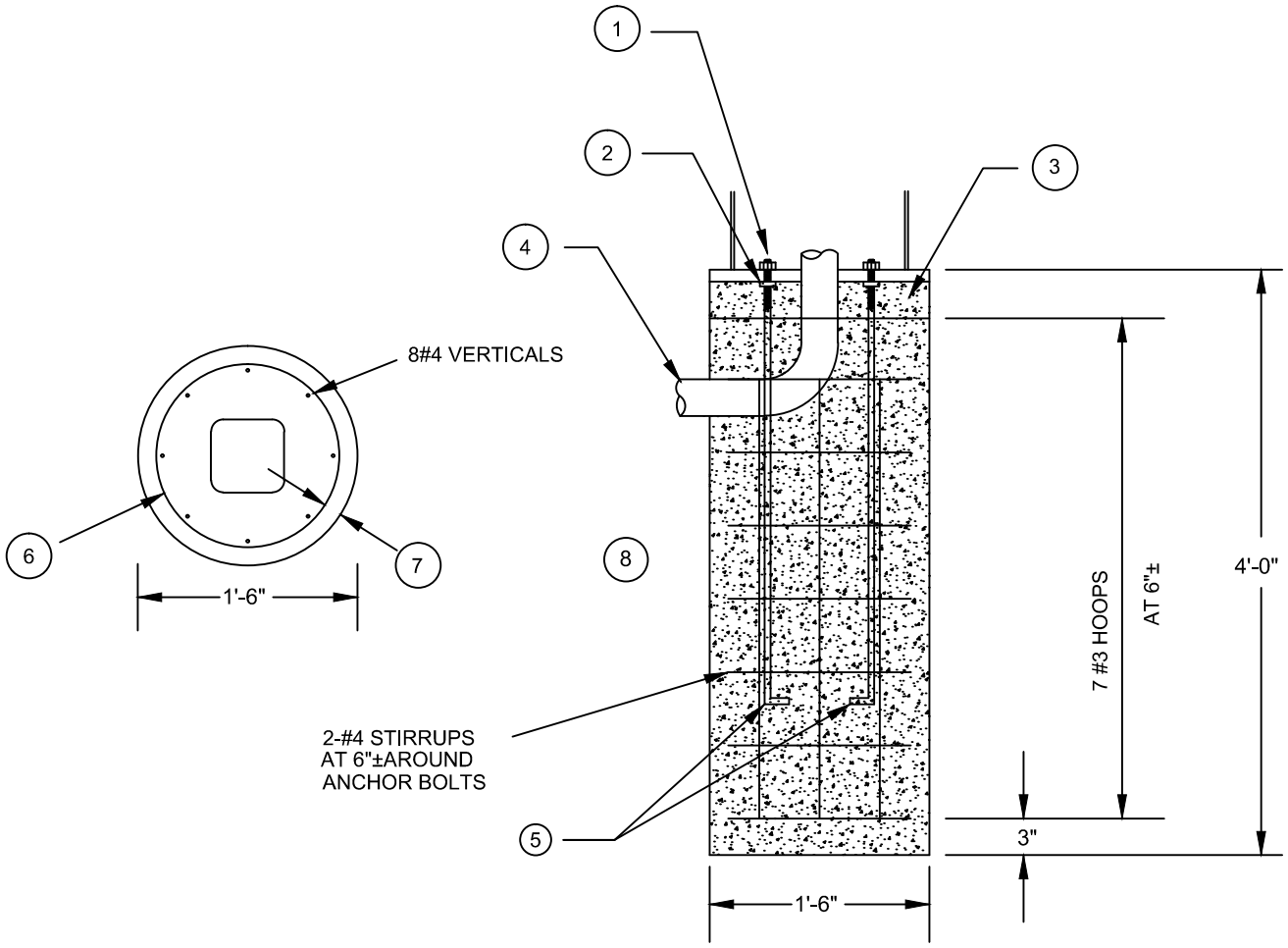
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL TRAFFIC SIGNAL POLE FOOTING INSTALLATION

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700–3



FOOTING NOTES

1. HEX NUTS
2. SQUARE NUTS
3. 4" - 7" MIN. NON-SHRINKABLE GROUT OVER ROUGH FOUNDATION
4. RIGID CONDUIT (24" MIN. DEPTH, 30" MIN. DEPTH UNDER ROADWAY) CONDUIT STUB FROM PULL BOX TO POLE SHALL BE 3" DIA.
5. INSTALL ANCHOR BOLTS (FURNISHED WITH POLE) PER MANUFACTURER'S TEMPLATE PRINT (FURNISHED WITH ORDER)
6. MINIMUM OVERLAP 12"
7. 1-1/2" CLEARANCE FOR HOOPS
8. ALL INSTALLATIONS TO BE PROPERLY GROUNDED.

CAISSON DESIGNS REQUIRE THAT THE CAISSON BE FOUNDED IN COMPACT SAND, CLAY, OR SANDY CLAY. IF BY VISUAL INSPECTION OF THE HOLE OTHER MATERIAL IS PRESENT, THE CAISSON DESIGN SHALL BE MODIFIED AS DETERMINED BY THE RESPONSIBLE PARTY'S ENGINEER.

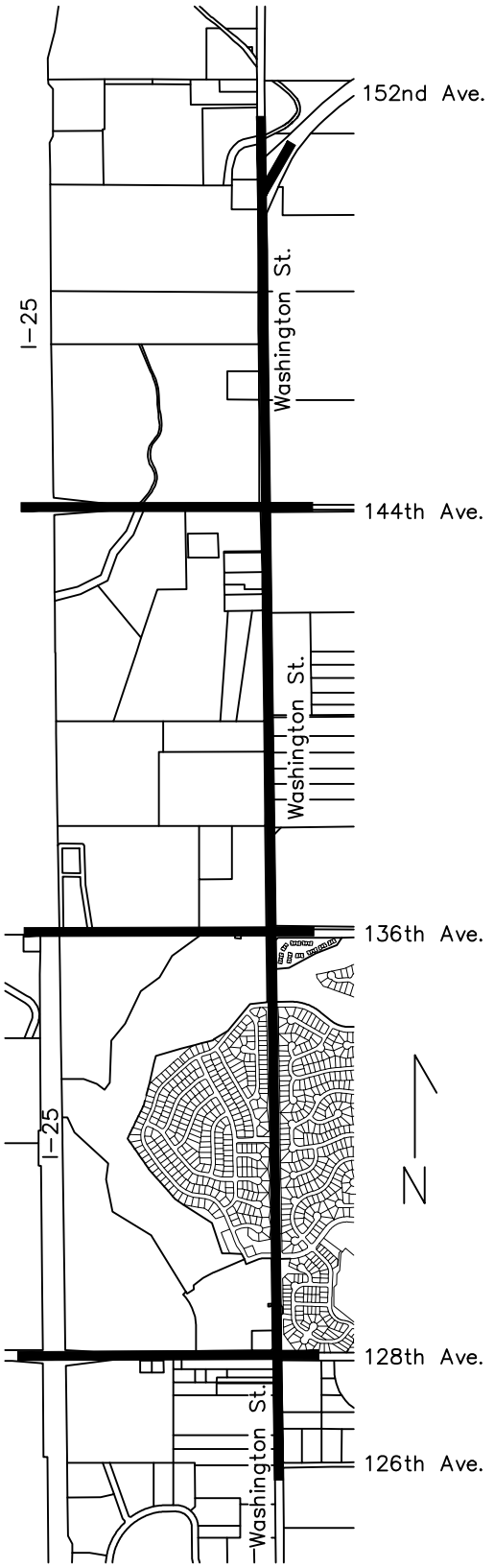
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL PEDESTRIAN POLE FOOTING INSTALLATION

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700–4



STREET LIGHTS AND TRAFFIC SIGNAL POLES AND MAST ARMS

TOP COAT BEIGE FEDERAL COLOR #20227 (SEMI-GLOSS), AMERCOAT #450GL ALIPHATIC POLYURETHANE IN CONJUNCTION WITH AMERCOAT #71 POLYAMIDE CURED EPOXY PRIMER

TRAFFIC SIGN POLES

POWDER COATED MOCHA BROWN FEDERAL COLOR #10075, POWDER RESIN #10075

STRUCTURAL CONCRETE

BEIGE FEDERAL COLOR #30450

I-25 AND BIG DRY CREEK BRIDGE GIRDERS

DARK BROWN FEDERAL COLOR #30117

LETTERING ON I-25 BRIDGE, LIGHT SCULPTURE CRADLES AT I-25, BIG DRY CREEK BRIDGE, CORNER MONUMENTS, AND LETTERS ON THE THORNTON ENTRY SIGN

TIGER DRYLAC METALLIC, POWDER COAT, #49/90620, ANTIQUE/VEIN COPPER (SEMI-GLOSS)

THORNTON ENTRY SIGN BACKGROUND COLOR

DAVIS COLOR MESA BUFF

WHITE SPHERE BRIDGE MONUMENTS

PPG GLACIER WHITE PEARL METALLIC, CLEAR COAT: DELTA, #DCU 2070

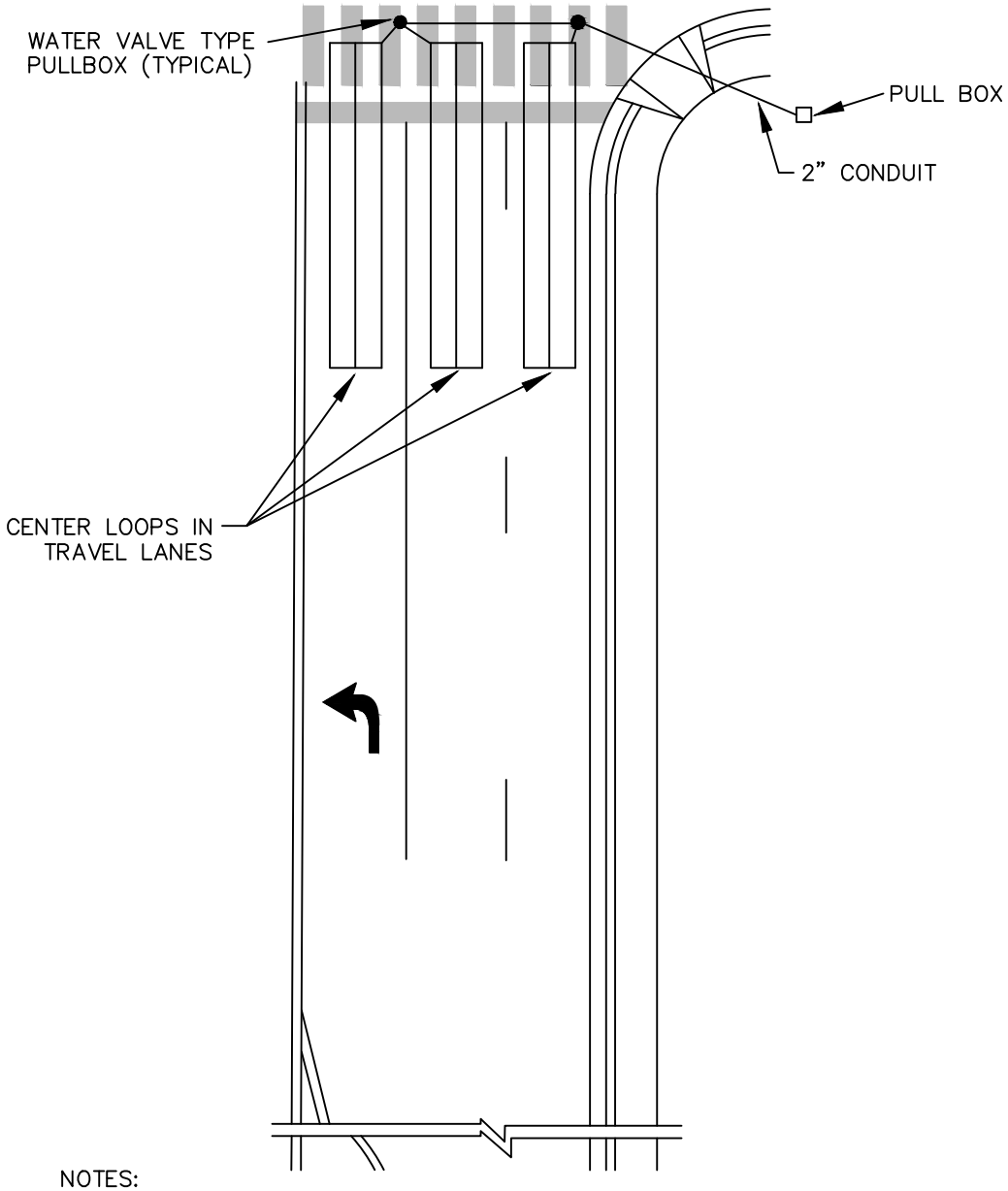
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

EXTERIOR COLORS
WASHINGTON ST CORRIDOR

ISSUED:
JANUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700-5



NOTES:

1. THIS MAY ONLY BE USED WITH WRITTEN AUTHORIZATION OF THE TRAFFIC ENGINEER.
2. ALL LOOPS SHALL BE WIRED FOR SINGLE CHANNEL.
3. SEE PLANS FOR LOCATION AND LENGTH OF EACH DETECTOR.
4. CIRCULAR LOOPS MAY BE USED AS AN ALTERNATIVE.

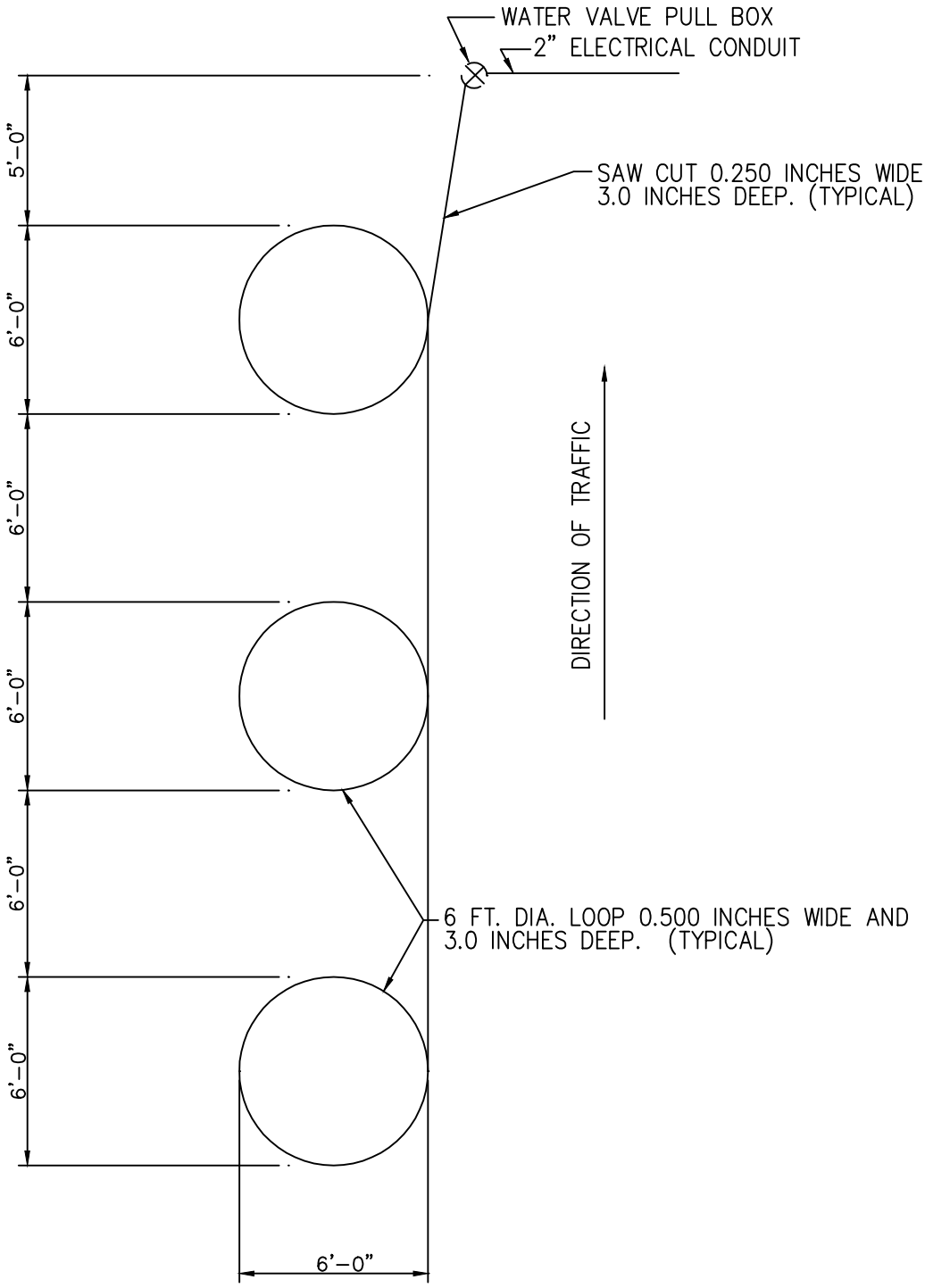
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL LOOP PLACEMENT DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-6



NOTE:

THIS LOOP DETECTOR MAY ONLY BE USED WITH THE WRITTEN AUTHORIZATION OF THE TRAFFIC ENGINEER. THIS LOOP DETECTOR CAN BE USED INSTEAD OF 6' x 40' QUADROPOLE LOOP SHOWN ON PLAN.

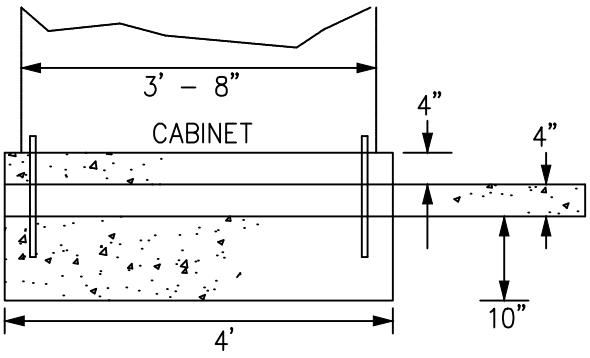
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

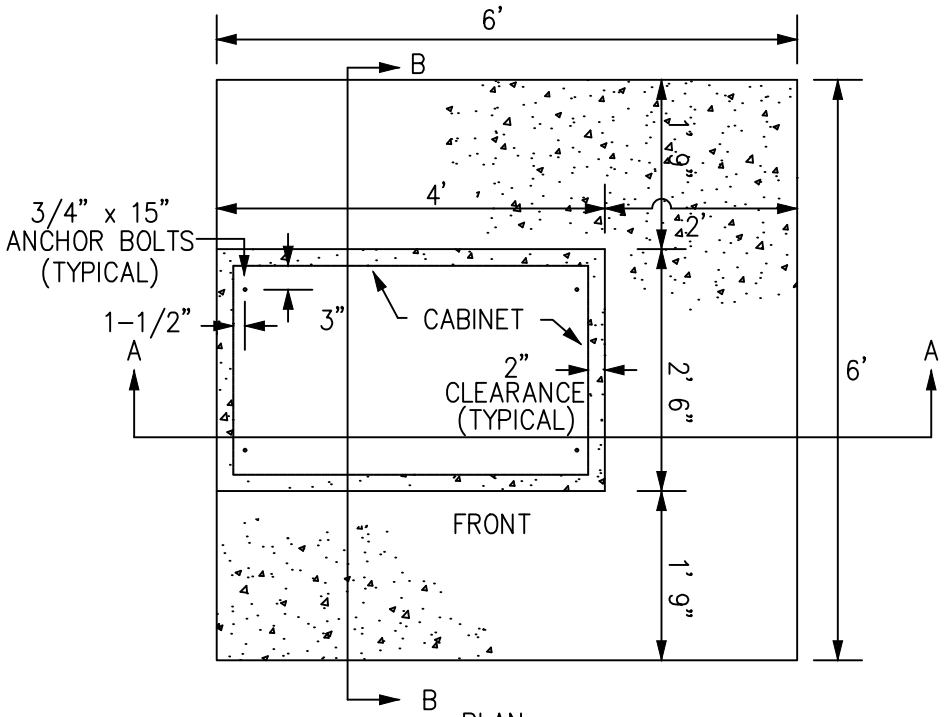
TYPICAL ALTERNATIVE ROUND LOOP LAYOUT

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

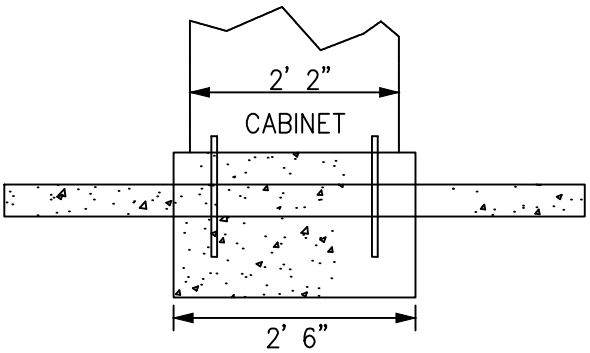
DRAWING NO.
700-7



SECTION A-A



PLAN



SECTION B-B

NOTE: ALL CONCRETE TO BE CLASS D

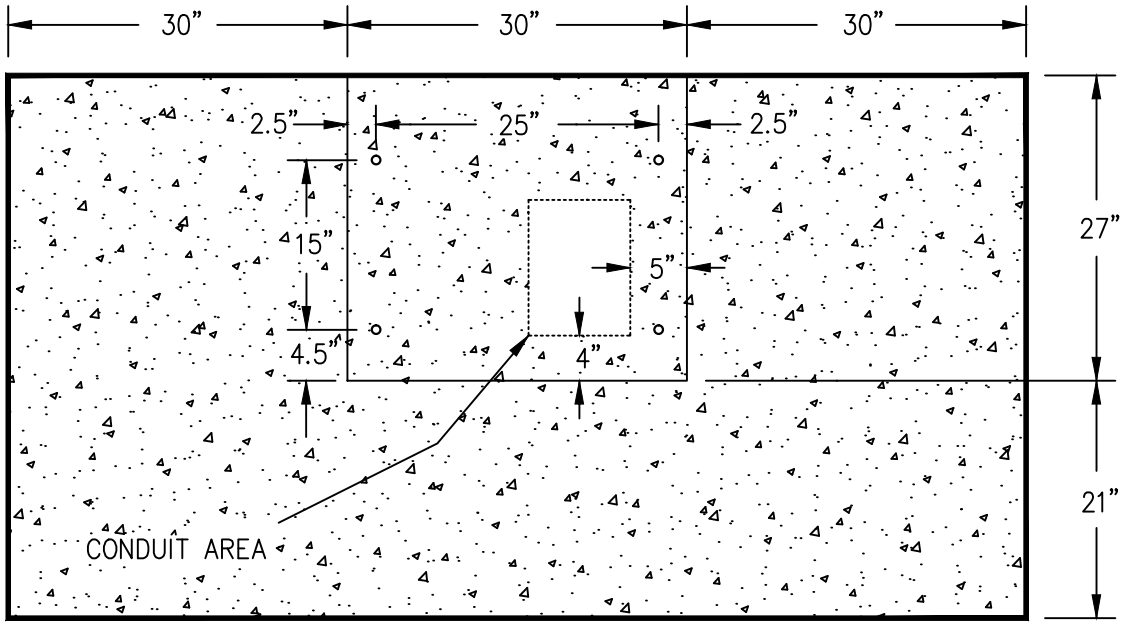
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

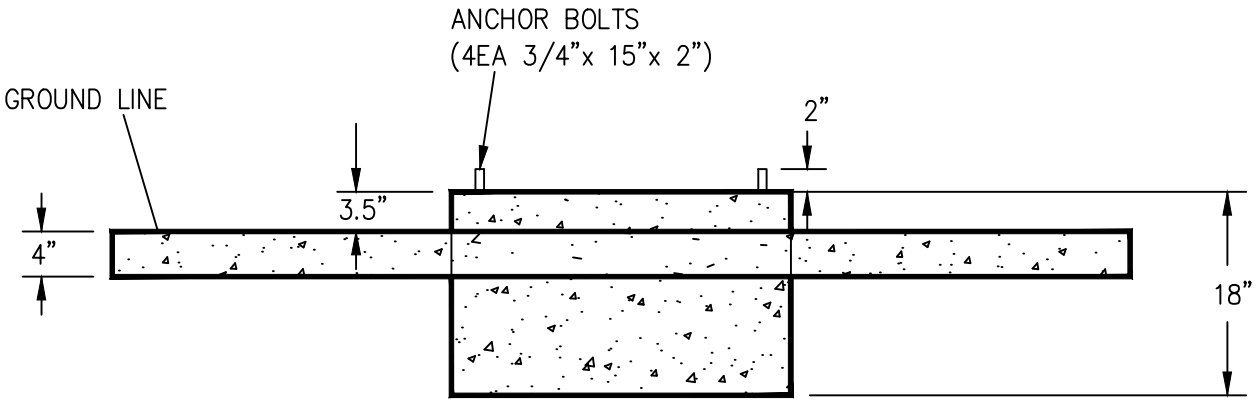
333 CONTROLLER CABINET FOUNDATION DETAILS

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-8



TOP VIEW



FRONT VIEW

NOTE: ALL CONCRETE TO BE CLASS D

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

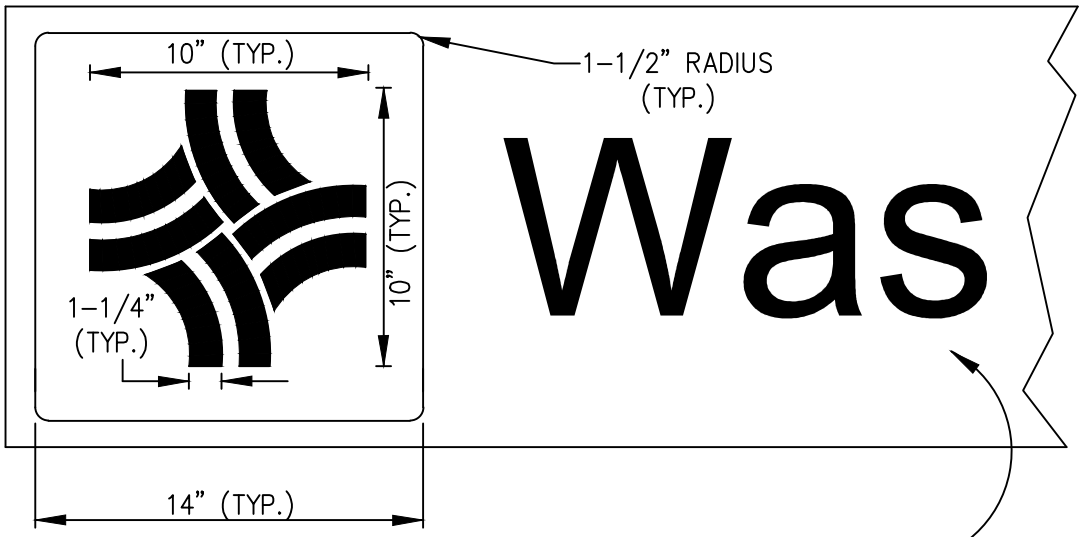
336 CONTROLLER CABINET FOUNDATION DETAILS

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

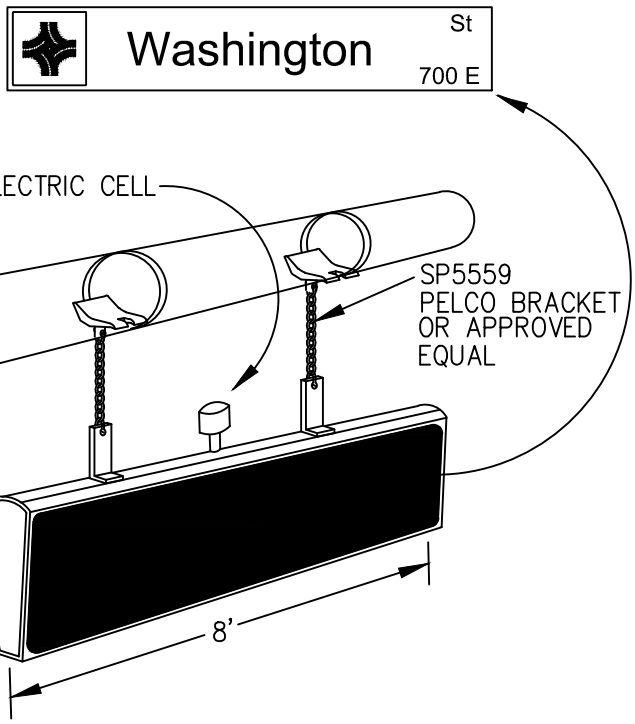
DRAWING NO.
700-9

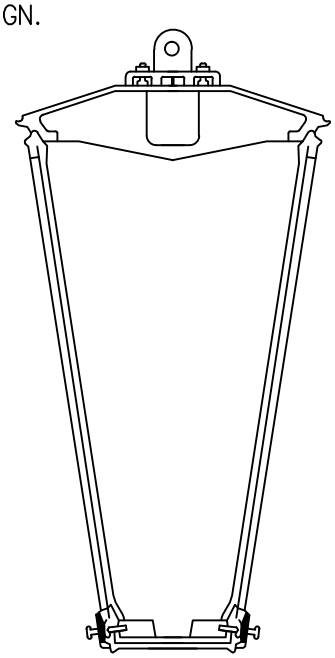
TYPICAL LAYOUT

COLORS:
LOGO = PANTONE 300 INTENSE BLUE
LOGO BACKGROUND = WHITE
SIGN FIELD = PANTONE 3435c EMERALD GREEN
STREET NAME LETTERING = WHITE
HOUSING COLOR = PER DRAWING NO. 700–5



TEXT SIZE FOR STREET NAME TO AS LARGE AS POSSIBLE AND AND STILL MAINTAIN A +/– 1" BORDER AROUND SIGN.





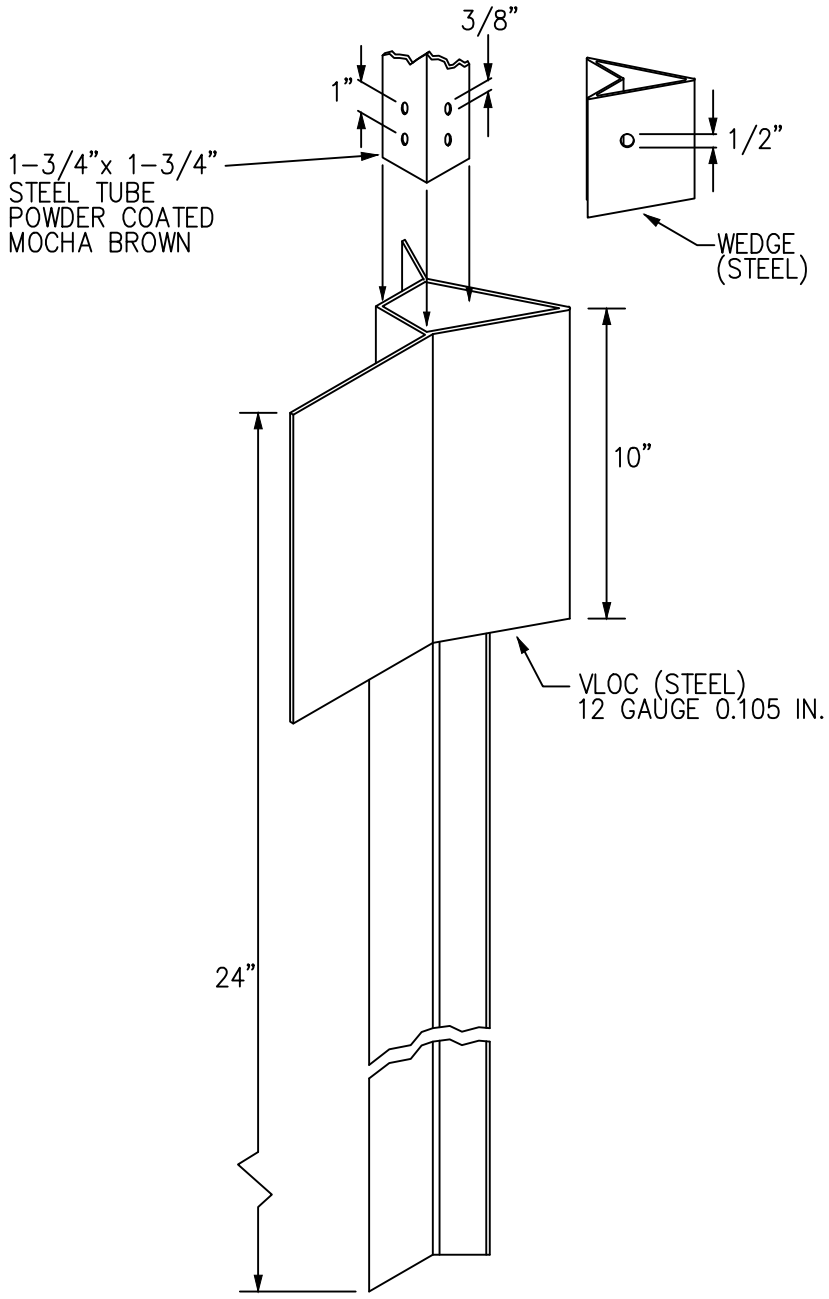
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL ILLUMINATED STREET SIGN INSTALLATION

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700–10



NOTE: ALL TUBINGS ARE #12 U.S. STD. GAUGE WALL THICKNESS.
SIGN POST INSTALLATION SHALL FOLLOW THE MANUFACTURER'S INSTRUCTIONS AND THESE SPECIFICATIONS:

1. THE SIGN POST ANCHOR SHALL BE DRIVEN INTO THE GROUND TO 1" ABOVE THE GROUND. SIDEWALK SHALL BE POURED AROUND SIGN POST ANCHOR OR EXISTING SIDEWALK SHALL BE CORE DRILLED AND SEALED AROUND THE POST ANCHOR.
2. INSERT SIGN POST INTO ANCHOR ASSEMBLY 6 INCHES AND INSTALL WEDGE.
3. INSTALLED SIGN AND POST SHALL BE PLUMB AND FREE OF VERTICAL AND LATERAL MOVEMENT.

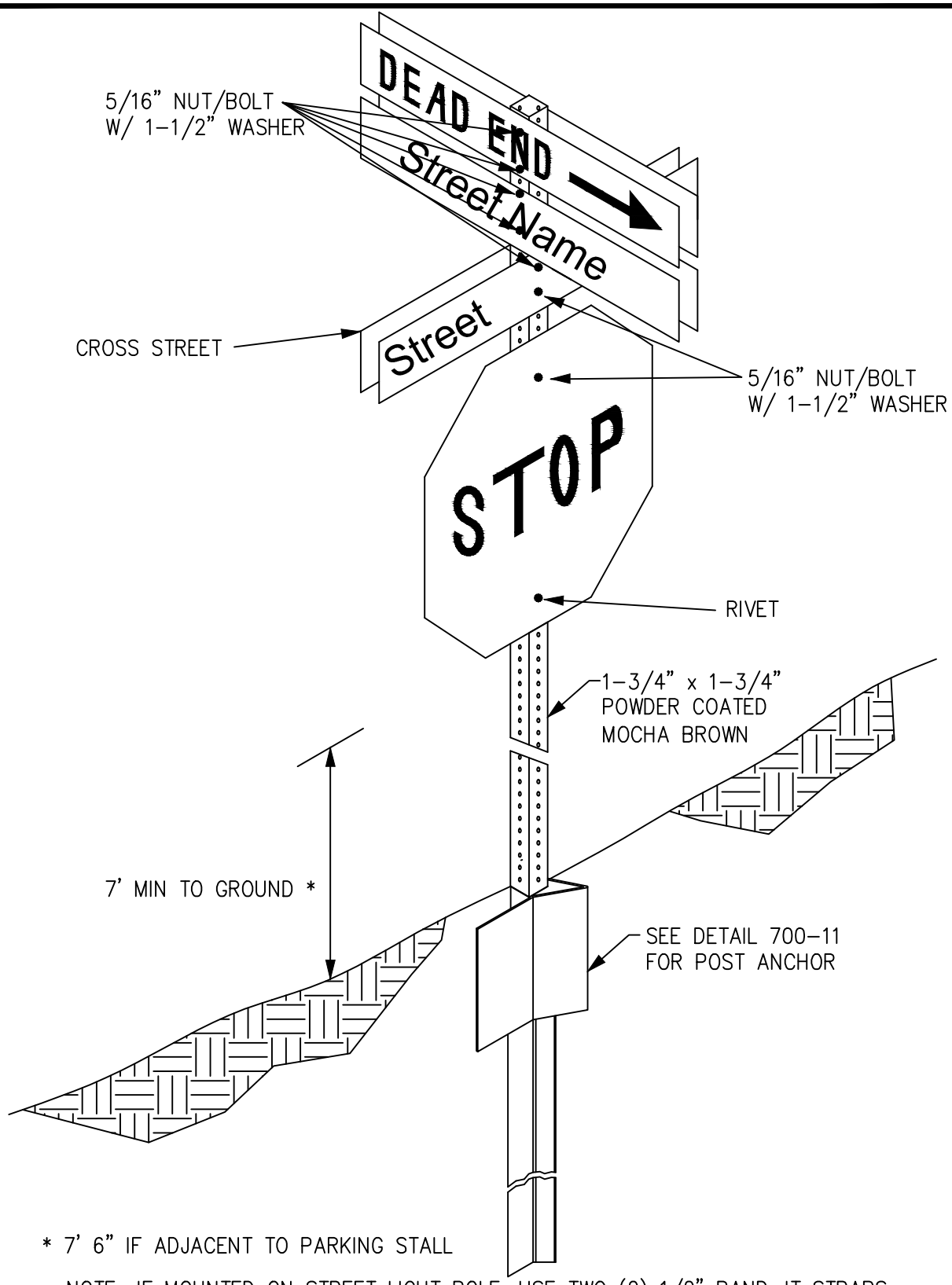
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SIGN POST ANCHOR DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-11



* 7' 6" IF ADJACENT TO PARKING STALL

NOTE: IF MOUNTED ON STREET LIGHT POLE, USE TWO (2) 1/2" BAND-IT STRAPS

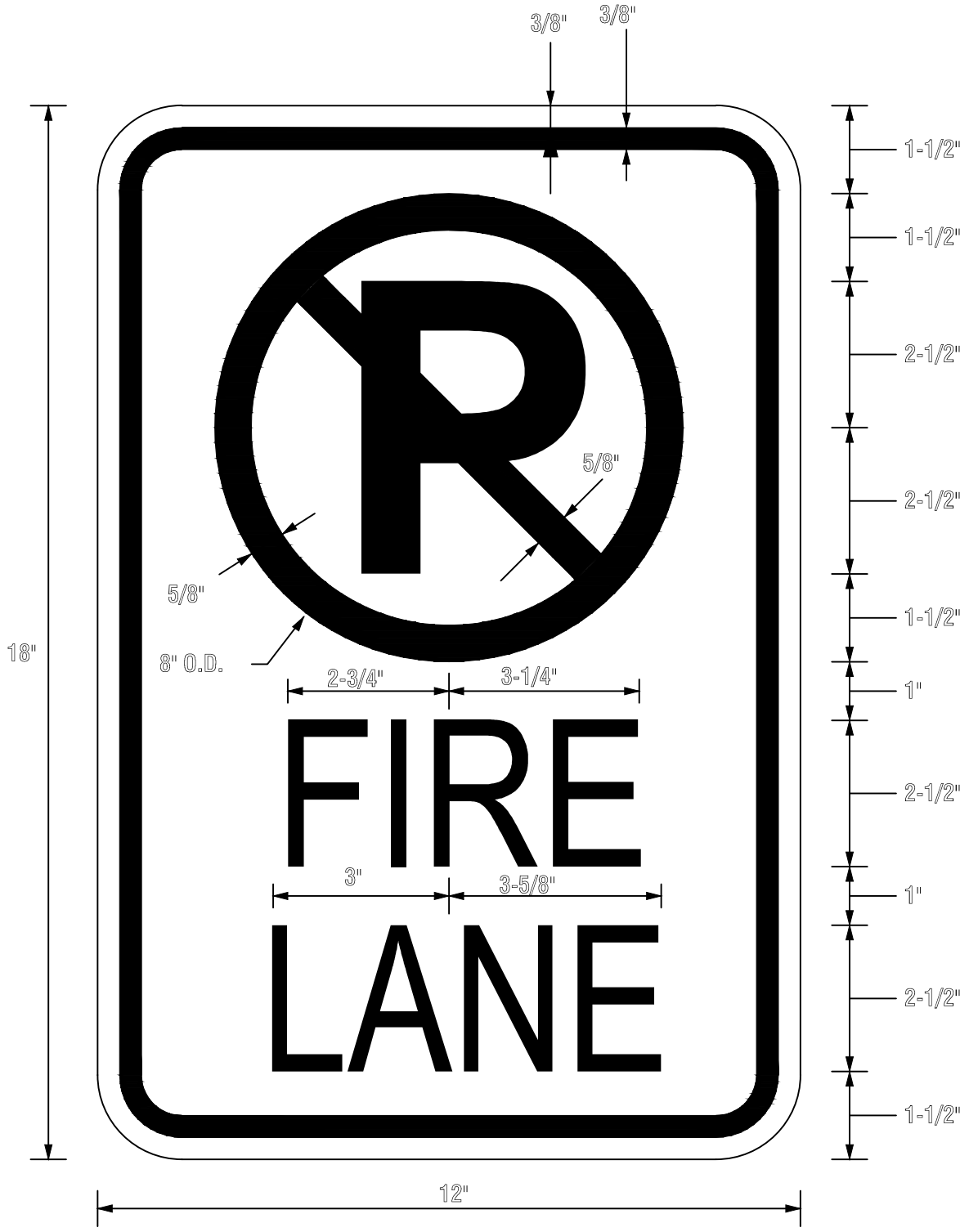
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SIGN ASSEMBLY DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
AUG 2012

DRAWING NO.
700-12



COLORS:
FIRE LANE, CIRCLE, DIAGONAL - RED
BACKGROUND - WHITE
LETTER "P", BORDER - BLACK

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

FIRE LANE – NO PARKING REGULATORY SIGN

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700–13

COLORS:

(TOP) RED BACKGROUND, WHITE LETTERING AND SNOWFLAKE

(MIDDLE) WHITE BACKGROUND, BLACK "P", RED CIRCLE & DIAGONAL

(BOTTOM) BLUE BACKGROUND, WHITE LETTERING

N.T.S.

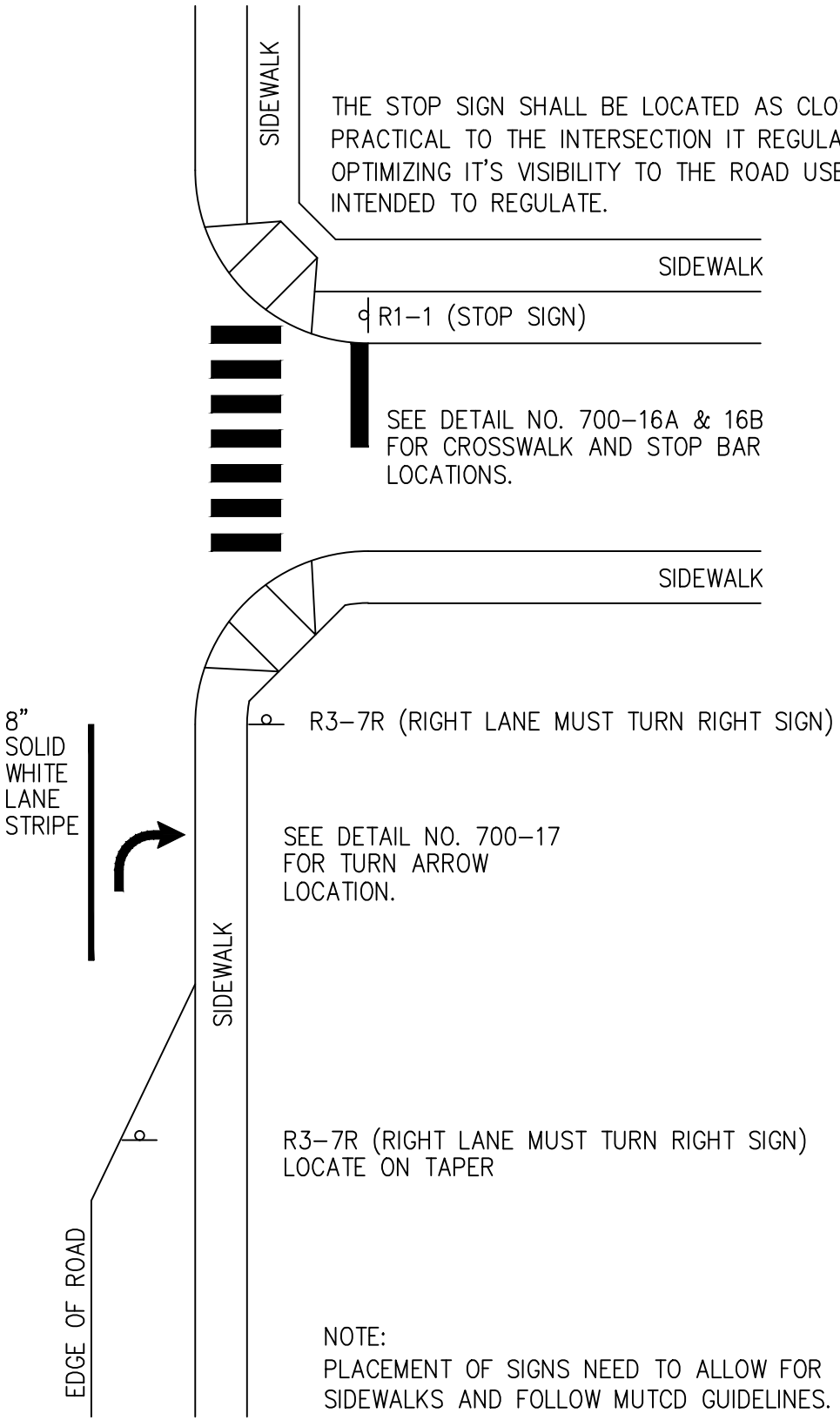
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SNOW ROUTE – NO PARKING REGULATORY SIGN

ISSUED:
FEBRUARY 2005

REVISED:
APRIL 2010

DRAWING NO.
700–13A



NOTE:
PLACEMENT OF SIGNS NEED TO ALLOW FOR SIDEWALKS AND FOLLOW MUTCD GUIDELINES.

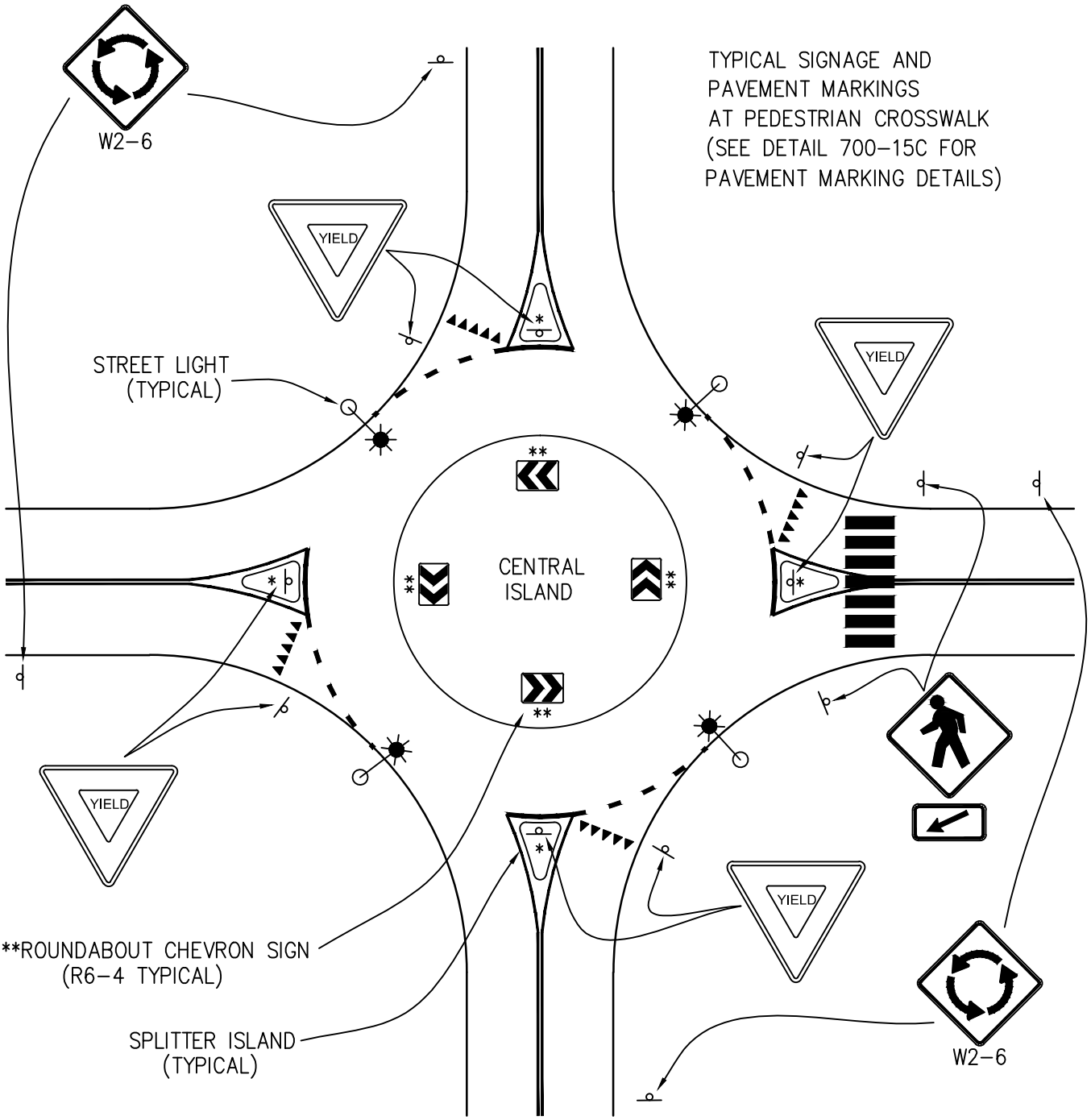
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

PAVEMENT MARKINGS AND SIGN LOCATIONS DETAIL

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700-14



TYPICAL SIGNAGE AND
PAVEMENT MARKINGS
AT PEDESTRIAN CROSSWALK
(SEE DETAIL 700-15C FOR
PAVEMENT MARKING DETAILS)

* YIELD SIGN ON SPLITTER ISLAND IS OPTIONAL FOR ONE LANE APPROACHES AND ONLY IF SPLITTER ISLAND IS RAISED.

STREET NAME SIGNS SHALL BE ON TOP OF THE SHOULDER YIELD SIGN
ALL SIGNS AND STRIPING SHALL BE PER THE M.U.T.C.D.

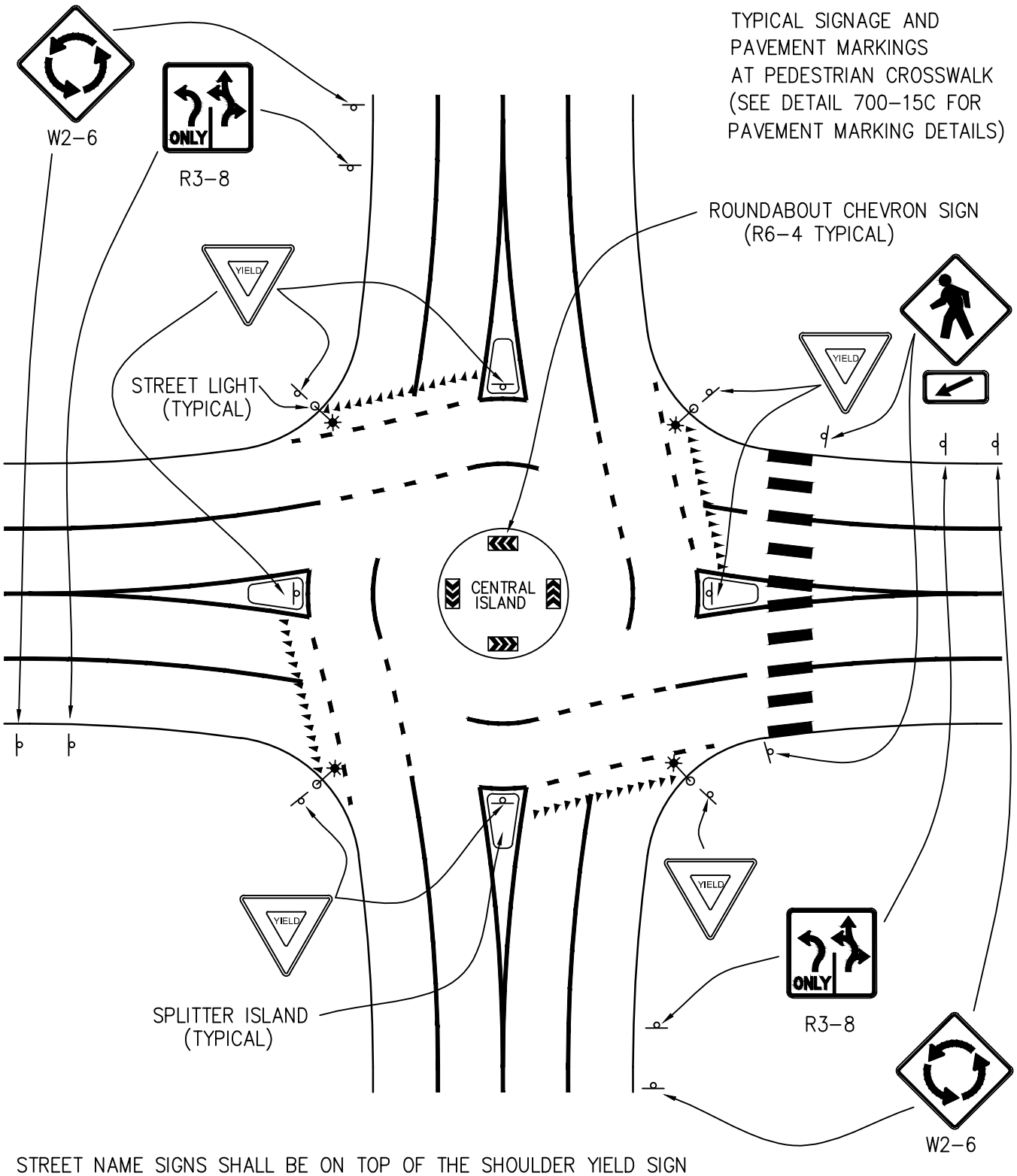
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TRAFFIC CIRCLE SIGN AND PAVEMENT MARKING STANDARDS WITH STREET LIGHT PLACEMENT

ISSUED:
FEBRUARY 2005
REVISED:
AUG 2012

DRAWING NO.
700-15A



STREET NAME SIGNS SHALL BE ON TOP OF THE SHOULDER YIELD SIGN
ALL SIGNS AND STRIPING SHALL BE PER THE M.U.T.C.D.

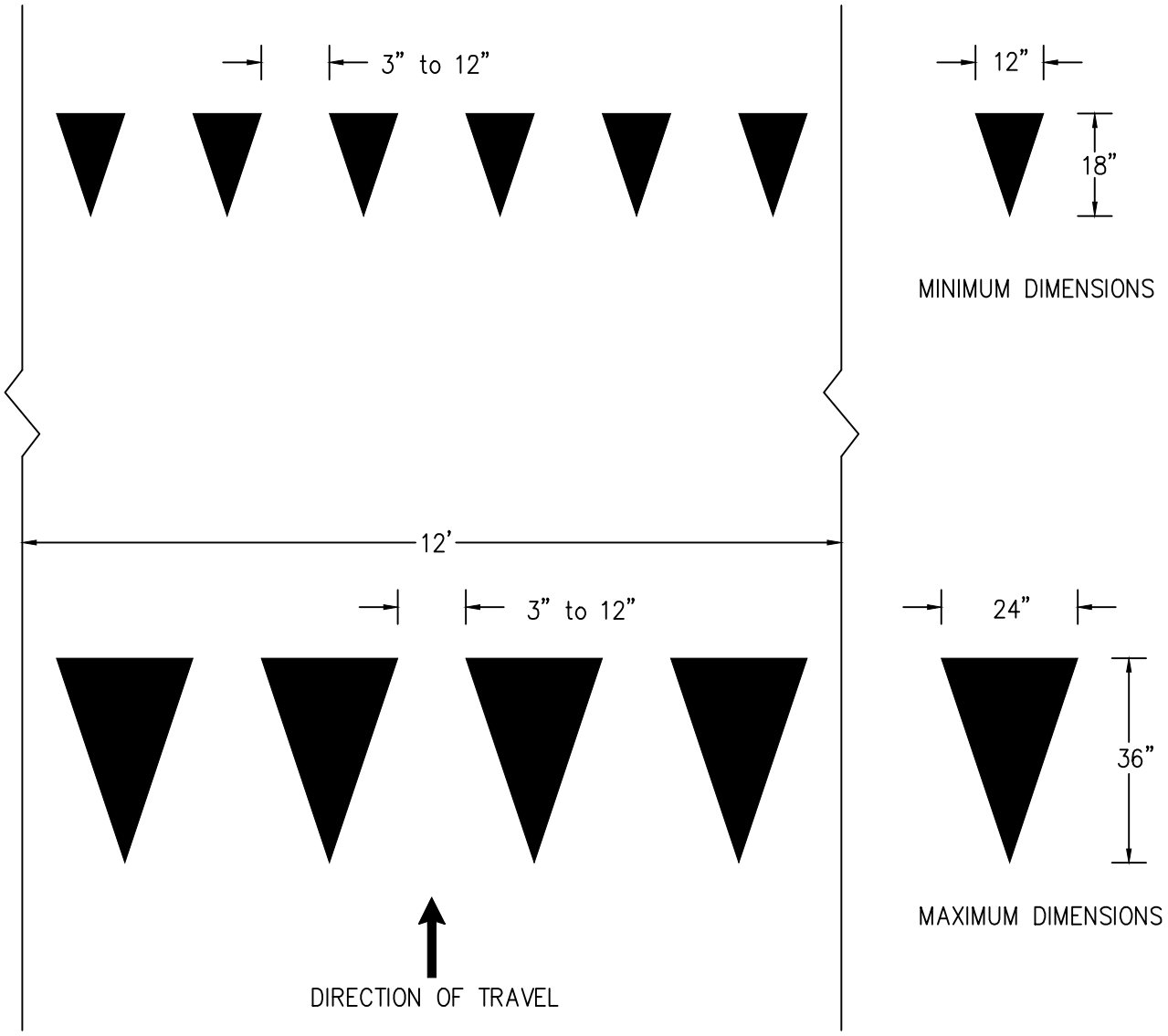
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TRAFFIC CIRCLE/MULTI-LANE SIGNS & PAVEMENT MARKING STANDARDS W/ STREET LIGHT PLACEMENT

ISSUED:
JANUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700-15B



NOTES:

1. TRIANGLE LENGTH IS EQUAL TO 1.5 TIMES THE BASE DIMENSION.

2. YIELD LINES MAY BE SMALLER THAN SUGGESTED WHEN INSTALLED ON MUCH NARROWER, SLOW-SPEED FACILITIES SUCH AS SHARED-USE PATHS.

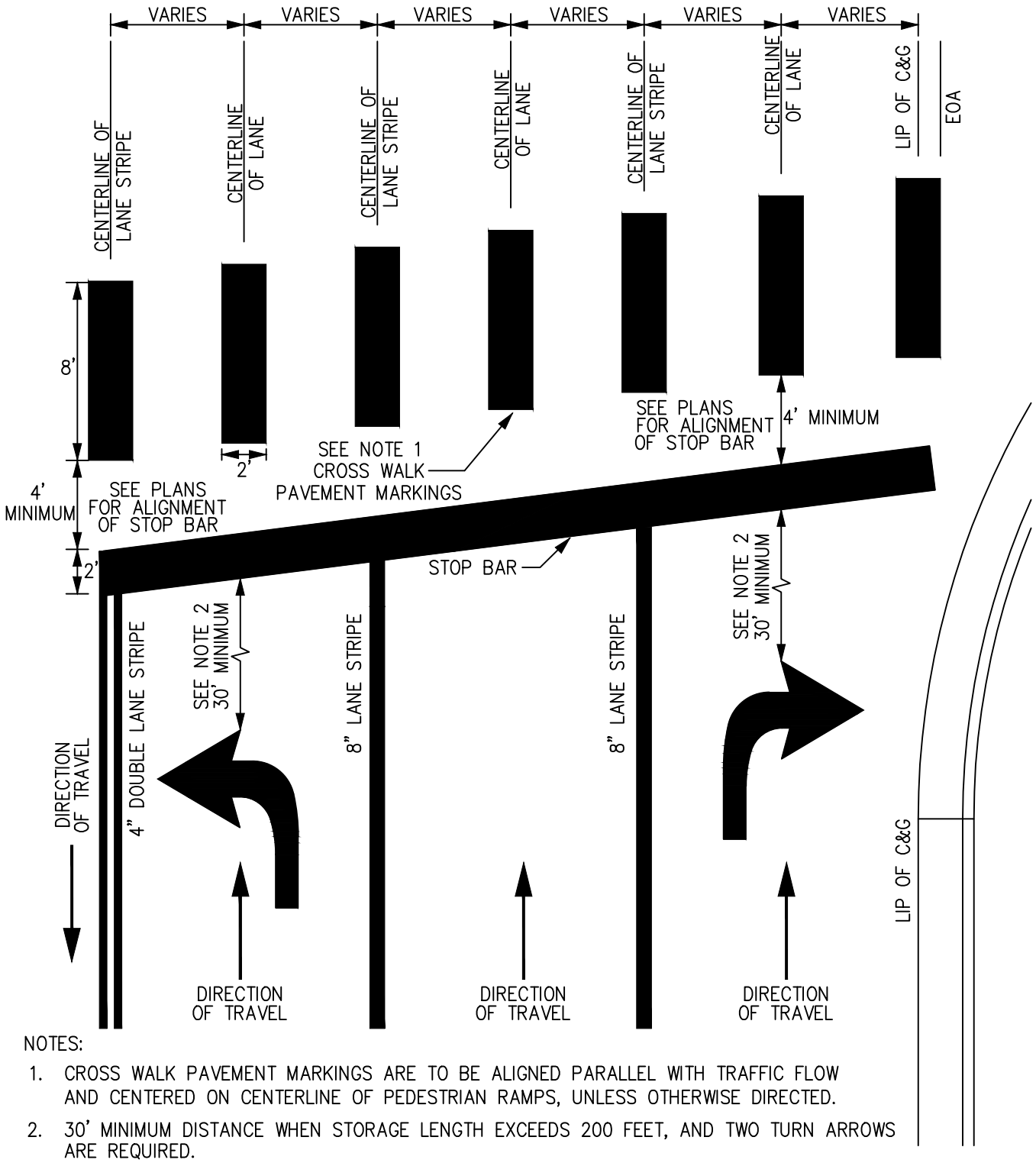
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL YIELD LINE LAYOUT FOR STREETS AND HIGHWAYS

ISSUED:
JANUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-15C



NOTES:

1. CROSS WALK PAVEMENT MARKINGS ARE TO BE ALIGNED PARALLEL WITH TRAFFIC FLOW AND CENTERED ON CENTERLINE OF PEDESTRIAN RAMPS, UNLESS OTHERWISE DIRECTED.
2. 30' MINIMUM DISTANCE WHEN STORAGE LENGTH EXCEEDS 200 FEET, AND TWO TURN ARROWS ARE REQUIRED.

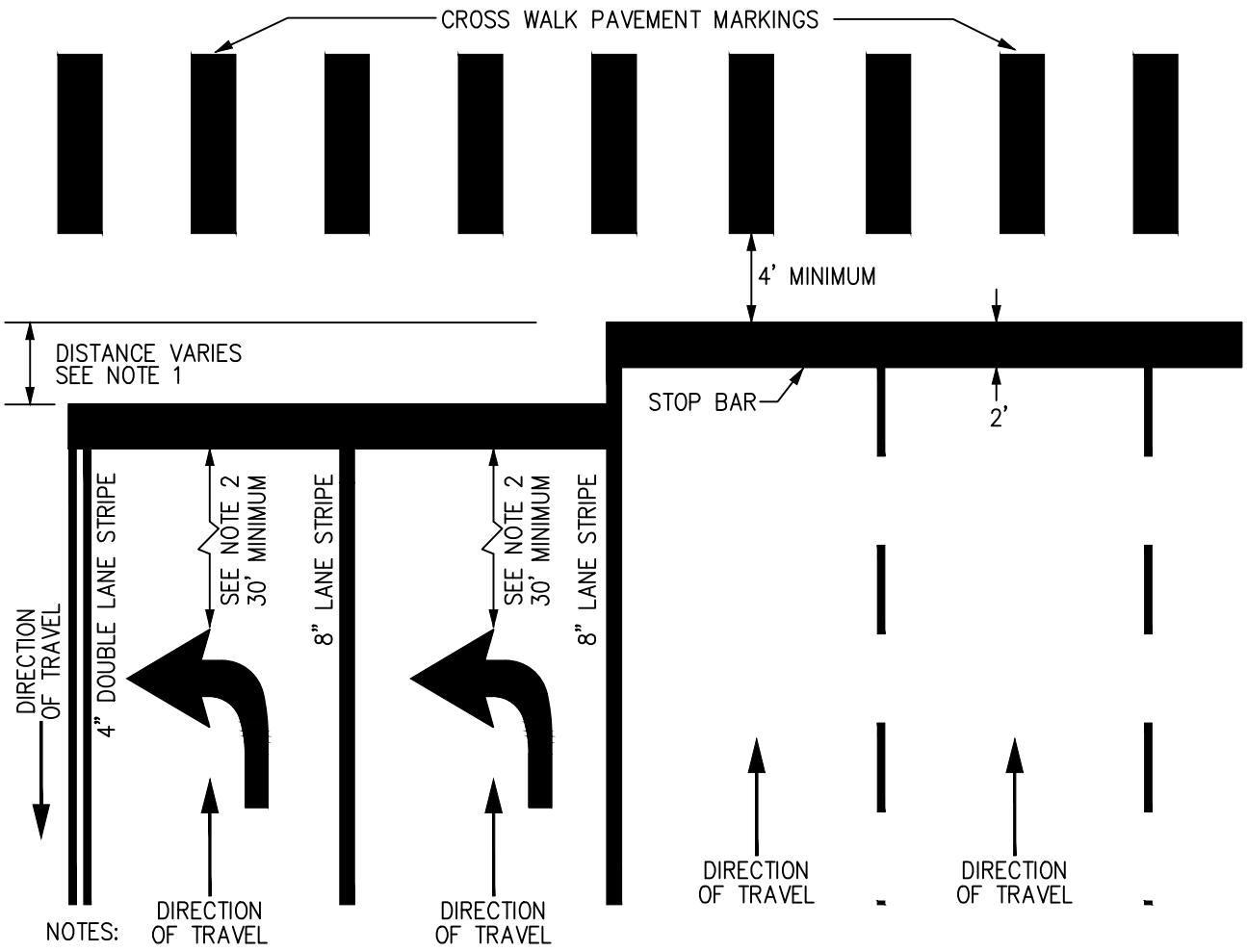
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CROSSWALK & STOP BAR PAVEMENT MARKING DETAIL

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700–16A



NOTES:

1. DISTANCE TO BE FIELD DETERMINED TO ACCOMMODATE TURNING RADIUS; LAYOUT TO BE APPROVED BY THE TRAFFIC ENGINEER PRIOR TO INSTALLATION.

2. 30' MINIMUM DISTANCE WHEN STORAGE LENGTH EXCEEDS 200 FEET, AND TWO TURN ARROWS ARE REQUIRED.

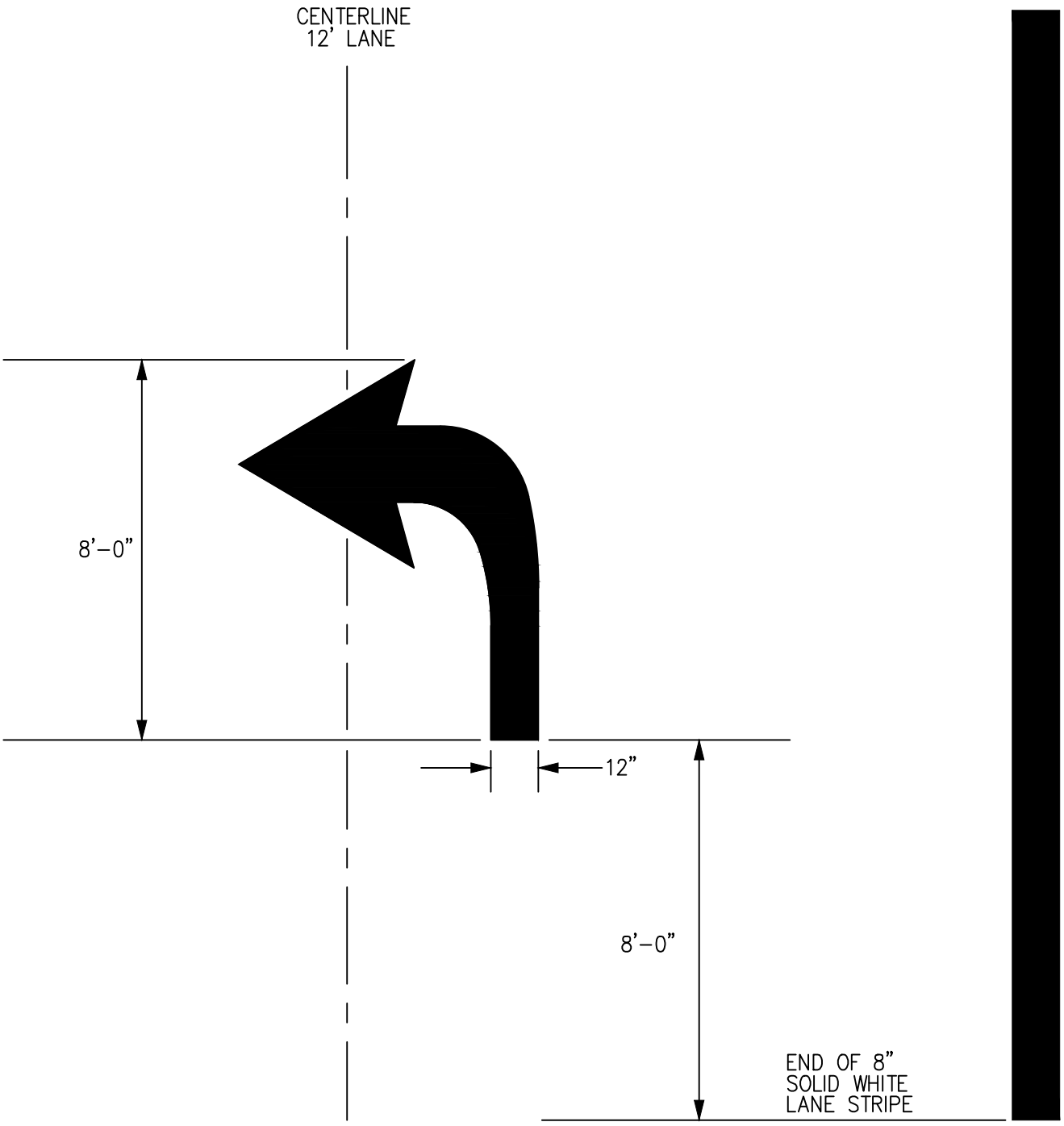
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STOP BAR LAYOUT FOR DOUBLE LEFT TURNS

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700–16B



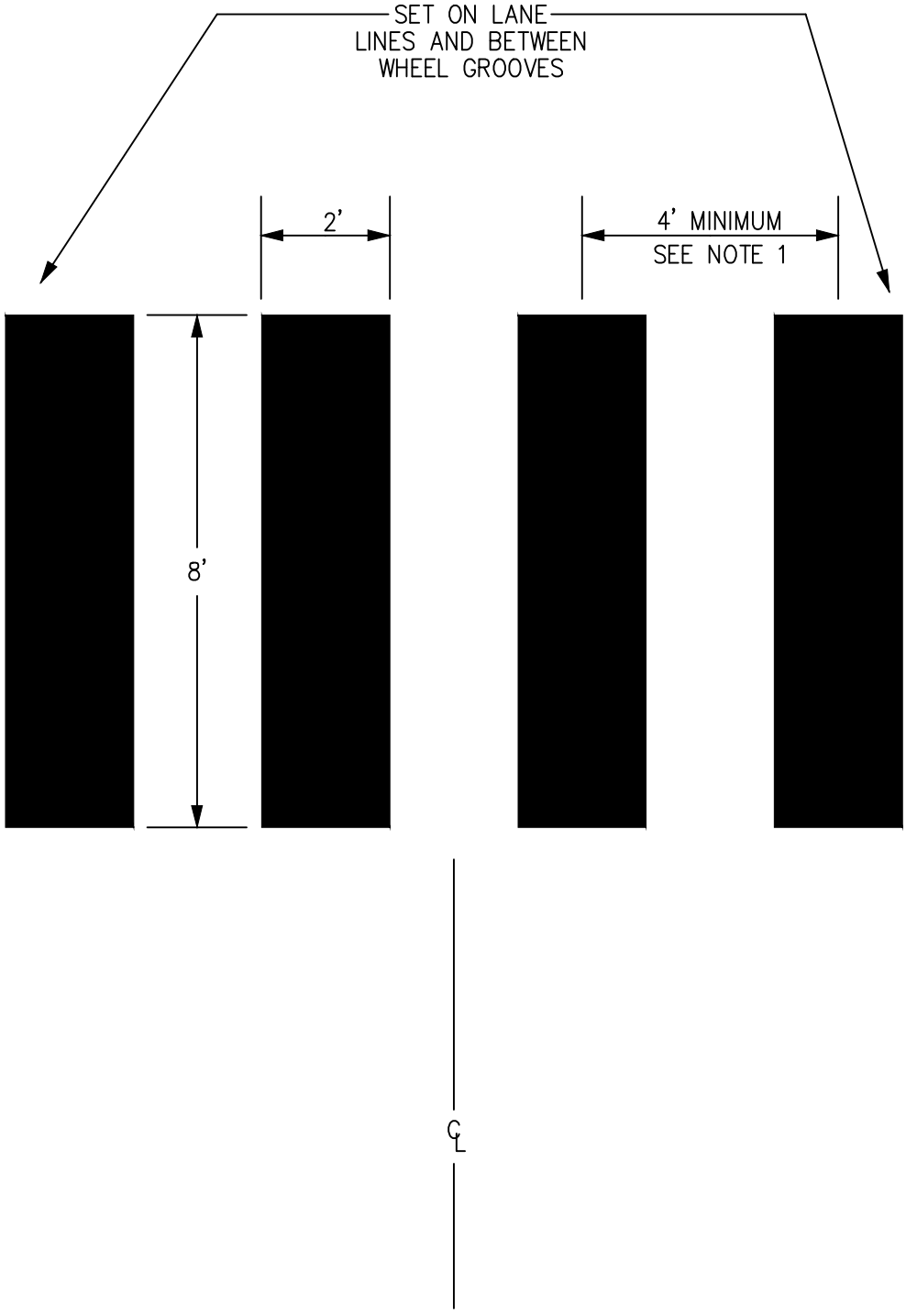
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TURN ARROW PAVEMENT MARKING DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-17



FIELD ADJUST SPACING TO AVOID VEHICLE TIRE PATHS.

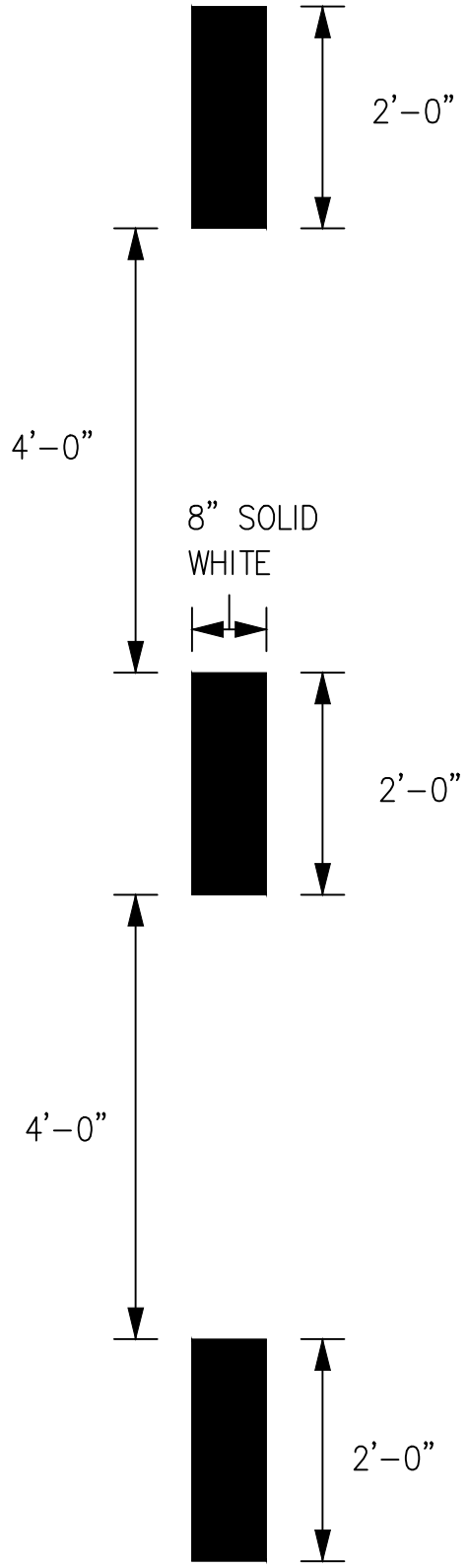
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CROSSWALK PAVEMENT MARKING DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700–18



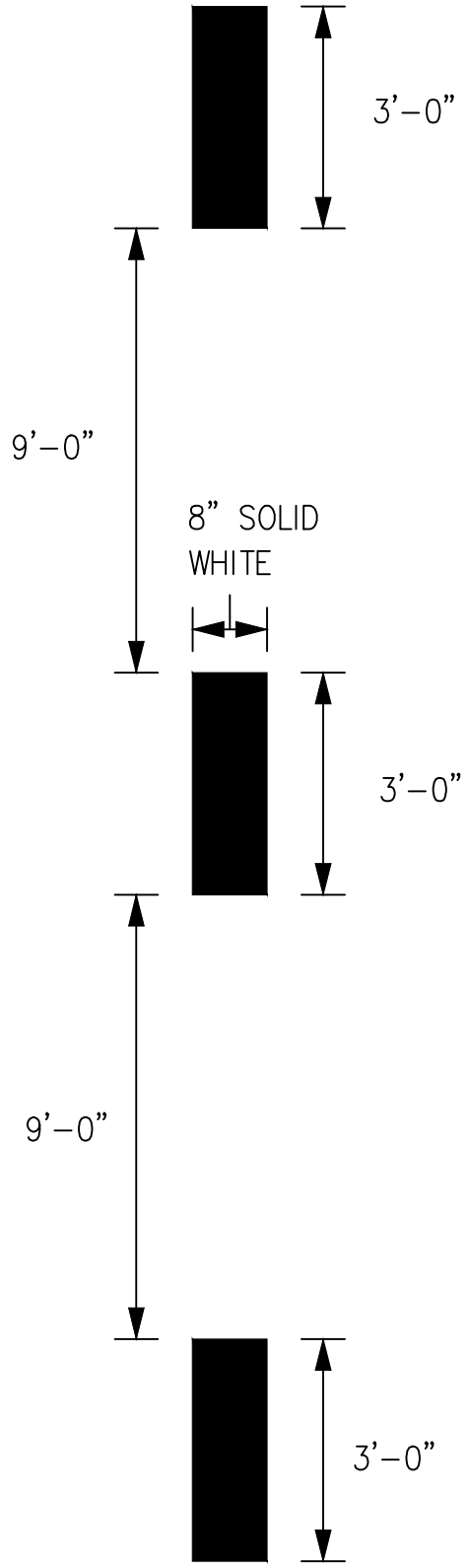
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

INTERSECTION LANE USE CONTROL PAVEMENT MARKING DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700–19A



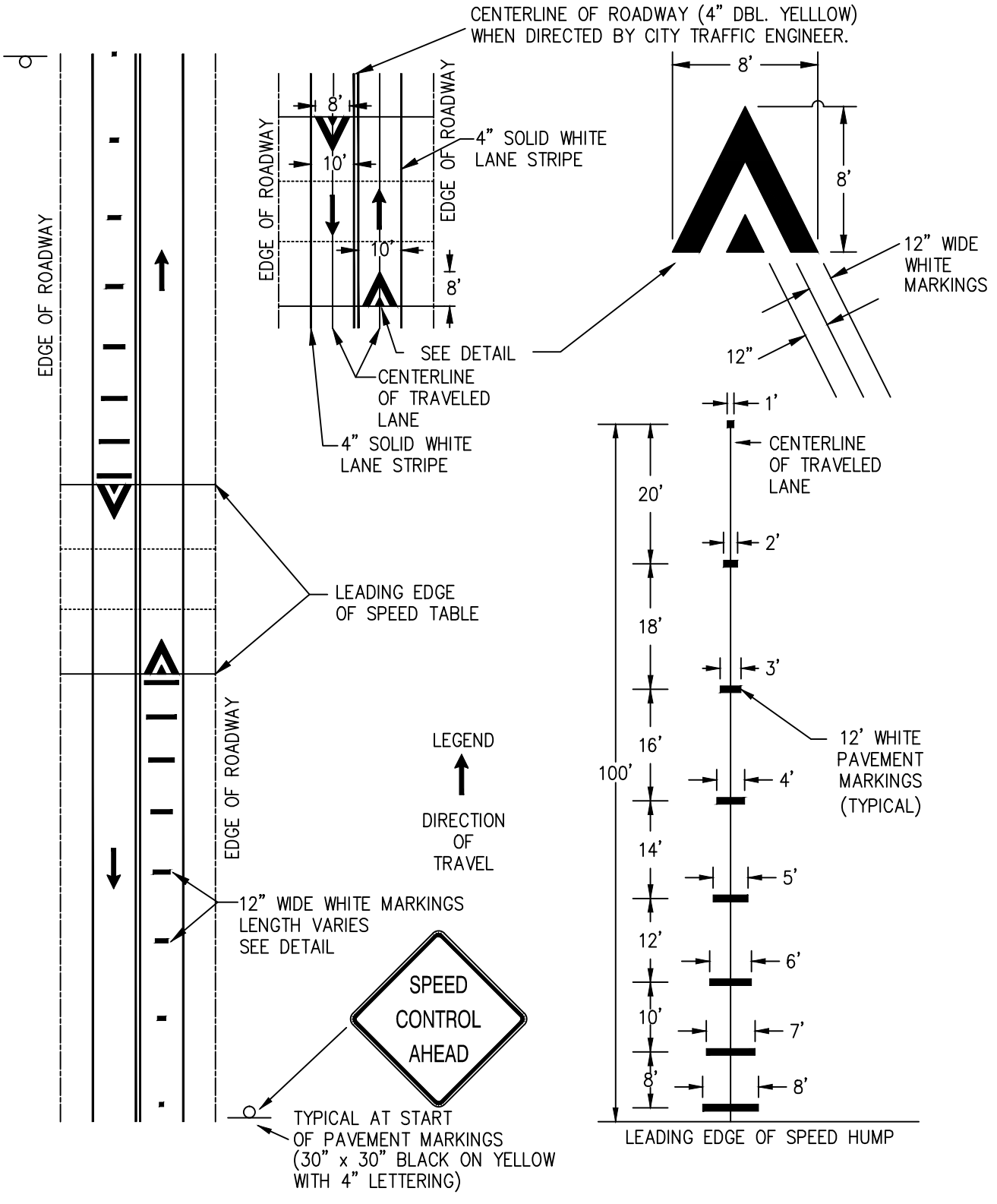
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

LANE DROP
PAVEMENT MARKING DETAIL

ISSUED:
SEPT 2012
REVISED:

DRAWING NO.
700–19B



N.T.S.

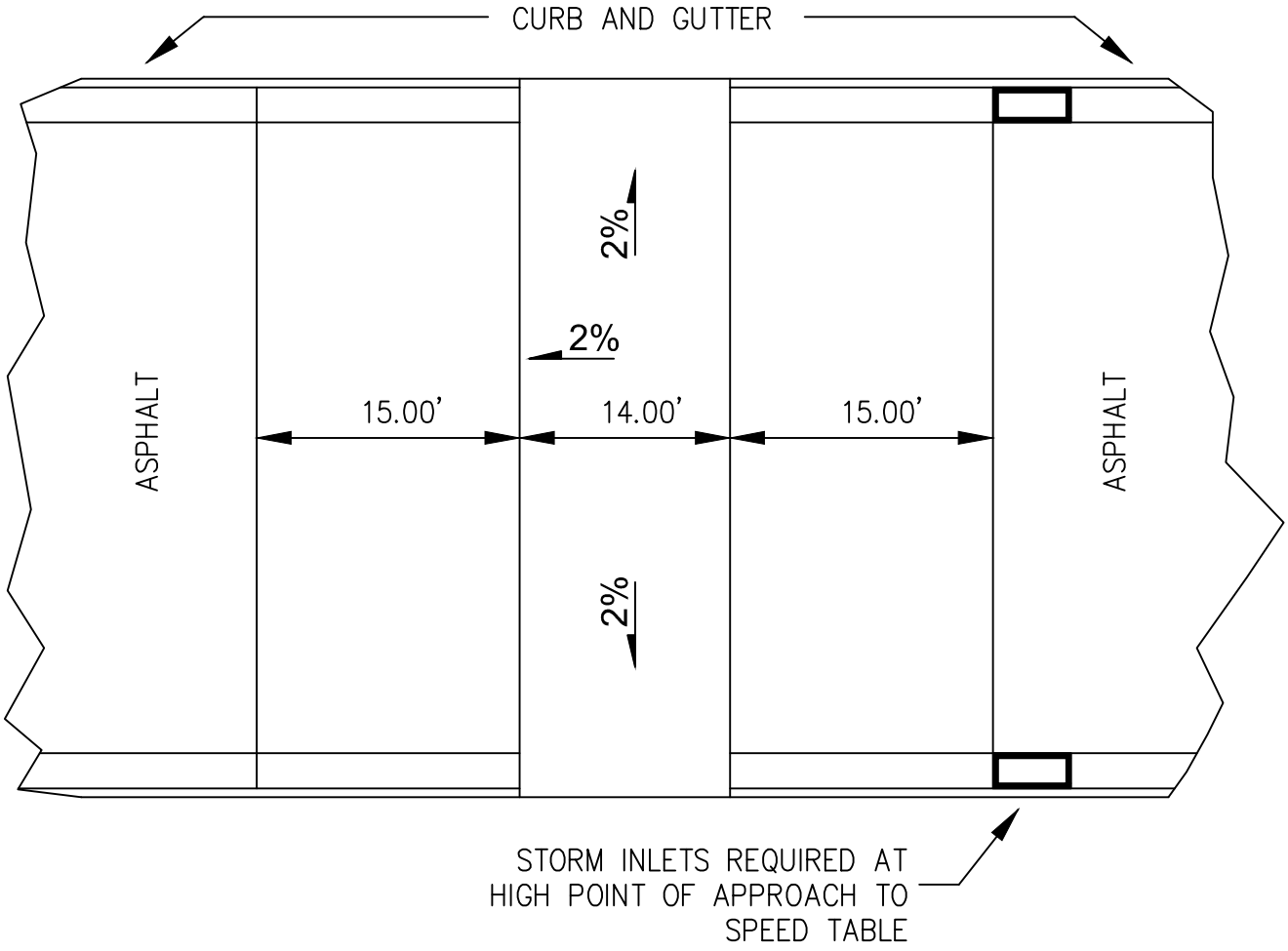
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL SPEED TABLE (FOR 25 MPH SITE)

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

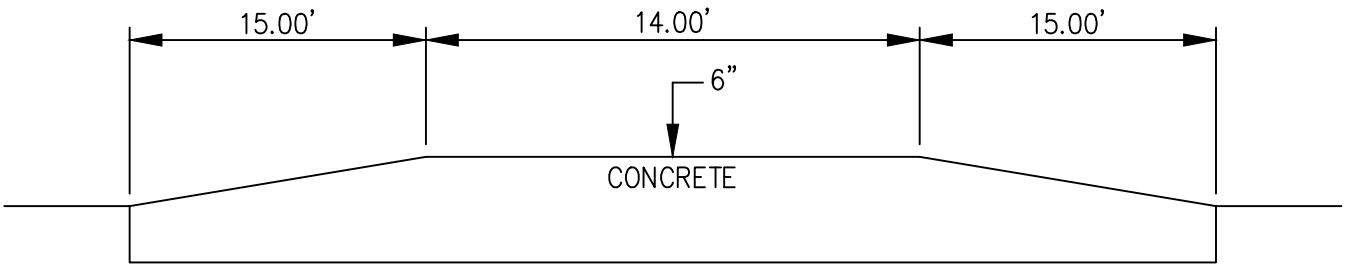
DRAWING NO.
700–20A

TYPICAL PLAN VIEW



CHANGE IN GRADE AT SPEED TABLE RAMPS SHALL BE 3.33% +/– .25%

TYPICAL LONGITUDINAL SECTION



N.T.S.

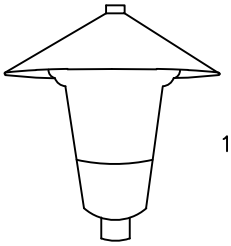
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL SPEED TABLE (FOR 25 MPH SITE)

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700–20B

POST TOP LUMINAIRES



LUMINAIRE, POST TOP
MODERN STYLE
100 WATT COLOR BLACK

LUMINAIRES FOR STEEL DAVIT OR MAST ARM POLES

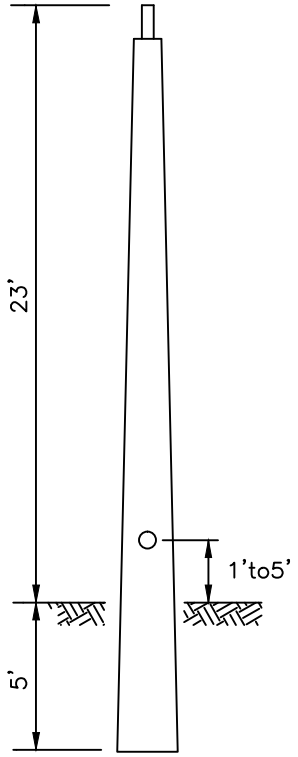
FLAT LENS

LIGHT EMITTING DIODE (LED) LUMINAIRES
COLOR GRAY

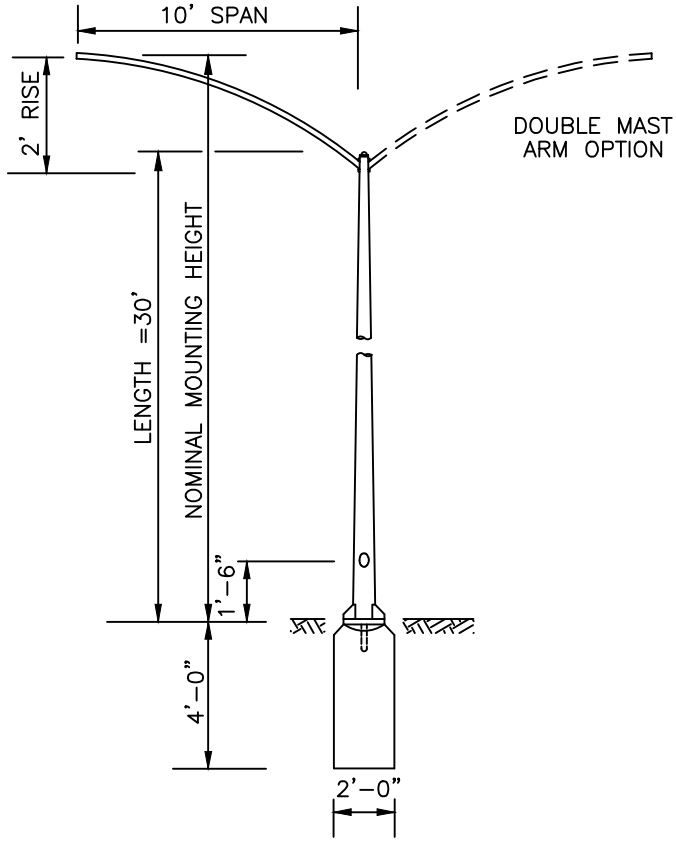
LOCATIONS	HPS EQUIVALENT WATTAGE
LOCAL	100
COLLECTORS	250
ARTERIALS *	250
INTERSECTIONS	400

STREET LIGHT SPACING SHALL BE INSTALLED AS INDICATED ON CONSTRUCTION PLANS.

* USE LED, 400W HIGH PRESSURE SODIUM EQUIVALENT, ALONG ARTERIALS NEXT TO COMMERCIAL AREAS WITH CITY APPROVAL



POLE, FIBERGLASS
DIRECT BURIED



STEEL MAST ARM POLE

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STREET LIGHTS DETAIL

ISSUED:
MAY 1993
REVISED:
APRIL 2010

DRAWING NO.
700-21

POLE

SMOOTH, STRAIGHT, STEEL 38' PAINTED POLE, 5.6" DIAMETER SHAFT, 4" x 8" HAND HOLE 48" FROM 13" POLE BASE PLATE, AND 11" TO 13" BOLT CIRCLE. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE
MOUNTAIN STATES LIGHTING PART NO. 28SRS-5.6/258 XX

ARM

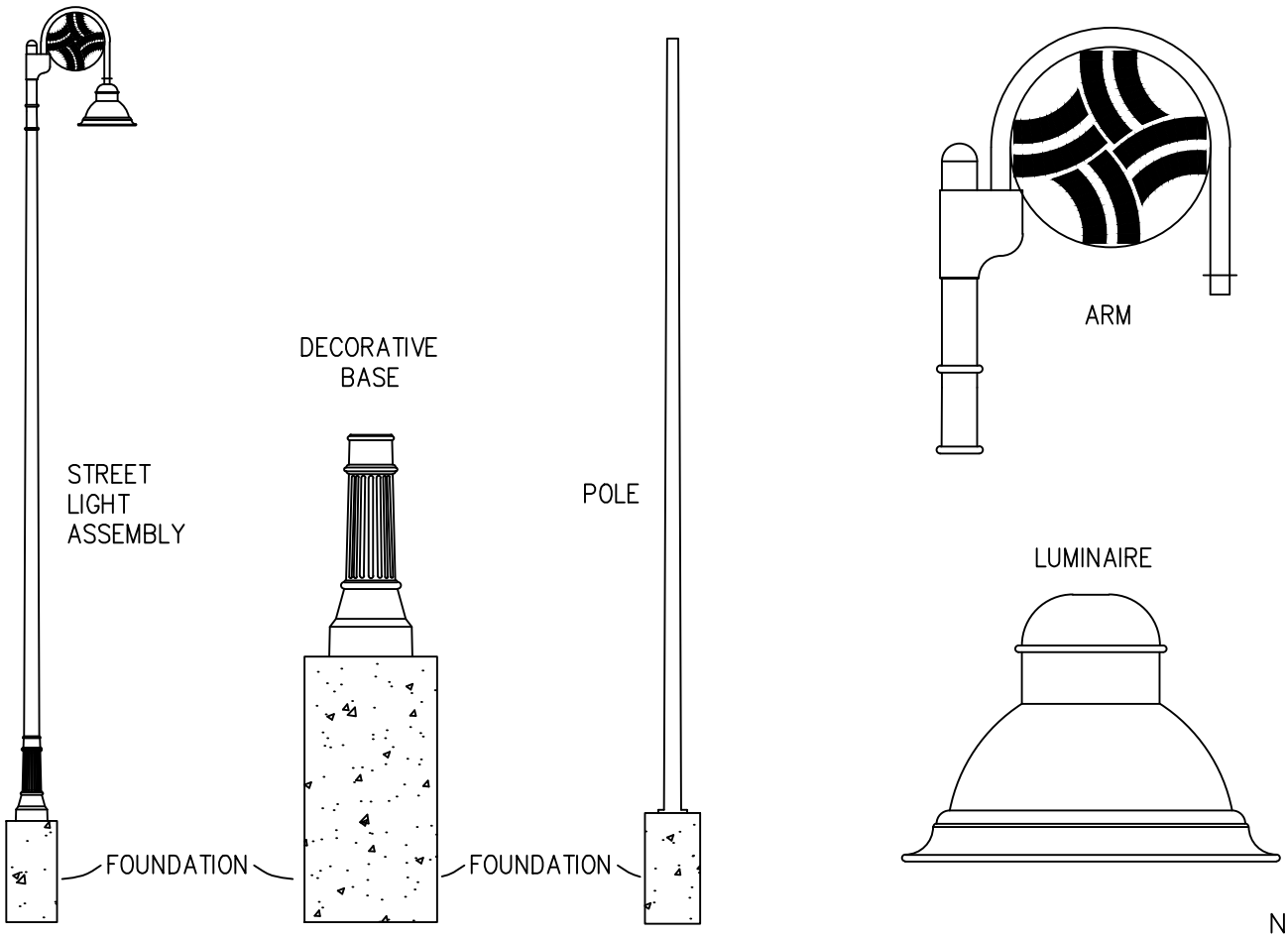
LUMINAIRE ARM, ALUMINUM, PAINTED, SLIP-OVER POLE FOR 9" WITH 5.6" OD, WITH BRACKET CAP SECURED WITH (3x) ¼-20 STAINLESS STEEL SET SCREWS @ 120 °. ARM IS ORDERED WITH BENT ALUMINUM DECORATIVE SCROLL. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE
LUMEC PART NO. LM1ACOLTXLMS (MODIFIED TO 30")
CITY LOGO SHALL BE REMOVABLE AND ANCHORED TO ARM USING STAINLESS STEEL BOLTS

LUMINAIRE

LED LIGHT, 250 WATT HIGH PRESSURE SODIUM EQUIVALENT, DOMUS FLAT LENS, 120/208/240/277 VOLT, MOGUL SOCKET, MULTI-TAP BALLAST, PENDANT MOUNT CLEAR GLASS TYPE III DISTRIBUTION. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE

DECORATIVE BASE

BASE, POLE, SPLIT ORNAMENTAL STANDARD, 16-1/2" DIAMETER x 40" HEIGHT, HIGH DENSITY ELASTOMER. FRANKLIN STYLE 16.5. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE
MOUNTAIN STATES LIGHTING PART NO. 16.5"W x 40"H-HDEB-XX



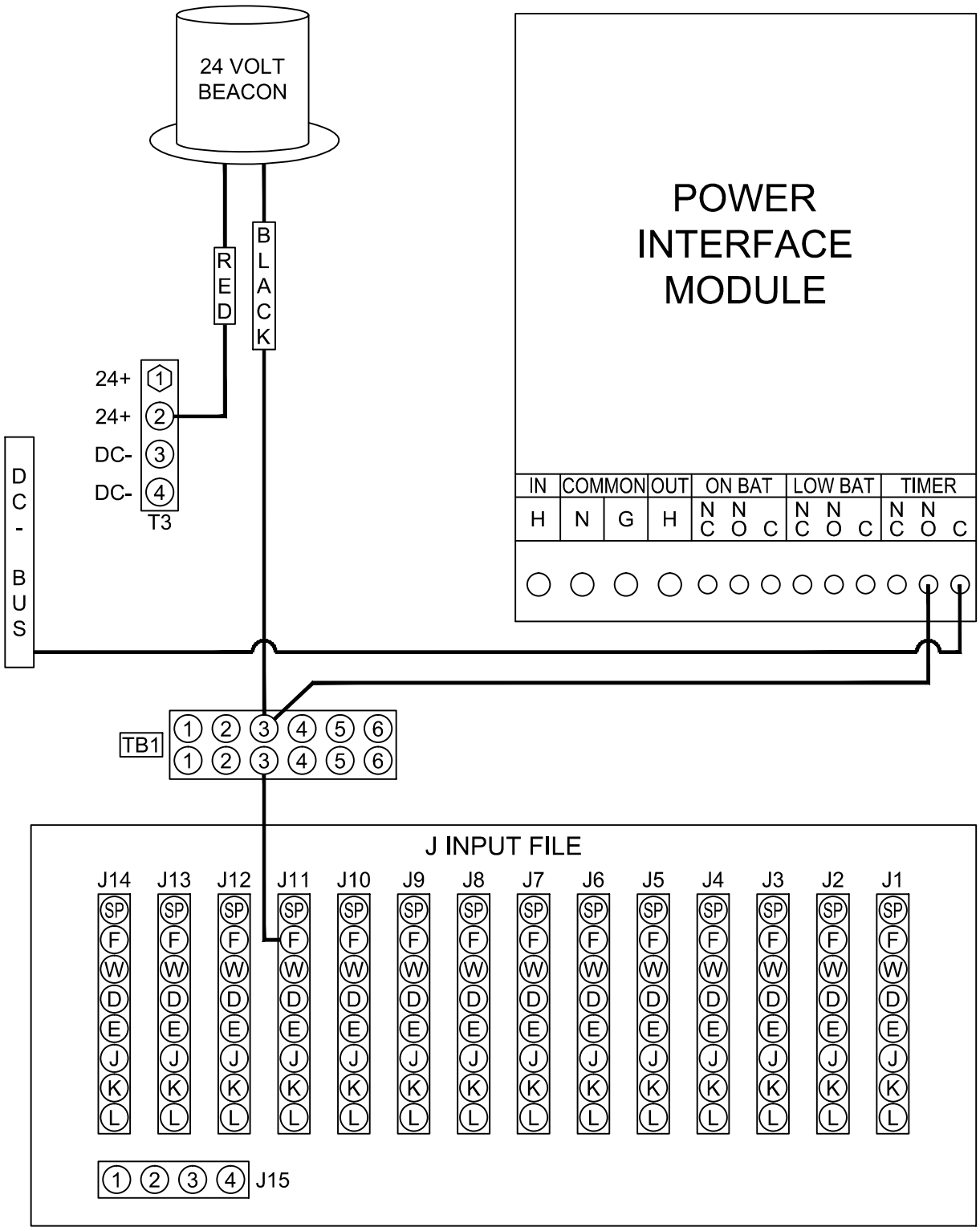
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STREET LIGHTS FOR WASHINGTON STREET CORRIDOR

ISSUED:
JANUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700-22



N.T.S.

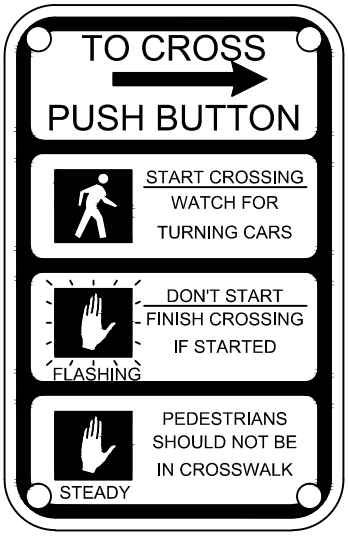
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CONTROL CABINET BEACON WIRING DETAIL

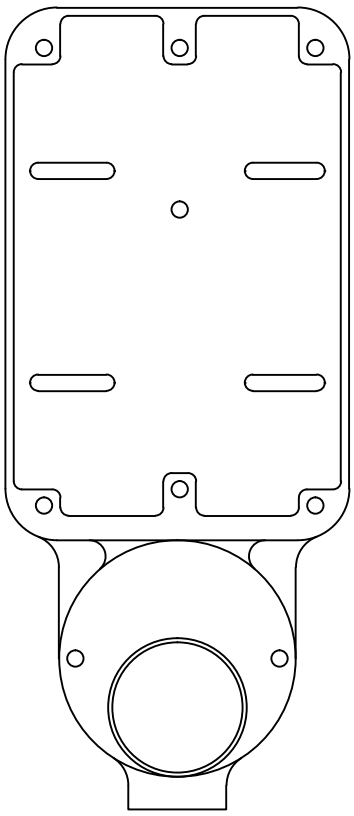
ISSUED: SEPT 2012

REVISED:

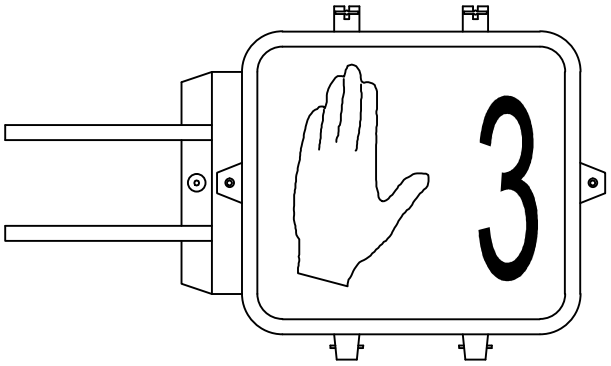
DRAWING NO. 700–23

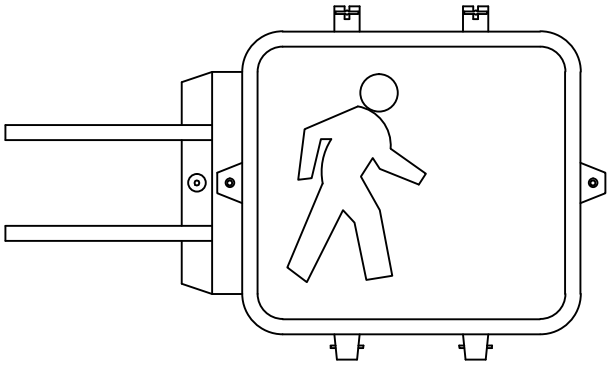


PUSH BUTTON SIGN PLATE
(5" x 7-3/4")



2" PUSH BUTTON &
PUSH BUTTON SIGN MOUNTING ASSEMBLY
(POLARA BULLDOG PUSHBUTTON)





ALL PEDESTRIAN
SIGNAL HEADS
(COUNTDOWN TYPE)

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

PEDESTRIAN TRAFFIC SIGNAL, SIGN AND PUSH BUTTON

ISSUED:
SEPT 2012
REVISED:

DRAWING NO.
700-24

SECTION 800 – LANDSCAPE IMPROVEMENTS
TABLE OF CONTENTS

SECTION 800 – LANDSCAPE IMPROVEMENTS

800.1 Purpose

The purpose of these Standards and Specifications is to ensure high quality design and construction of water-wise, maintainable landscapes that balance citywide design consistency and sense of place with a variety of materials to support a sustainable landscape and livable City. The Standards and Specifications describe how specific portions of a development project shall be designed, installed, cultivated, and maintained. Reference the Development Code for landscape definitions and development landscape requirements, and reference Section 100 for inspection and warranty requirements.

801 GENERAL PROVISIONS

801.1 Description

These Standards and Specifications apply to: all landscape areas including, but not limited to, trails, park areas and facilities, detention and drainage channel areas, rights-of-way and median areas, and open space landscape improvements required by the development review process of the City, and constructed by private interests unless otherwise indicated.

801.2 Quality Assurance

A. For all residential landscapes, the Responsible Party and the landscape contractor shall attend a pre-construction meeting with the Senior Landscape Architect for each phase of construction, as depicted on the Developer's Agreement Phasing Map.

B. The Responsible Party shall provide all soil amendment load tickets and Soil Amendment Affidavits for each dwelling before the construction of the next phase when requested by the Senior Landscape Architect.

801.3 Preparation

Consult the records and drawings of adjacent work and of existing services and utilities, which may affect site work operations. Obtain on-site underground utilities locates prior to excavation**.**

801.4 Inspections

The following inspections are required before work shall proceed. See other inspection requirements in Sections 105.12 and 809.6 in these Standards and Specifications.

A. Weed Eradication

The soil shall be inspected for weeds, especially noxious weeds prior to soil amendment and tilling.

B. Compost Amendment

After weed control, yet prior to incorporation by tilling, the layer of required compost amendment shall be inspected for adequate quantity and quality.

C. Post Tilling

After tilling and fine grading, the prepared soil shall be inspected for the required 8" tilling depth, and for overall quality and absence of construction debris.

D. Post Planting

All plantings shall be inspected for proper planting per detail 800-1 and 800-2 prior to mulching.

E. Final Completion

The project shall be inspected for overall completion and compliance with the approved construction drawings or landscape plan.

802 SITE PREPARATION

802.1 General

The Responsible Party shall provide all labor, materials, and equipment necessary to complete site preparation work as shown on the drawings approved through the development review process and as stipulated in these Standards and Specifications. Features to be retained shall be properly protected in a manner approved by the

Development Engineering Manager. The Responsible Party shall identify and stake all surface and subsurface features of the project area, including all property corners. Refer to Sections 100 and 500 of these Standards and Specifications for related information.

802.2 Protection of Existing Plant Material

Refer to subsection 105.6 for protection of existing plant material.

803 SITE GRADING

803.1 General

The Responsible Party shall provide all labor, materials, and equipment necessary to complete all grading work as shown on the approved drawings and as stipulated in these Standards and Specifications. Refer to Section 100 and Subsections 802 and 804 for related information.
The following general design standards shall apply:

A. Positive drainage, at a gradient suitable for the surface material, shall be maintained into all proposed or existing drainage ways. Ponding of water shall be avoided, except in designated detention areas, in order to minimize compaction and undermining problems.

B. In general, no slopes within landscaped areas shall exceed four to one (4:1). Where needed, retaining walls shall be provided by the Responsible Party to keep slopes within acceptable ranges.

C. Transitions from existing to proposed grades, and from gentle to steep grades within the site, shall be rounded off to minimize sharp contrasts in landforms and to prevent "scalping" by mowing equipment.

D. Drainage from all public or private common landscaped areas shall not be conveyed onto private residential lots.

E. Turfgrass areas intended as programmable athletic fields shall be laser graded.

803.2 Testing

All classification testing shall be performed by a qualified independent testing laboratory under the supervision of a registered PE specializing in soils engineering at the expense of the Responsible Party. The Responsible Party shall coordinate with and fully comply with all recommendations made by the testing agency.

803.3 Process

A. All applicable safety standards shall be followed for grading operations.

B. All grading operations shall be tested and inspected in accordance with these Standards and Specifications.

C. The Responsible Party shall establish the horizontal and vertical limits of grading through use of stakes, properly labeled, and shall have such staking approved by the Development Engineering Manager. On turf grass areas intended for sports fields, laser grading shall be employed.

D. No grading operations shall be permitted on a soft, spongy, frozen, unstable, or otherwise unacceptable subgrade.

E. All disturbed soils shall be periodically wetted as needed to minimize blowing dust.

F. When filling is required to meet the desired grade, each lift of the fill material shall not exceed eight (8) inches in loose depth. The Responsible Party shall thoroughly mix fill materials to secure suitable uniform moisture content and to insure uniform density and proper compaction. Any backfilling done against a building shall meet the requirements of the engineered soils report for that parcel. The City shall reserve the right to have graded areas tested at appropriate times and locations, at the Responsible Party's expense.

G. Final rough grade shall allow for specified soil amendments and subsurface materials required for finished surfaces.

804 SOIL PREPARATION - LANDSCAPED AREAS

804.1 General

Prior to soil preparation the Responsible Party shall remove all construction debris from the soil including: large rocks, concrete, asphalt and soil clods; all building materials such as boards, insulation, shingles, rebar, wire,

and grading stakes. Before soil preparation, the Responsible Party shall rip the soil to a minimum depth of 12 inches if it has been compacted by heavy machinery or by working it while wet.

804.2 Materials

A. Organic Materials

Organic soil amendment for all landscape areas, including all turf, native seed, tree, shrub planting beds in their entirety, annual, vine, and groundcover areas shall be a Class I or Class II Compost that meets the U.S. Composting Council's testing requirements. The compost must be produced at a composting facility meeting EPA 40 CFR 503.13 requirements for the production and marketing of Class A material for unrestricted use and distribution. Amending only the planting hole is not acceptable.

804.3 Preparation

A. Noxious Weed Control

If the area to be developed is infested with bindweed, thistle or other noxious weeds, such vegetation shall be completely eradicated by application(s) of a systemic, non-selective herbicide like glyphosate (Roundup) or approved equivalent. All herbicides shall be applied by an applicator licensed by the State of Colorado Department of Agriculture at a rate and period required by the manufacturer's labeling instructions.

B. Ripping of Compacted Soils

Soils previously compacted by heavy machinery during construction, as identified by the Senior Landscape Architect, shall be ripped prior to required soil amendment incorporation. The ripping equipment used shall rip the soil in rows no greater than 18" apart, and shall be powerful enough to rip the soil to a minimum depth of 12". Ripping operations shall be timed to commence when soil moisture is adequate enough to allow penetration, but is not at all wet or muddy.

C. Soil Amendments

1. A minimum 4 cubic yards (6 cubic yards for City maintained landscapes and all metropolitan district parks) per 1,000 sf of a Class I or II compost shall be distributed across the soil surface of all landscape areas in a uniform 1⅓" (6 cubic yards = 2 inch layer) and incorporated into the top 8 inches of soil with a rototiller capable of tilling to 8 inches in depth. Shrub beds shall be amended throughout the entire bed prior to planting, not just the planting hole.

2. Native grass seeding: broadcast 1500 lbs/Ac Biosol Forte Mix 7-2-3, or approved equal, before seeding.

D. Landscaped Median Soil Preparation

Within landscaped medians, fill with 36 inches of A-1 Organics Amended Topsoil or equivalent in no greater than 12 inch lifts. In lieu of using premixed amended topsoil, planting bed soil shall be topsoil and professionally mixed with 27 cubic yards of a Class I or II compost per 1,000 sf of median landscape area and incorporated into the entire soil profile to a depth of 36 inches in no greater than 12 inch lifts after mixing.

E. Final Grading

The finished surface shall be even and uniform and no dirt clumps, stones, sticks, residual plant material, or other debris larger than one (1) inch in diameter shall appear on the surface. When sodded areas are next to fixed surfaces such as walks, curbs, or borders, finished grade prior to sodding shall be 1.5 inches below such surfaces.

804.4 Inspections

Refer to Subsection 105.12 and Subsection 803.6 of these Standards and Specifications.

A. Materials Inspection

The Contractor shall retain and submit to the Senior Landscape Architect upon request, an Affidavit of Soil Amendment Installation verifying the source, quantity, and identification of the soil amendment used. Unsatisfactory materials, as determined by the Senior Landscape Architect, shall be removed and replaced with materials conforming to these Standards and Specifications.

805 SEEDING SPECIFICATIONS

805.1 General

A. In general, grassed landscaped areas shall be sodded. In areas where sod installation of practical turf areas is not desired or possible, seeding with a mix of species shall be considered when justified by size of area, type of use, and level of anticipated maintenance, and with specific approval of the Senior Landscape Architect.

B. Mow strips at the edges of seeded areas shall be established if visibility is an issue, or to incorporate a maintained appearance to the perimeter.

C. A permanent, automatic irrigation system shall be provided to support establishment and maintenance of seeded areas or as approved through the Development Permit review process.

805.2 Submittals

A. The proposed seed mix, pounds pure live seed per acre and a note stating that all seeding will be installed in accordance with Section 805 of these Standards and Specifications shall be included in the appoved construction drawings and/or Development Permit for the project.

805.3 Materials

A. "Native" Seed Mixes: Per-acre seeding rates are based on 144 pure live seeds (PLS) per square foot, which is equivalent to one (1) pure live seed per square inch. These seed mixes are not intended to replicate the diversity of a truly natural, undisturbed stand of native grasses. Instead, they have been developed to provide a more uniform look, which is what the urban setting demands. Most of the species are native, some are naturalized, but all are water efficient and low maintenance, excluding the wet detention mix. Seed mixes have been purposefully developed with all warm or all cool season grasses to minimize the perception of a weedy look, and to optimize maintenance practices. Requests for alternative mixes, for special site conditions, shall be submitted to the Senior Landscape Architect for review.

1. Thornton Buff/Blue Grama Mix:
(This all native, all warm season, upland mix is our most commonly planted mix. These two spreading grasses are very similar and complement each other well. They provide a uniform carpet when mowed, but don't get very tall if left unmowed. This mix is also ideal for large detention pond bottoms that stay predominately dry.)

60% Buffalograss *(Buchloe dactyloides)*	37 lbs./Acre
40% Blue Grama *(Bouteloua gracilis)*	8 lbs./Acre
	45 lbs./Acre

2. Thornton Signature Warm Season Mix:
(This taller, all native, all warm season, upland mix has added color interest, especially when dormant. It's our most diverse and natural looking mix. It can tolerate mowing, but also has a wilder, natural look with variable height if left unmowed.)

40% Little Bluestem *(Schizachyrium scoparium)*	15 lbs./Acre
20% Side Oats Grama *(Bouteloua curtipendula)*	10 lbs./Acre
20% Blue Grama *(Bouteloua gracilis)*	3 lbs./Acre
20% Buffalograss *(Buchloe dactyloides)*	12 lbs./Acre
	40 lbs./Acre

3. Thornton Wheatgrass Mix:
(This taller, all native, all cool season, upland mix is best left unmowed after establishment, which will give it the "Amber Waves of Grain" look.)

40% Western Wheatgrass *(Pascopyrum smithii)*	32 lbs./Acre
40% Streambank Wheatgrass *(Elymus lanceolatus)*	18 lbs./Acre
20% Slender Wheatgrass *(Elymus trachycaulus)*	10 lbs./Acre
	60 lbs./Acre

4. Thornton Short, Cool Season Mix:
(This all cool season, upland mix contains both native and naturalized grasses. It's quick to establish and has a mottled dusty blue-green appearance that is most noticeable during the growing season. It can tolerate mowing, but also has a wilder, natural look with variable height if left unmowed. These grasses may handle extreme heat by going dormant in mid to late summer, but green-up again in early fall.)

50% Crested Wheatgrass *(Agropyron cristatum)*	20 lbs./Acre
25% Sheep Fescue *(Festuca ovina)*	3 lbs./Acre
25% Hard Fescue *(Festuca longifolia)*	4 lbs./Acre
	27 lbs./Acre

5. Thornton Moist and Salty Detention Pond Bottom Mix:
(This all cool season mix contains both native and naturalized grasses, and has a dusty blue-green overall color. This mix likes moist sites and is very salt tolerant, which makes it ideal for variably wet detention pond bottoms that get salty from sub- irrigation.)

40% Alkaligrass *(Puccinellia distans)*	2 lbs./Acre
30% Western Wheatgrass *(Pascopyrum smithii)*	22 lbs./Acre
30% Smooth Brome *(Bromus inermis)*	16 lbs./Acre
	40 lbs./Acre

6. Thornton Always Wet Detention Pond Bottom Mix:
(This all cool season mix is designed for perpetually wet and sometimes flooded detention pond bottoms that won't ever be mowed. These species are also suitable for growing on the bottom slopes of the pond, and canal and stream banks. Sedges, rushes and bulrushes can be added to the mix as desired.)

15% Meadow Brome *(Bromus riparius)*	8 lbs./Acre
15% Western Wheatgrass *(Pascopyrum smithii)*	11 lbs./Acre
15% Canada Wildrye *(Elymus canadensis)*	10 lbs./Acre
15% Basin Wildrye *(Leymus cinereus)*	9 lbs./Acre
15% Beardless Wildrye *(Leymus triticoides)*	8 lbs./Acre
15% Creeping Foxtail *(Alopecurus arundinaceus)*	2 lbs./Acre
10% Reed Canarygrass *(Phalaris arundinacea)*	2 lbs./Acre
	50 lbs./Acre

7. Flower seed may be added to mixes but shall not substitute for quantities of seed. Chemical weed control that may be needed to establish grasses will likely kill off any such flowers. Wait to plant the flower seed until after grass establishment .

805.4 Process

A. Seedbed Preparation

The seedbed shall be free of debris including weeds, plant matter, rocks, clods, and other impervious material over one (1) inch in diameter. Seedbed shall be smooth and free of large clumps, fluffy yet firm, moist but not wet.

B. Fertilization

Refer to section 804.3.C.2 or follow the site specific fertilization requirements outlined in the approved construction drawings or landscape plans.

C. Seeding

1. Seeding shall be done immediately after soil preparation operations to discourage weed competition. Seed shall be evenly distributed over fertilized ground on a still day into a slightly moist seedbed, using an approved grass drill followed by packer wheels. Hand-broadcasting methods shall be at double the seeding rate and shall be 'raked in' or otherwise covered with soil to a depth of ¼ inch. Hydraulic seeding can be used in areas not accessible for machine methods; seed and mulch shall not be applied in the same operation.

2. Seeding of irrigated "native" grasses can take place at any time during the growing season. For best and quickest results, warm season grasses should be seeded in May and no later than July. Irrigated cool season "native" grasses are best seeded in the spring. Generally, dormant seeding of cool season non-irrigated grass shall occur between November 15th and April 15th on unfrozen ground. Seeding of non-irrigated warm season grasses shall occur between March 15th and June 15th.

3. All seeded areas shall be hydromulched, applied with tackifier at rates recommended by the manufacturer. Hydraulic mulching shall not be performed in the presence of free surface water. In areas not able to be hydromulched, cover all seeded area with 100% biodegradable straw blanket with biodegradable blanket pins. Within 12 hours of seeding, water seeded area frequently and lightly. Water enough to keep the soil moist, but not so heavily as to cause soil washing and loss of the grass seed.

D. Weed Control

1. Weed control is an important factor for grass establishment. Timely mowing operations are the most successful method of control. Mow at six (6) inches with a flail type mower. No mowing for the first six (6) weeks after seeds sprout; mow weeds before annual seed set. It shall be necessary to mow several times the first growing season, depending on when grass was seeded. It shall be necessary

to mow in the second year. For perennial weed control, use spot chemical spraying or hand weeding after grass plants are up and fairly mature, at the minimum, past the three (3) to five (5) leaf stage.

2. The use of Journey selective, pre-emergent herbicide or approved equal shall be required in areas infested with Cheatgrass (*Bromus tectorum*) and other grassy weeds. Journey shall be applied in late summer prior to germination of Cheatgrass and other winter annual weeds.

805.5 Establishment Time and Acceptance

A. For both native and naturalized grass seed species, germination should start within three (3) to six (6) weeks. Depending on planting time, available moisture and success of weed control, full establishment and initial acceptance of irrigated seed can take a minimum of one (1) full growing season, but usually takes longer. Full establishment of non-irrigated seed can take three (3) to five (5) years or more. Higher seed rates, shallow drilling of no greater than ½", and narrow (2-4") seeder row spacing have proven to be critical in obtaining rapid establishment.

B. Seeded areas will not be accepted until the stand of grass displays uniform coverage of the seed mix planted, with all species of the mix being well represented, and minimal weeds are present, as determined by the Senior Landscape Architect.

806 SODDING SPECIFICATIONS

806.1 General

The Responsible Party shall provide all labor, equipment, and materials necessary to furnish and install all sod or plugs as required by the drawings and these Standards and Specifications.

806.2 Materials

A. Fertilizer

1. On public projects apply, a 18-46-0 starter fertilizer at a rate of 1 (one) pound per 1,000 (one thousand) square feet having the following composition by weight: Nitrogen, eighteen percent (18%), and phosphoric acid (P205), forty-six percent (46%). These elements may be organic, inorganic, or a combination of the two, and shall be measured according to the methods of the Association of Official Analytical Chemists. Or, follow the site specific fertilization requirements outlined in the approved construction drawings or landscape plans.

2. On private sod installations, follow the site specific fertilization requirements outlined in the approved construction drawings or landscape plans.

B. Sod

1. Turfgrass blends and mixes shall be selected based on site conditions, intended use, and water conservation; and shall be determined through the Development Permit review process.

2. Sod shall be healthy and certified by the State of Colorado as insect, disease, and noxious weed free. The cultivars that comprise each sod blend or mix must test well above average on the National Turfgrass Evaluation Program trials, as reviewed by the Senior Landscape Architect. The sod shall be mowed at two (2) inches and thoroughly watered before harvested. All sod shall be cut to provide a minimum thickness of three-fourths (¾) inch of soil adhering to the roots. Each sod strip shall be harvested in a minimum width of 16 inches and a minimum length of 24 inches. Sod may be supplied in wider and longer rolls.

3. The following turfgrass blends and mixtures are approved for use as sod in the City of Thornton and shall be specified on the approved plans:

a. Kentucky Bluegrass (*Poa pratensis*)
Must be a blend of at least three (3) improved cultivars (varieties) that are acclimated to Thornton's growing conditions.

b. Texas Hybrid Bluegrass (*Poa pratensis x Poa arachnifera*)
The minimum amount of Texas Bluegrass (*Poa arachnifera*) allowed in the hybrid is 25%. If the sod is a blend, it must be all Texas Hybrid Bluegrass; no mixes of predominantly straight Kentucky Bluegrass with small percentages of Texas Hybrid Bluegrass will be approved as Low Water Demand Turf. This turf has excellent heat tolerance that leads to drought tolerance as well.

c. Tall Fescue (*Festuca arundinacea*)
Must be a blend of at least three (3) improved cultivars. Rhizomatous cultivars are preferred.

d. Fine Fescue Mix (*Festuca ovina, Festuca glauca, Festuca longifolia, Festuca rubra, Poa compressa*)
Variations of this mixture must contain no more than 20% Creeping Red Fescue (*Festuca rubra*), as it is a moderate water demand turfgrass species. This mixture has increased maintenance requirements, and is generally more difficult to maintain than other turfgrasses. It is also less available, as many sod farms no longer carry it.

4. Warm season sod and plugs shall be 100% certified turf-forming variety Legacy or Prestige Buffalograss, or approved equal.

5. Cold-tolerant varieties of Hybrid Bermudagrass (Cynodon x transvaalensis), such as Yukon and Riviera, will be approved for a given site on a case by case basis.

6. Other types of sod, as approved through the Development Permit review process.

806.3 Process

A. Care and Handling

Care shall be exercised at all times to retain the soil on the sod roots during transportation, handling, and planting. Dumping sod from vehicles shall not be permitted. The sod shall be installed within 24 hours from the time it is cut, unless it can be stored to the satisfaction of the Senior Landscape Architect. During delivery and while in stacks, all sod shall be kept moist and protected from drying, sun, or freezing. All damaged sod shall be rejected. All sod discolored due to excessive drying shall be rejected.

B. Transporting Sod On-site

Sod can be transported on or across the site on pallets by forklift, bobcat, or equivalent. Damage to the sod bed by the vehicles shall be avoided; any damage shall be repaired prior to sodding of the area. Damage caused to paving, curbs, fences, plants or other objects from sodding operations shall be remedied by the Responsible Party at his expense, as directed by the Senior Landscape Architect.

C. Sodding

1. Sod shall be laid on a firm, pre-moistened, but not wet, bed by staggering joints with all edges touching so that no voids occur under or between strips. Sod roll length shall run perpendicular to all slope fall lines, with biodegradable sod staples employed on slopes, as necessary. End joints shall be staggered at least 18 inches between adjacent rows.

2. Sod shall be laid flush with paving, curbs, and irrigation heads and one (1) inch below the top edge of steel edging. All rolls terminating at the project edge shall be cut in a straight line. No sod shall be installed within a radius of three (3) feet around any tree.

3. Sod placed in drainage swales shall be staked, with stakes spaced not more than 30 inches apart, driven into the ground at an angle against the flow of the water. Sodding shall begin at the bottom and progress upward, with strips laid perpendicular to the flow of the water.

4. Warm season sod and plugs shall be installed between May 1st and July 15th. Plugs shall be planted on 12-inch centers with a requirement of at least nine (9) plugs per square yard of ground.

5. Immediately after the sod has been laid, it shall be rolled with approved equipment to eliminate air pockets and to provide a smooth and even surface, and watered. Sufficient water shall be applied to saturate the sod or plugs completely. The planting shall be protected from drying and shall be watered as often as needed to prevent drying. Settled sod areas shall be pulled, re-graded, and re-laid. Excessively shrunken sod (over ¾ inch shrinkage) shall be replaced with new sod.

806.4 Maintenance

A. Protect and maintain sod and plugs until Initial Acceptance. Maintenance shall include irrigation controller programming and watering, mowing, and trimming as necessary to prevent sod and plugs from drying and shrinking, and to maintain proper soil moisture and a neat appearance. Care should be given to avoid standing water, surface wash, or erosion from over-watering. Failure of the irrigation system shall not relieve the Responsible Party from applying the water required during this period.

B. Under normal weather conditions, after new, green top growth is seen, warm season sod and plugs will require between 1 and 1-½ inches of water per week for two (2) to three (3) months, to prevent drought stress, until deeper rooting takes place.

C. For public sod installations, apply fertilizer after initial mowing (within approximately 20 days after sodding), when grass is dry, using fertilizer that will provide actual nitrogen of at least 1 lb/1000 SF. 20-10-5 plus iron and 8% sulfur fertilizer (50% sulfur coated urea). Continue fertilizer applications every 30 days thereafter at the rate of ½ lb actual nitrogen per 1000sf until Initial Acceptance of project--in March, April, May, June, (0 nitrogen in July), ½ lb/1000sf in August, September, October and November (no fertilizer in July, December, January, February). Six months into maintenance program, take a soil sample and adjust fertilizer accordingly and as approved by COT.

807 PLANTING GUIDELINES AND SPECIFICATIONS

807.1 General

A. These planting guidelines and specifications address the location and installation of trees, shrubs and ground covers. There shall be a pre-construction conference prior to the beginning of any work or the ordering of any materials.

B. The work to be performed consists of installation of all plants, including the furnishing of materials, equipment, supplies, labor and transportation to the site. All work shall be performed under the direct supervision of an experienced, qualified superintendent.

C. Plant material installed prior to installation of the irrigation system shall be hand watered as necessary.

807.2 Materials

A. Mulch

1. As approved through the Development Permit review process.

2. Plant material located in rock mulch shall be selected from Ultra-Low and Low Water-Demand Plant Material lists.

B. Geotextile Landscape Fabric

1. Geotextile landscape fabric is required in all City maintained organic and inorganic mulched beds.

2. Planting beds mulched with inorganic material (rock, cobble, etc.) can include a porous geotextile fabric installed below the mulch covering. Landscape fabric is not recommended for placement under organic mulch materials.

C. Staking Materials

1. The practice of staking trees at planting is not required except for City owned and maintained property, but is strongly recommended in certain planting situations. Staking is recommended for evergreen trees, especially those greater than six (6) feet in height. Staking is also recommended for deciduous trees greater than two (2) inches in caliper, and any tree planted on slopes or in predominantly windy conditions. Staking is not recommended for ornamental trees, especially multi-stemmed ornamentals.

2. All newly planted trees are expected to be monitored and straightened promptly if they develop a lean, whether they are staked or not.

3. All trees that are staked shall be done so using Details 800-1 and 800-2 in these Standards and Specifications.

D. Plant Materials

1. Plant material shall conform to current standards of the American Association of Nurserymen as published in the current edition of “American Standard for Nursery Stock”.

2. All selected plant material shall be subject to review, revision and approval by the Senior Landscape Architect. No substitutions shall be made to plant material on the approved drawings without written permission from the Senior Landscape Architect.

3. To support the development of a healthy urban forest by providing tree diversity, and to prevent uniform insect or disease susceptibility associated with planting a single species, a variety of trees shall be selected for planting as follows:

a. For 10-19 trees in the site or corridor, maximum 25% is allowed of any one species.

b. For 20-39 trees in the site or corridor, maximum 20% is allowed of any one species.

c. For 40 and over trees in the site or corridor, maximum 15% is allowed of any one species.

4. Trees that exhibit signs of injury, girdling roots or crushed trunks or root balls shall not be accepted. All trees shall be well branched; trees of the same species planted in groups shall be well matched. Unless characteristic of a species, trees with co-dominant leaders shall not be accepted unless one leader can be eliminated at planting time without compromising the balance of the canopy.

5. Plant material shall be free of disease and insect infestation and have healthy buds. Evergreen foliage (needles) shall be abundant and have healthy and intense color. Deciduous trees exhibiting one-fourth (1/4) to one-third (1/3) of the canopy dead and/or that exhibit uncharacteristically short annual twig elongation shall not be accepted.

6. All trees for City owned and maintained projects and metropolitan district parks shall be inspected and tagged with a locking tree tag by the Senior Landscape Architect, at the nursery prior to delivery to the site. Trees delivered to the site without a City locking tree tag must be inspected, accepted, and tagged prior to planting.

7. All plant material shall conform to the measurements as noted on the plans approved in the development review process. All deciduous trees shall be a minimum two (2) inch caliper. Evergreen trees shall be a minimum of six (6) feet in height. Shrubs shall be completely rooted within containers.

E. Tree Wrap

Tree wrapping material shall be first quality, four (4) inch wide, bituminous impregnated tape, corrugated or crepe paper, brown in color, specifically manufactured for tree wrapping.

F. Edging Material

Planting bed edging materials shall be approved through the Development Permit review process and shall be commercial grade and durable with minimal visual impact (unless the visual impact of such material is an essential element of a pleasing design).

G. Fertilizer

1. Where shown to be needed by the soil analysis, fertilizer shall be added to all planted areas. The selection of fertilizer type, rate, and method of application shall be based on anticipated maximum effectiveness in aiding plant establishment. Nitrogen shall not be applied to trees prior to planting or through the warranty period without specific approval of the Senior Landscape Architect.

2. Keep fertilizer off hardscape areas and maintain a minimum 10 foot buffer zone between application area and surface water bodies.

807.3 Process

A. Location Staking

1. Landscape and utility plans shall be coordinated. The Responsible Party shall arrange to have the locations of all utility lines (including, but not limited to, water, sewer, gas, electrical, phone, cable television, and irrigation) marked to assure safety and protection.

2. Deciduous trees shall be planted a minimum six (6) feet from sidewalks and planting bed edge or centered in parkways that are six (6) feet and over in width. Evergreen trees shall be planted a minimum 10 feet from sidewalks or planting bed edges. Evergreen trees should be located a minimum 10 feet from edge of buildings; deciduous trees a minimum of six (6) feet. Shrubs should be planted a minimum four (4) feet from sidewalks, planting bed edges or edge of buildings or one-half (1.5) their mature width, whichever is greater. Spacing for plant placement shall be measured from the centerline of the plant.

3. On City maintained landscape areas and metropolitan district parks the Responsible Party shall stake the proposed locations of all trees and planting beds on-site for approval prior to planting.

B. Delivery/Handling

1. Plants shall be protected from the time of digging to the time of Initial Acceptance from mechanical injury, excessive drying or winds, improper ventilation, over watering, freezing, high temperatures, or any other condition damaging to the plant. Any plants showing evidence of poor care or which are molded, mildewed, excessively wilted, or dried shall be rejected.

2. Evergreen plants and deciduous plant material that is in leaf shall be covered with shade cloth during transportation. Plant material not protected during transportation may be rejected. Plant material shall be planted on the day of delivery, if possible. All plants not planted on the day of delivery shall be placed in a temporary nursery and heeled-in immediately with mulch, and kept moist.

3. Plants with root balls that are loose, cracked, broken, man-made, or completely dry or plants with trunks loose in the root ball before or during planting operations shall not be accepted. Trees with branches broken or trunks injured during transportation or planting may be rejected. Plants that are rejected on site shall be removed within 24 hours at the Responsible Party's expense.

C. Planting

1. Ball & Burlap Trees and Shrubs

a. The planting pit shall not be excavated until the tree is on site and the true height of the top of the root ball has been properly identified. This true height must be identified by probing the top of the root ball as it came from the nursery and finding the flare of the first order major root at the trunk/root interface. Remove any soil from the top of the root ball that is greater than one (1) inch above this true height point, as it is common for trees to come from the nursery with too much soil added above the root system. Pits shall have a flat bottom and be excavated to a depth of two (2) inches less than the measured true height of the root ball of deciduous trees, and three (3) inches less than the measured true height of the root ball of evergreen trees. Planting pits shall be excavated to a width that is at least twice the diameter of the root ball with sides that have a 1:1 slope; loosen the sides to avoid glazing. The use of mechanical augers to dig the planting pit is prohibited. The base of all root balls shall be placed on undisturbed soil. Plants shall be set in the center of the pit, plumb and straight. Trees that are not centered or planted plumb, or which have been mechanically straightened, shall be rejected. Trees that are planted too deeply due to a failure to identify the true height of the top of the root ball will also be rejected. Trees shall be watered in by hand with a hose during the backfill process. Do not wait until the tree is completely planted to begin watering, as the water will not reach the bottom depths of the rootball, or there is a chance that the entire pit will be filled with water, risking the drowning of the tree. No soil should be added to the top of the rootball, to prevent soil interface problems.

b. It is not anticipated that planting shall be done where the depth of soil over underground construction obstructions or rocks is insufficient to accommodate the roots or where pockets in rock or impervious soil will require drainage. If such conditions are encountered in excavation of planting areas, and if the stone, boulders, or other obstructions cannot be broken and removed by hand methods in the course of digging plant pits of the usual size, other locations for the planting may be designated. Removal of rock or other underground obstructions and relocation of plant materials shall be done only as directed by the Senior Landscape Architect.

c. For balled and burlapped plant materials, strive to remove the entire wire basket and all rope, twine, and burlap from the root ball and trunk. If there is any concern about the integrity of the rootball it is acceptable to leave the bottom 1/3 of the wire basket and burlap. Do not fold excess burlap into the backfill area. Place the removed wire basket, rope or twine and burlap next to each planted tree for inspection by the Senior Landscape Architect.

d. Trees planted in sod, turf, or grass require tree trunk protectors. At the time of planting, install a nine (9) inch tall, expandable tree trunk protector such as Arborgard+ or approved equal. This requirement is in addition to the mulch ring specified on the planting detail 800-1. Trees damaged by string trimmers or mowers during the warranty period will be required to be replaced.

2. Containerized Trees

All trees are required to be ball and burlapped. If container grown trees are approved by the Senior Landscape Architect through the Development Permit process or during the construction process, they are to be planted like a ball and burlapped tree with the following exception. Shave 1" off of the surface of the sides of the root mass vertically with a sharp saw or knife around the entire perimeter of the root mass immediately prior to planting.

3. Containerized Shrubs and Perennials

a. Plants in containers shall be removed from the container prior to planting. If the root system of a container grown plant has become root bound, shave ½" off of the sides and bottom of the root mass with a sharp saw or knife prior to planting. The outside edge of the rootball shall be loosened on all container plants to increase the spreading of roots. See Detail number 800-3 of these Standards and Specifications.

b. Container plants are expected to be planted straight, and no higher than the surrounding soil grade. Cover the rootball with backfill soil, but no more than one (1) inch deep, to prevent moisture wicking and to allow roots to grow into the surrounding soil. Mulch shall be graduated from a three (3) inch depth outside the rootball perimeter to one (1) inch or less over the rootball.

c. Backfill for planting pits shall consist of a thoroughly blended mix of 1/3 soil amendment and 2/3 material removed for planting. Shrub beds shall be amended throughout the entire bed prior to planting. All plants shall be kept plumb and straight as the pit is filled with backfill mix. Any plant which is not plumb prior to Final Acceptance shall be rejected.

d. Locking tree tags shall remain on the plants until the time of Final Acceptance on all City owned and maintained Development projects and metropolitan district park projects.

e. The top of all edging material shall set flush with the finish grade of adjacent lawn and ½ inch above top of mulch.

D. Pruning of New Plant Materials

All pruning shall conform to current International Society of Arboriculture practices. Only dead and broken branches shall be removed. For most tree species, a tree with one leader should have been selected from the nursery. If a newly planted tree does have co-dominant leaders, it shall be corrected by removing the weaker of the two co-dominant stems immediately. All pruning shall be done with clean, sharp tools. Branch bark ridges and branch collars must be left intact after the final cut is made. Neither flush cuts nor unsightly branch stubs shall be allowed.

E. Wrapping

No tree wrapping shall be permitted until the Senior Landscape Architect has inspected the tree. It is the responsibility of the Responsible Party to wrap deciduous trees during the warranty period. Trees shall be wrapped between October 15 and November 1 of the year they are planted. Wrapping shall begin at the base of the trunk working upward to the lowest lateral branch and overlapping tightly on each turn by at least ½ inch. Tree wrap shall be taped securely at the top and bottom of the tree. In no instance shall staples be used to secure tree wrap. Tree wrap shall be removed again the following spring.

F. Staking and Guying

Tree stakes shall be driven into stable ground and not into disturbed backfill. Two (2) stakes, oriented northwest/southeast, shall be used for two (2) inch caliper deciduous trees; three (3) evenly spaced stakes shall be used for evergreen trees and deciduous trees over three (3) inches in caliper. Secure trees to stakes using a properly sized nylon strap with metal grommets for attachment of wire between strap and stake. Straps shall be of sufficient length in relation to tree caliper so that grommets do not touch tree trunk.

G. Mulching

1. Immediately prior to plant bed mulching, obtain inspection and approval of planting bed irrigation system in operation. Bed areas shall be free from grass and weeds immediately prior to mulching.

2. Shredded wood mulch shall be installed per the planting details using landscape fabric underneath.

H. Winter Watering

1. Winter watering of deciduous and evergreen trees and other plant material shall be arranged and at the expense of the Responsible Party until such time as Final Acceptance is received. Winter watering generally means a deep soaking once a month when temperatures are above 40° F.

2. The Responsible Party shall water rights-of-way and median landscapes, in magnesium chloride stress areas, a minimum once in early spring to flush salts and other toxins off foliage and down through the soil below the root zone.

807.4 Protection, Maintenance, Acceptance, Guarantee, and Warranty

Refer to subsection 105.16 for Protection, Maintenance, Acceptance, and Guarantee, and Warranty procedures.

808 TREE PRUNING SPECIFICATIONS

A. All work shall be performed under the direct supervision of a qualified Arborist and shall be performed in accordance to ANSI A 300 standard practices. Branch bark ridges and branch collars must be left intact after the final cut is made. Neither flush cuts nor unsightly branch stubs shall be allowed.

B. Tree work shall be required when a tree poses a hazard to persons or property or when age, disease or mechanical injury have so impaired the tree's ability to survive that harm to persons or property appears imminent, as determined by the Senior Landscape Architect.

C. Trees shall generally be pruned in such a manner as to prevent branch or foliage interference with requirements of safe public passage. Over-street clearance shall be kept to a minimum of 14 feet above the paved surface of the street, and eight (8) feet over the surface of a public sidewalk or pedestrian path.

809 IRRIGATION SYSTEMS

809.1 General

All irrigation systems required for City maintained properties shall conform to approved construction drawings and these Standards and Specifications.

Private irrigation systems installed with or as part of a Development Project shall conform to approved construction drawings and Section 809.9 of these Standards and Specifications.

Installation work for all irrigation systems shall be performed in accordance with the best standards of practice relating to the various trades and by an ALCC Certified Landscape Technician who is capable of interpreting drawings and specifications. The Responsible Party shall notify the Senior Landscape Architect as soon as any discrepancies between plans and specifications are discovered. Omissions from the specifications or drawings, or any mis-descriptions of detail work which are absolutely necessary to carry out the intentions of the drawings or specifications, shall be executed by the Responsible Party as if fully set forth in the specifications and drawings.

809.2 Irrigation System Design

A. General Requirements

Irrigation systems shall be designed by an Irrigation Association Certified Irrigation Designer. Irrigation systems shall be designed using the Low HGL static pressure available for the site. Head-to-head coverage and matched precipitation rates are required. Systems shall be designed for optimum uniformity and for an average Scheduling Coefficient of no greater than 1.2. The use of “Kicker” heads is strongly discouraged and is restricted to 2% of the total used for that type of head on the entire site.

Irrigation systems shall be designed to deliver at least 1½ inches of weekly precipitation with each individual control zone operating only between the hours of 10 p.m. and 5 a.m. Unless specifically approved otherwise, planting beds shall be zoned and controlled separately from turf areas.

Locate irrigation point of connection and electrical components together in mulched beds, including the controller, master valve, flow sensor and backflow preventer. See Details 800-11A and 800-11B.

The following irrigation design information shall be provided prior to design approval:

1. Location, sizing, and materials descriptions of all system components, including service lines, water meters, delivery lines, RPZ backflow prevention devices, automatic controller(s) and wires, mainline and lateral piping, control valves, isolation valves, quick coupling valves, and sprinkler heads.

2. Location of plant material on the irrigation plan relative to the irrigation system.

3. Each control valve shall be labeled displaying valve size, total zone flow in GPM and an identification number and/or letter.

4. Friction Loss Worksheet proving that ample pressure is delivered to the last head of the worst case or most critical zone.

5. Seasonal Operating Schedule that proves that the system is capable of watering the landscape with 1.5” of water per week within the 49-hour watering window.

6. If requested, a water budget shall be provided showing total estimated gallons used per month.

B. Point of Connection (Tap, Service Line, Curb Stop and Irrigation Meter)

1. All taps, service lines and curb stop gate valves shall be 4" unless otherwise approved by the Senior Landscape Architect. Curb stop gate valve boxes shall be 10" Round Carson with PVC access sleeve, just like a regular gate valve, or approved equal. Curb stop gate valve boxes shall be located in turf or landscape beds. See Detail 800-11A and 800-11B

2. Copper and ductile iron irrigation service lines shall be sized for maximum water velocities of seven and a half (7.5) feet per second. PVC and polyethylene mainlines and lateral lines shall be sized for maximum water velocity of five (5) feet per second.

3. All water taps, meters, and backflow prevention units shall be approved by the Senior Landscape Architect and installed in accordance with all pertinent City and State regulations and these Standards and Specifications. The service line is likely to be a different size than the water meter. Service line size transitions shall occur outside of the meter pit/vault. See Details 800-9. 800-10A, 800-10B and 800-10C.

4. Water meters shall be sized for maximum continuous flow and based on total irrigated area assuming a peak Irrigation Water Requirement of 4.29 gallons/square foot according to the following chart. The Irrigation Water Requirement and maximum irrigated area have been calculated using an assumed Irrigation Efficiency of 0.775 and a Landscape Coefficient of 0.9. The corresponding required service line size reflects a maximum velocity of 7.5 feet per second at the maximum continuous flow of the meter.

TABLE 800-1
METER SIZING

Meter Size	Maximum Continuous Meter Flow (Gallons per Minute)	Required Service Line Size @ Maximum Continuous Meter Flow	Maximum Meter Flow in 48-Hour/Week Watering Window	Maximum Irrigated Area	
				Acres	SF
⅝"x¾"	15	4" DIP or C900 PVC	189,000	1.01	44,090
¾"	25	4" DIP or C900 PVC	315000	1.69	73,483
1"	50	4" DIP or C900 PVC	630,000	3.37	146,966
1 ½"	80	4" DIP or C900 PVC	1,008,000	5.40	235,146
2" turbo	200	4" DIP or C900 PVC	2,520,000	13.50	587,865
3" turbo	450	6" DIP or C900 PVC	5,670,000	30.36	1,322,696
4" turbo	800	8" DIP or 10" C900 PVC	10,080,000	53.98	2,351,459
6" turbo	1000	10" DIP or C900 PVC	12,600,000	67.48	2,939,324

C. Backflow Prevention Device

The backflow prevention device shall be a Reduced Pressure Zone Assembly. The Febco 825 Y or YA model shall be used for all two (2) inch and smaller applications, and the Febco 880V shall be used for all applications greater than two (2) inch or approved equivalents. The backflow prevention device shall be protected by a Strongbox® Smooth-Touch enclosure by V.I.T. Products, Inc. or approved equivalent. The main housing shall be mounted on a stainless steel frame secured to a concrete pad. Provide sleeving through concrete pad. Locking mechanism shall be full release type that allows removal of the entire housing from its base without the use of tools. The handle controlling the locking mechanism shall be concealed within the surface of the housing and shall provide for either a single or dual padlock system. The inlet pipe entering the backflow unit shall be winterized by eliminating the remaining water from the winterization pipe. See Details 800-11A and 800-11B.

D. Booster Pump

When hydraulic analysis indicates that a booster pump is required, it shall be a Rain Bird CRE Series pump or approved equivalent, with magnetic starter, heater, and pump bypass piping and approved by the Development Engineering Manager prior to installation. The pump and ancillary equipment shall be enclosed in a ventilated, weather resistant, locking pump house with concrete floor. Provide sleeves through concrete pad.

E. Pipe and Fittings

1. Pipe shall be continuously and permanently marked showing the manufacturer's name, the size, and the class of the pipe. All pipe shall conform to the requirements of ASTM-D-2241. Provide a minimum six (6) inch clearance between pipe trenches.

2. Mainline pipe shall be Class 315 PVC. Use of 90 degree ells on mainline is prohibited. Use ring-tight, rubber-gasketed pipe and Leemco restrained fittings for mainline pipe two (2) or greater in size.

3. On systems where the service connection is one and one-half (1.5) inch or larger, lateral lines for rotary and spray zones shall be Class 200 PVC. The minimum allowed lateral pipe size is three-fourths (¾) inch. On systems where the service connection is one (1) inch or smaller, lateral lines for rotary and spray zones shall be either 1) Eagle 'Green Stripe' 80# polyethylene lifetime warranty pipe or approved equivalent; 2) 100# NSF polyethylene pipe, or 3) Class 200 PVC. All rotor and spray zone lateral piping shall be of the same material throughout the system.

4. Fittings for PVC pipe shall be solvent weld Schedule 40 PVC, or threaded Schedule 80 PVC. Fittings for polyethylene pipe shall be ASTM D2466 insert pipe fittings with stainless steel hose clamps with stainless steel screws.

5. PVC repair couplings shall be Slip-Fix® by Nibco or approved equivalent sized to pipe. No compression fittings will be allowed. No repair couplings will be allowed within five (5) feet from other fittings or control valves.

6. Piping from lateral lines to irrigation heads shall be connected by one (1) inch pre-manufactured, PVC swing joints for all Rain Bird 8005 rotors, and by flexible "funny" pipe for all Rain Bird 5505 rotors and 1800 Series pop-up spray heads.

7. Responsible Party shall use purple primer and then Weld-On 711 or equivalent solvent to make solvent-welded joints. The pipe and fittings shall be thoroughly cleaned and otherwise prepared before applying solvent. The manufacturer's recommendations and the best practices of the industry shall be followed when making any pipe connections.

8. The Responsible Party shall inspect the pipe and fittings carefully to assure conformance with the standards as outlined in these Standards and Specifications. Fittings and piping that do not have a friction fit before the pipe "bottoms" into the fitting shall NOT be accepted under the terms of the Responsible Party's work. Rejected pipe and fittings shall be removed from the site daily to prevent use of this material at another location on the work site.

F. Quick Coupler Valves

Quick coupler valves shall be Buckner QB44LCAR10 or equivalent, having a brass two (2) piece body designed for a working pressure of 150 psi, operable with a quick coupler key. The quick coupler valve shall be connected to the mainline using a pre-manufactured PVC swing joint and shall be equipped with a rubber cover and solid brass body with anti-rotation stabilizing wings. All Quick Coupler Valves shall be located in an approved heavy-duty Carson 10 inch round valve box or approved equivalent. Key size and type shall be shown on plans. Quick coupler valves shall be located a minimum of every 300 feet along the mainline, immediately following the Point of Connection components, and anywhere else specified on the approved plans.

G. Master Valve and Flow Sensor

1. On systems that require the Signature Constellation controller (see section 809.2.K.1), use the Netafim Hydrometer, which is a combination master valve and flow sensor, or approved equal. Place it above ground and within the same enclosure as the backflow prevention device. See Detail 800-11A and 800-11B.

2. On systems that require the Rain Master Eagle controller (see section 809.2.K.1), use the Toro 220 Brass Series globe valve as a master valve with a Data Industrial flow sensor or approved equal. Place this master valve underground and in a super jumbo valve box in the same manner as you would an automatic control valve. See Detail 800-8. The flow sensor shall be the same size as the mainline and shall access it per manufacturer's specifications using a tee specifically made for housing the sensor. The flow sensor shall reside within close proximity to the controller and be placed in a super jumbo valve box just as an automatic control valve would be.

H. Automatic Control Valves

All zone valves shall be Toro 220 Brass Series globe valves and shall be operated by the Spike Guard™ 24-VAC solenoid, and be equipped with the EZR-100 EZReg pressure regulator; this is specified as model number 220-27-0-x or approved equivalent. There shall be a union installed both immediately before and after the valve. A Schedule 80 PVC manual ball valve shall be installed within the valve box upstream of the zone valve immediately before the first union. Provide four (4) inches of clearance between ball valve and valve box. All piping, fittings, unions and ball valves shall be the same size as the zone valve. See Detail 800-8.

I. Isolation Valves

1. Install Leemco LMV Mainline Gate Valves at both sides of sleeving for streets along the main line, at mainline intersections, and as otherwise shown on the approved plans.

2. Also place a line-sized PVC ball valve in each valve box directly upstream of each control valve. See Detail 800-8.

J. Valve Boxes

1. All valves shall be installed in Carson valve boxes, or approved equal. All valve boxes shall be supported by a three (3) inch layer base of compacted three-fourths (¾) inch crushed granite that extends six (6) inches outward from all edges of the bottom of the box.

2. Spray and rotor zone control valves shall be installed in Carson 1324-15-3L, extra deep Super Jumbo Series, 23" x 32" x 15" rectangular boxes. A maximum of one (1) valve shall be installed per box. See Detail 800-8.

3. Quick coupling valves shall be installed individually in a 10 inch round box. Isolation gate valves shall also be installed in a 10 inch round box with appropriately sized vertical sleeving. All electrical wire splices shall be made with approved water-proof connectors, and placed in an appropriately labeled 10 inch round box with expansion loops.

4. All valve boxes shall be labeled by the Responsible Party. Control valves, gate valves, and quick coupling valves shall be labeled CV, GV, and QC respectively. CV designations shall be followed by the control valve number(s), e.g. 'CV 5'. Label electrical splices with ES. Valve box lids shall be labeled with a branding iron.

K. Irrigation Heads

1. Irrigation heads shall be spaced such that they provide a minimum of head-to-head coverage for the nozzle selected at the pressure required. Kicker heads shall not be used; head spacing shall be adjusted to eliminate the need for kickers.

2. In turf areas 30 feet or wider use Rain Bird 5505 and 8005 series rotor heads. In turf areas smaller than 30 feet use Rain Bird RD 1806 heads (RD-06-S-P30-F) with Rain Bird U-Series nozzles.. Irrigation heads shall be installed for head-to-head coverage and matched precipitation nozzling.

   a. Always use the head's bottom inlet; never use automatic drains.

   b. Use Rain Bird RD 1812 heads (RD-12-S-P45-F) for the irrigation of all medians with a planted area of 15' or less, or approved equal. Check with the Senior Landscape Architect for the best nozzle to use on a case by case basis.

3. Design Sports Fields with the Rain Bird 8005 head at a minimum of 60 psi operating pressure. Use the #12 nozzle and a head spacing of 55 feet.

4. All irrigation heads shall have check valves to avoid low head drainage. If necessary on steep slopes, stronger check valves shall be installed in the lateral line to prevent low head drainage. Ideal pressure for each zone with its type of head shall be set using an EZ Reg adjustable pressure regulator at the Toro 220 automatic control valve.
5. Pressure at the base of all heads within a single zone shall not vary more than 10%. The system shall be designed in such a manner that the following minimum pressures are delivered to each head, including the most critical, worst case zone: 60 psi for Rain Bird 8005's, 50 psi for Rain Bird 5505's and 30 psi for Rain Bird RD 1806's with U-Series nozzles.

L. Controllers

1. For all projects greater than 36 zones use the Signature Constellation Series CON/SHTS1/CP---/S/O irrigation controller with steel pedestal, spread spectrum radio adder and premium surge protection, or approved equivalent. For systems with 36 zones or less use the Rain Master Eagle-i RME-XXEGi-SPED controller with cellular modem or approved equal. Depending on the project hydraulics, the Senior Landscape Architect reserves the right to require the Constellation controller when there are fewer than 36 zones.

2. The power supply (120V) for all irrigation controllers shall be routed through a fused UL listed service disconnect panel and 110/120V AC power line suppressor.

3. Provide an eight (8) foot copper-clad grounding rod at controller location. A rain sensor shall be connected to the controller as shown in the rain sensor. The Senior Landscape Architect shall approve all features.

4. Controllers shall be located in a landscape bed and adjacent to the irrigation pump and electrical meter pedestal. All electrical components, including the pump if required, shall not be sprayed on by the irrigation system. Design the system to eliminate overspray onto these components.

M. Electrical Wire (24 Volt)

1. All electrical splices and conductor connections shall be made with a waterproof 3M DBY or DBR connector, or approved equivalent. Do not directly bury connections or splices; they shall reside in a valve box or a labeled splice box.

2. The control wire shall be a minimum of 14-gauge UF listed, AWG, direct burial solid copper wire with the insulation being a consistent color throughout the entire length of the wire. Larger gauge control wire shall be provided when lengths require.

3. Control wire insulation shall be a solid color red; common wire insulation shall be white.

4. Three (3) extra black insulated wires shall be looped through each valve box and provided to the farthest valve on each mainline branch.

5. Tracer Wire
Install one (1) 14-gauge UF single strand, direct burial solid copper wire with yellow insulation in all trenches containing irrigation piping (mainline and laterals). The purpose of this wire is for locating all underground piping. The lateral tracer wire end shall be accessible at each zone valve box.

N. Sleeving

1. Install separate sleeve beneath hardscape areas to route each run of irrigation pipe or wiring bundle. Extend sleeve ends six (6) inches beyond edge of all paved surfaces. Install isolation valves on both sides of sleeves that convey irrigation water. Bore for sleeves under obstructions that cannot be removed. Mark all sleeves with an 'X' chiseled in hardscape directly over sleeve location.

2. Sleeving material shall be PVC Class 200 pipe with solvent welded joints. Diameter shall be as indicated on the drawings and installation details or equal to a minimum of twice that of the pipe or wiring bundle.

O. Drip Control Zone Assemblies

Drip assemblies are prohibited from use on City owned and maintained landscapes, including medians and parking lot islands.

809.3 Site Conditions/"As-Builts"

A. The Responsible Party shall coordinate the work with that of other trades wherever possible to prevent conflicts and future site disruption. Before starting work, the Responsible Party shall inspect the site and check all existing conditions to ensure that the work may safely proceed. Before proceeding with any work, the Responsible Party shall carefully check and verify all dimensions as shown on the approved plans.

B. Changes or alterations in the system to meet site conditions shall be made at the Responsible Party's expense. If any work is installed in locations other than those shown in the accompanying irrigation plan, the Responsible Party shall show on the as-built plans the exact location of those changes. Exact measurements of buried valves and wire locations shall be shown. Hand-written changes to the plans will not be accepted; the changes to the original CD's must be made using CAD.

C. The Responsible Party shall present the as-built plans as a PDF file via email or on a compact disk at the time of Initial Acceptance.

D. The Responsible Party shall be responsible for all costs incurred for supplying the electrical needs required for the job. The electrical meter pedestal shall be located in the same landscape bed as the irrigation pump and controller. The appropriate electric company should be contacted for information on possible electrical sources.

809.4 Excavation

A. Pipe shall be installed in a trench. Trenches shall be dug true to the alignment shown on the approved plans. Excavation of the trenches shall be done in a workman-like manner, resulting in a trench that is straight and true with a flat bottom and containing no rocks or other deleterious material that may damage the pipe.

B No trench shall be left open overnight without specific prior written approval by the Senior Landscape Architect. Sufficient barricades to protect the public shall be provided at all times, as needed.

809.5. Process

A. Verify available static water pressure at the point of connection, ensuring that it matches the design pressure identified in the plans.

B. Prior to excavating or trenching, the Responsible Party shall stake out the irrigation system including sprinklers, sleeving, mainline and lateral lines, valves, and controller. Stake out or flag all proposed and existing utilities. Stakes or flags shall be color-coded for materials and shall be maintained throughout the irrigation installation process.

C. Separate trenches shall be dug for each line; no doubling up of lines in a single trench shall be allowed. Trenches shall be of sufficient depth to allow the following cover over the top of the pipe:

Lines	Minimum Cover to Top of Pipe
Laterals	14 inches
Mainline	18 inches

D. Gasketed mainline pipe three (3) inches or greater in size shall be mechanically restrained with Leemco, Piping Solutions ductile iron self-restrained fittings with fusion bonded epoxy coating or approved equal.

E. Control valves shall be installed with the top of the valve stem three(3) inches below grade and covered by a valve box with the lid set at the finished grade. All zone valves shall be placed in valve boxes. The bottom of valve boxes shall be lined with a geotextile fabric and a layer of three (3) inches of three-fourths (¾) inch crushed granite shall be placed on top of the fabric. A service loop of both common and zone wire, twice the depth of the buried wire, shall be coiled and placed inside the valve box. Where connecting to the valve, a wire coil shall be made by tightly wrapping the control wire around a one-half (½) inch piece of pipe, then removing the pipe and placing the coil inside the valve box. The bottom of the control valve shall be four 4) inches above the granite in the bottom of the valve box.

F. Whenever possible, the electrical valve control wires shall be buried under and to one side of the mainline. Where more than one (1) wire is placed in a trench, the wires shall be bundled together at 10 foot intervals. Only 3M DBY connectors or approved equivalent shall be used in making wire connections; all connectors must be within a valve box. All wire shall be kept deep enough to maintain a minimum cover of 24 inches when not along the mainline and shall have a yellow, six (6) inch wide warning tape placed 12 inches above all wiring.

G. Provide minimum wire loop of 24 inches at each valve box and controller, at each change of direction greater than 90°, at both ends of sleeves, and at 100-foot intervals along continuous runs of wire.

H Install a common wire and one (1) control wire for each remote control valve. Multiple valves on a single control wire are not permitted.

I. All trenches shall be inspected prior to backfilling.

J. All backfill material shall be free of rocks and soil clods one (1) inch in diameter and larger. Backfill material shall be compacted to 90% standard proctor density.

K. Backfill shall be tamped under the irrigation head flange and around the head for a distance of one (1) foot by a suitable means.

L. Prior to head installation, all pipelines shall be flushed with water. Install heads of matched precipitation rates being careful not to get dirty water or debris in the riser and flush again prior to nozzle installation. All sprinklers shall be checked for the proper operation and proper alignment for direction of throw.

M. Locate rotary sprinklers six (6) inches and overhead spray sprinklers three (3) inches from adjacent walls, fences, or edges of paved areas.

N. After the system is thoroughly flushed and ready for operation, each zone of sprinklers must be tested to insure proper operating pressure at the farthest head on the zone (refer to Subsection 809.6 D).

O. Design plans, including specifications and details, shall be approved, and a pre-construction meeting held, prior to the commencement of any irrigation work.

1. Surplus material resulting from the Responsible Party's work shall be removed from the site by the Responsible Party. During the work, the Responsible Party shall keep the site as clean and free of rubbish as possible.

2. The Responsible Party shall guarantee all material and workmanship for a minimum period of one (1) year commencing with the date of Initial Acceptance.

P. Work shall include all labor, materials, equipment, and appliances as required to complete the irrigation system as indicated on the approved irrigation plan and as herein specified. The work shall comply with all City Codes. The Responsible Party shall apply for all necessary permits as required by the City prior to the beginning of any work. There shall be a pre-construction conference prior to the beginning of any work or the ordering of any materials. All existing utilities shall be located before any excavation work is started.

The Responsible Party shall furnish the City with:

1. Two (2) quick coupler keys and hose swivels

2. Two (2) drain valve keys

3. Two (2) manual valve keys

4. Two (2) control clock keys

5. Warranty cards on irrigation controller

6. Equipment manual on booster pumps

7. Color coded, laminated, reduced copy of the irrigation system as-built for irrigation controller, sized to fit inside controller cabinet

809.6 Inspections

Refer to Subsection 105.12 of these Standards and Specifications.

A. Irrigation Location Staking

The staked locations of all lines and heads shall be inspected for conformance to the approved plans and these Standards and Specifications. The Senior Landscape Architect reserves the right to move, shift, and adjust any of the stakes, with the designer's concurrence, to better achieve the design intentions as shown on the approved plans. No trenching shall be done until the inspection is complete and the staked locations are approved.

B. Mainline Pressure Test Inspection

The depth of all joints, stop and waste valves, manual drain valves, sumps, control valves, and solvent welds shall be inspected for conformance to the drawings and these Standards and Specifications before they are buried. A pressure test shall be conducted at 120 psi or 40 psi over static pressure, whichever is greater, for a period of two (2) hours to ensure that the system is watertight.

C. Wiring Inspection

Once the wiring has been installed, it shall be inspected for conformance to the approved plans and these Standards and Specifications. No partial acceptance shall be made.

D. Coverage and Pressure Test

After the irrigation heads have been installed and backfilling operations are complete, the Responsible Party, in the presence of the Senior Landscape Architect, shall perform a coverage test to ensure that there is complete and uniform coverage. No partial acceptance regarding coverage or pressure test shall be made. Coverage shall be 'head-to-head' for all spray and rotor heads.

809.7 Drought Management Irrigation Guidelines

A. Use evapotranspiration and precipitation data to schedule irrigation by hydrozone, and according to soil type and plant material root depth. Seasonally adjust the irrigation schedule to maximize water conservation.

B. Water infrequently but deeply using the cycle and soak method.

C. Under severe drought conditions, consider allowing Kentucky Bluegrass lawns to go summer dormant to conserve water.

809.8. Private Irrigation Systems

A. Private irrigation systems shall be designed by an Irrigation Association Certified Irrigation Designer. "Design-Build" irrigation systems will not be accepted. Head-to-head coverage is required; and the use of "kicker" heads is restricted to two (2) % of the total of that type of head used on the site.

B. Systems must be designed with a fast acting rain sensor such as Hunter Rain-clik or approved equal, master valve, pressure regulation and check valves as needed to minimize the most common causes of water waste. The use of smart/ET controllers, weather stations and/or moisture sensors, and high uniformity emission devices like MP Rotators and in-line drip irrigation is encouraged.

C. The following irrigation system design information shall be provided with the approved construction drawings, or as stand alone Irrigation Plans, after the landscape plans have been approved or are near approval as part of the Development Permit process:

1. Friction loss worksheet proving adequate operating pressure is supplied to the last head of the most critical zone at design capacity. State the design capacity (maximum flow). Identify this zone on the worksheet by its designated letter or number.

2. Use available static pressure at the point of connection as calculated using the low hydraulic grade level for that portion of the City water zone.

3. Point of connection (POC) information including water meter, service line, and backflow prevention device sizes and locations. Water meters shall be sized for maximum continuous flow and based on total irrigated area assuming a moderate peak Irrigation Water Requirement of 3.37 gallons/square foot according to the following chart. The Irrigation Water Requirement and maximum irrigated area have been calculated using an assumed Irrigation Efficiency of 0.775 and a Landscape Coefficient of 0.73 (14.99 gallons/square foot per year). The corresponding required service line size reflects a maximum velocity of 7.5 feet per second at the maximum continuous flow of the meter, with four (4) inches being the minimum size allowed unless otherwise approved by the Senior Landscape Architect through the plan approval process.

TABLE 800-2
PRIVATE IRRIGATION METER SIZING

Meter Size	Maximum Continuous Meter Flow (Gallons per Minute)	Required Service Line Size @ Maximum Continuous Meter Flow	Monthly Water Allowance	Maximum Irrigated Area	
				Acres	SF
⅝" x ¾"	15	4" DIP or C900 PVC	142,000	.97	42,136
¾"	25	4" DIP or C900 PVC	200,000	1.36	59,347
1"	50	4" DIP or C900 PVC	259,000	1.76	76,855
1 ½"	80	4" DIP or C900 PVC	502,000	3.42	148,961
2" t	200	4" DIP or C900 PVC	715,000	4.87	212,166
3" t	450	6" DIP or C900 PVC	1,771,000	12.06	525,519
4" t	800	8" DIP or 10" C900 PVC	1,819,000	12.39	539,763
6" t	1000	10"DIP or C900 PVC	4,000,000	27.25	1,186,944

4. The order of POC components are displayed as shown in Detail 800-11A & 11B. The order of the most common POC scenarios is: service line, curb stop, water meter, isolation valve, reduced pressure zone backflow assembly, master valve, quick coupler valve.

5. The spot elevation at the point of connection. Show proposed grade lines grayed back significantly, and identified every five (5) feet.

6. A legend with all components listed with their size, brand, model number and any other pertinent information. Choose symbols to represent components and show them on the legend as well as the plan.

7. The details of all components as necessary to communicate installation instructions to the irrigation contractor. City of Thornton water meter and POC detail are required; choose the appropriate detail at the end of Section 800 of these Standards and Specifications.

8. A note shall be provided stating that the system is designed to meet a three (3) day per week watering schedule operating between 6:00 PM and 10:00 AM at the design capacity.

9. Irrigation system designs for single family home typicals shall be approved through the Development Permit approval process.

10. Private irrigation systems shall be installed per approved plans, and any changes must be approved and then documented on As-Builts.

11. Specific hydraulic information must be provided for every drip irrigation zone in like manner as any other zone. Simply labeling zones as "drip" is not sufficient.

12. All irrigation backflow prevention devices shall be safeguarded from theft by using a locking enclosure or other approved locking device.

13. All private irrigation systems installed with or as part of a Development Project shall be inspected by the Senior Landscape Architect following installation and prior to the issuance of the Certificate of Occupancy. At the inspection, the Senior Landscape Architect shall be supplied with a set of accurate and complete As-Builts. Another set of As-Builts must be placed in or near the controller cabinet. The controller shall be programmed accurately considering site soil properties, zone precipitation rate, and zone distribution uniformity for each zone. A seasonal irrigation schedule outlining monthly water requirement changes by % shall be placed in or near the controller cabinet. Final inspection will be performed using the following checklist, verifying:

    a. sprinkler coverage, and dynamic pressure if necessary.
    b. that components used match the approved plans.
    c. that the quick acting rain sensor is installed and functional.
    d. As-Built plan completeness.
    e. that a copy of As-Built plans has been placed in or near the controller.
    f. correct controller programming.
    g. seasonal irrigation schedule calculation accuracy.
    h. that the seasonal irrigation schedule is posted in or near the controller.

810 PARKS & OPEN SPACE AREAS AND RECREATION FACILITIES

810.1 General

A. The design of all parks and open space areas and recreational facilities including but not limited to, athletic fields, swimming pools, tennis courts and other hardscape recreational areas and playgrounds shall be reviewed and approved by the Senior Landscape Architect on a case-by-case basis. Construction shall not begin without an approved construction plan.

B. All parks and open space areas shall be designed to blend with adjacent areas and, to the degree possible, shall be organized as a continuation of existing or proposed landscape areas.

C. Adequate bicycle parking at activity generators shall be installed as appropriate.

D. City properties shall include signage with a minimum five (5) foot clear zone from pedestrian areas. Other site furnishings shall be required including benches, trail lighting, trash receptacles, dog waste stations, and other furnishings.

E. Any outdoor steps proposed on parks and open space properties shall be designed in accordance with the International Building Code as adopted by the City.

F. All site furniture shall have a powder coated paint finish.

G. All site furniture for City owned and maintained parks shall be installed with in-ground mounts.

H. As much as possible park perimeters shall be bordered by streets and have attached, eight (8) foot wide sidewalks unless otherwise determined through the development process.

810.2 Playgrounds

A. All playgrounds shall comply with the Consumer Product Safety Commission Technical Guidelines for equipment, surfacing, and area requirements. All playgrounds shall comply with all applicable standards to include the ASTM standards for equipment and surfacing and shall comply with ADA guidelines where applicable. All playground equipment shall comply with all guidelines found within the list provided as well as all other guidelines produced by CPSC, ASTM, and ADA. The Responsible Party is to verify that all statements contained within the list are accurate and current.

B. Guarantee

The Responsible Party shall guarantee the work against defective materials or faulty workmanship for a period of one (1) year from the date of Initial Acceptance. All equipment warranties accompanying any equipment shall be submitted to the City.

C. Playground Site Preparation

1. Description of Work
   The contract work to be performed under this section consists of furnishing all required labor, materials, equipment, implements, parts and supplies necessary for, or appurtenant to, the site preparation and grading of playgrounds in accordance with these Standards and Specifications.

2. General Site Layout
   Per approved construction drawings.

3. Materials
   a. Subgrade Materials
      After topsoil has been stripped, the existing subgrade material may be used unless aggregate fill is called for on the approved construction drawings.

   b. Execution

D. Playground Drainage Systems

1. Description of Work

   a. The work to be performed under this section consists of furnishing all required labor, materials, equipment, implements, parts and supplies necessary for, or appurtenant to, the construction of the subsurface drainage systems required.

   b. Playground areas shall be provided with a subsurface drainage system sufficient to adequately drain the playground area. Provide a cleanout in a 10 inch round Carson valve box outside of playground area. Playground drains shall be conveyed to storm drainage systems or shall be suitably day-lighted in a non-obtrusive area, away from playfields to a planting bed, as possible. Install protective concrete daylight collar as necessary.

2. Materials

   a. Subsurface Drainage Pipe. Four (4) inch diameter perforated corrugated polyethylene drainpipe shall be installed within play lot confines. Non-perforated Class 200 PVC or smooth interior/corrugated exterior polyethylene pipe shall be installed outside of play lot confines as needed to daylight drainage pipe. No filter fabric shall be allowed on perforated pipe.

   b. Subsurface Drainage Pipe Backfill. Backfill shall be three-eighths (3/8) inch clean, washed pea gravel, with a minimum four (4) inch depth around and over drainage pipe.

   c. Drains shall have a clean out and shall have piping to daylight, or to another piped drainage outlet.

3. Execution

   a. The site preparation shall be done to provide positive drainage away from playground areas, and if needed, to provide intercepting landscaped swales to prevent drainage into the playground areas.

   b. Subsurface drainage pipe shall be oriented diagonally to prevailing slope of play lot subgrades, and shall be spaced to allow water to move laterally along subgrade a maximum of 20 feet before being intercepted by a drainpipe. Locate drainage pipe to avoid interference with play equipment. Drainage pipe layout shall be field adjusted as needed to best accommodate play equipment layout and for best interception of water.

   c. Install drainage pipe in minimum eight (8) inch wide by 10 inch deep trenches. The underdrain trench shall be encased with a non-woven filter fabric. Trench depth may vary greater than 10 inches as needed for minimum pipe gradients. Minimum drainage pipe and trench gradients shall be 0.5%. Backfill trenches with three-eighths (3/8) to one (1) inch pea gravel. Drainage pipe shall be encased with a minimum four (4) inch layer of pea gravel on both sides and bottom, with minimum four (4) inch pea gravel cover on top.

E. Playground Loose-fill Surfacing

1. Description of Work

   a. The Responsible Party shall install loose-fill surfacing in playgrounds and other outdoor applications where safety surfacing is required.

   b. The contract work to be performed under this specification consists of furnishing all of the required labor, materials, equipment, implements, parts and supplies necessary for, or appurtenant to, the installation of the loose-fill surfacing material within the interior of the playground curb.

2. Materials

   Loose-fill material for all playgrounds shall consist of Fibar material or equal, to meet CPSC guidelines. Material depths shall meet critical height requirements as set forth by ASTM, ADA, and CPSC after compaction.

3. Execution

   Depths shall be a minimum 12 inches unless otherwise indicated on approved construction drawings, and may vary due to varying height of any play equipment installed. The Responsible Party shall be responsible for the verification of depths depicted within any stamped construction plans to conform to the critical height criteria prior to the installation of any loose-fill material. All areas within the vertical curb shall conform to critical height criteria, as required by the referenced publications, with no exceptions. The Responsible Party shall submit a sample of the loose fill material to be used for approval prior to installation. The Responsible Party shall verify the required depth one (1) to two (2) months after installation. If material has settled, the 12 inch depth shall be re-established.

F. Resilient Cast-In-Place Playground Surfacing
The Responsible Party shall install cast-in-place surfacing in playgrounds and other outdoor applications where safety surfacing is required.

1. Description of Work

   a. General

      The work to be performed under this section of these Standards and Specifications consists of furnishing all of the required labor, materials, equipment, implements, parts and supplies necessary for, or appurtenant to, the installation of resilient safety surfacing for the accessible areas of the playground surface.

   b. Weather Limitations

      Surfacing shall be adhered to cured and stable concrete or aggregate base, as detailed on the approved plans, when surface temperatures are above 40° F. Do not install when surface temperature has been below 40° F for 12 hours before application. Do not apply when base contains excess moisture.

   c. Grade and Horizontal Control

      Establish and maintain required lines and elevations. Concrete shall slope to provide positive drainage at a minimum of one (1) inch per 10 feet and shall not pond water at any locations. If surfacing is to be laid on an aggregate base, provide subsurface drainage where shown on approved plans.

2. Materials

   a. Submittals
      Submit manufacturer's product and supporting data certifying that each material component complies with or exceeds the specified requirements prior to the beginning of any work in the following form:

      i. Manufacturer's sales brochures marked to annotate the specific product to be utilized.

      ii. Test data conforming to ASTM-F1292 at 30° F, 72° F, and 120° F for no less than the height specified on the approved drawings certified by a recognized independent testing laboratory within the past 12 months.

      iii. Statement of compliance with volatile emission regulations for all components, including adhesive systems or binders.

iv. Guarantee and warranty for no less than one (1) year. Two (2) representative samples and the recommended manufacturer's installation instructions shall be submitted.

b. Base

The concrete base shall consist of six (6) inch concrete slab with fiber mesh reinforcement. Concrete shall be placed on top of subgrade compacted to a minimum of 95% standard proctor density. Concrete shall meet the criteria as set forth in Section 600 of these Standards and Specifications.

c. Cast-In-Place Surface

The surface shall be manufactured on-site from UV stabilized polyurethane and rubber granules, no less than the specified thickness. Product components shall conform to the following physical test data:

i. Polyurethane Binders

One component, solvent free pre-polymer, methylene dephenyl iscyanate (MDI) type, and shall not incorporate any heavy metals.

(1) NCO content - no less than 10%
(2) Tensile strength > 1,850 PSI (ASTM D-412)
(3) Elongation > 450% (ASTM D-412)

ii. Base Course Rubber

100% recycled SBR black rubber, free of all dust and extraneous fiber, metal, and similar substances. Foam rubber fillers are not acceptable.

iii. Top Course Rubber 100% new EDPM rubber, peroxide cured, UV stabilized, size one (1) to three (3) millimeters.

iv. Minimum Performance Standards

In addition to meeting CPSC recommendations for critical full fall heights, the wearing course of all play surfaces shall possess the following minimum characteristics:

(1) Shore A > 50; < 70
(2) Elongation >100%
(3) Tear > 35%
(4) Abrasion Loss < 1.75 gm/200 cubic yards

v. Color

The Responsible Party shall provide color(s), as specified on the stamped construction plans, which may vary by area.

3. Execution

a. Surface Preparation

i. Concrete Base

Concrete shall have obtained a minimum of 80% of the required structural strength prior to placement of the surfacing. Cleaning of the concrete surface shall be completed prior to placement of the surfacing. Any surface irregularities greater than one-half (½) inch in 12 inches are to be filled with an approved structural bonding type filler prior to placement of surfacing.

ii. The Responsible Party shall request inspection prior to placement of any surfacing and shall be responsible for correction on any noted deficiencies prior to placement of any surfacing.

b. Layout

The Responsible Party shall plan the layout and placement of varying thickness zones by string lines, chalk lines, and grade stakes to provide reference points throughout the installation process.

c. Installation of Surfacing

i. The Responsible Party shall ensure that the sub base is clean, dry, and ready to accept wet mix. All components shall be pre-measured by individual weight to achieve consistency by high quality control during installation. All components shall be mixed in a clean, approved mixer taking care not to over mix or permit pre-cure. The mix cycle shall uniformly coat all rubber particles in batches that can be transported and placed without delays.

ii. The entire area shall be primed with a polyurethane binder at a rate of not less than .15 pounds per square yard, if site conditions warrant. A minimum of 15 minutes of cure time shall be allowed before base course application.

iii. The base course shall be placed in one or more lifts to achieve the specified attenuation values. Cold joints shall be primed but should not be over-worked in a manner that might create hard spots and/or joints. Raking and hand troweling shall be done to provide an even, uniform surface. The base course of surfacing shall not be compacted.

iv. After cure of the base course, the top EPDM course shall be screened and hand troweled to a smooth, uniform, seamless surface, of the minimum specified thickness.

d. Protection and Curing

The Responsible Party shall ensure that the surfacing is protected from all types of vehicle, equipment, and foot traffic and vandalism until the surfacing material is completely cured.

G. Playground Vertical Curb

1. Description of Work

The contract work to be performed under this section consists of furnishing all required labor, materials, equipment, implements, parts and supplies necessary for, or appurtenant to, the construction of a concrete vertical curb surrounding each playground.

2. Materials

Vertical curbs shall be constructed of concrete reinforced with Number Four (4) rebar spaced at 12-inch centers horizontally and vertically, or as depicted on stamped construction plans. Concrete shall meet the criteria of Section 600 of these Standards and Specifications. The vertical curb shall have a minimum six (6) inch top width and may have variable heights as according to approved plans. A minimum of eight (8) inches of the vertical curb shall be buried in compact subgrade. The Responsible Party shall submit drawings of the proposed curb section and layout before play equipment has been installed.

3. Execution

a. Forming

Forms shall be set to the lines and grades shown on stamped construction plans within plus or minus (+/-) one-fourth (¼) inch of finished grades indicated on said plans. Forms shall be securely braced to prevent settlement of movement during placement of concrete. Forms shall remain until concrete has taken final set.

b. Reinforcement

Reinforcement shall be installed in such a manner to as to keep it a minimum of three (3) inches above the ground by ties and/or chairs to prevent settlement or movement during placement of concrete.

c. Concrete Vertical Curb

i. Concrete shall be poured in accordance with Section 600 of these Standards and Specifications. Control joints shall be spaced as depicted on approved plans.

ii. Top of play lot curb shall be set at an elevation needed to provide a four (4) inch clear dimension between top of curb and top of play lot surfacing.

H. Play Equipment

1. Description of Work

The contract work to be performed under this section of the specifications consists of furnishing all required labor, materials, equipment, implements, parts and supplies necessary for, or appurtenant to, the installation of any play equipment and footings for said equipment.

2. Design Submittal

The Responsible Party shall provide detailed design and materials information specific to the play equipment line to the Senior Landscape Architect for review and approval. Design submittal shall include the following information:

a. Detailed plan view of play components within shown curb confines, at scale of 1/8" = 1'-0"; and a color rendered 3-D perspective rendering;

b. transfer station;

c. accessible surfacing layout, depths, and area measured in sq.ft.;

d. deck and stair heights;

e. fall zone delineations and dimensioning, and critical fall heights;

f. grab bars, stair kick plates, and railings;

g. materials specifications, product cut sheets, and pictures of each component and of main frame structure;

h. materials specifications, product cut sheets, and details for accessible surfacing and surfacing edge detail;

i. materials specifications for all clamps, fittings, and fasteners;

j. footing details and/or dimensions, including bury depths;

k. color specifications and color samples for all components, main frame, decking, post clamps, grab bars, and railings;

l. warranty descriptions;

m. a statement of conformance with CPSC, ASTM, and ADA guidelines as are current at the time of design submittal; and

n. a statement of IPEMA certification

3. Materials

Contractor shall supply all equipment shown on plans in the same configuration as shown on said plans. All equipment shall meet current ADA, CPSC, and ASTM guidelines for safety and accessibility. No equipment shall be changed or substituted without the expressed written consent of the Senior Landscape Architect . Equipment shall be arranged to conform to all fall zone requirements as set forth by ADA, ASTM, and CPSC. It shall be the responsibility of the contractor to verify that all designed play equipment configurations, as shown on plans, conforms to the ADA, CPSC, and ASTM guidelines.

a. Main Frame Posts

Minimum five (5) inch o.d., minimum 0.12" wall thickness, round steel tubing with a yield test of at least 50,000 psi. and tensile strength of at least 55,000 psi., complying with ASTM A-135 and ASTM A-500 Grade A. Tubing interiors and cut ends shall be coated with a corrosion resistant compound. Exteriors shall be galvanized, coated with chromate conversion coating, and then finished with electrostatically applied, oven cured dry polyester powder coat. Post caps shall be UV resistant, high-density, injection-molded plastic, or powder coated steel or aluminum, factory riveted to post, and color matched to post. Concrete post footings shall be the greater of

manufacturer's recommendations or 12-inch diameter and 34-inch deep as measured from finished top of surfacing.

b. Stairs and Stair Decks

Minimum 13-gauge steel decks, minimum 14-gauge steel stairs. Perforated on the standing surface, flanged and braced for structural integrity and bonded vinyl clad. Side flanges slotted for post attachment. Modular in design.

c. Main Frame Rails and Handloops

Minimum 1-1/8" o.d. galvanized, powdercoated steel. All welds shall be free of excessive splatter.

d. Climbers, Fire poles, and Horizontal Ladders

Galvanized, powder coated tubular steel, with concrete footings per manufacturer's recommendations. All welds shall be free of excessive splatter.

e. Slides and Slide Hoods

i. On City maintained and metropolitan district park playgrounds a minimum of one (1) slide shall be a minimum 96 inches high at the starting platform.

ii. Rotationally molded, linear low density, UV color stabilized polyethylene. Slide sections shall be connected with recessed fasteners. All steel tubing supports shall be powder coated. All steel welds shall be free of excessive weld splatter. Hoods shall attach to slides and provide full enclosure. Support footings shall be per manufacturer's recommendations. Spiral slide main support footings shall be at least 16-inch diameter and 34-inch deep, as measured from top of surfacing, or per manufacture's recommendation, whichever is greater.

iii. Playground wear mats shall be installed at all slide landings to slow erosion of the Fibar material.

f. Swings

i. See "Main Frame Posts" for post specifications. Concrete post footings shall be the greater of manufacturer's recommendations or 18-inch diameter and 44-inch deep as measured from finished top of surfacing.

ii. Pipe beam swing hangers shall be galvanized, malleable iron with oil-impregnated bearings, with double clevis chain attachment.

iii. Chains shall be hot galvanized 4/0 straight link welded, 670 lb. working load limit. Chain-to-seat attachment shall be by single clevis bolt link – no 'S' hooks will be allowed.

iv. Playground wear mats shall be installed under each individual swing to slow erosion of the Fibar material.

g. Clamps, Fittings, and Fasteners

i. Clamps: Powder coated, die cast aluminum alloy, pinned to posts with solid steel pins, and recessed clamp fasteners.

ii. Fittings & Fasteners: Tamper resistant, stainless steel or other approved non-corrosive material, free from protrusions.

4. Execution

The Responsible Party shall submit shop drawings for all play equipment, layout and footings. Shop drawings shall be submitted to the Senior Landscape Architect for approval before any equipment is ordered. Once shop drawings have been approved, play equipment shall be installed according to approved plans. Footings shall be installed below all surfacing and aggregate fill in compact subgrade.

a. Quality Assurance

Installation shall be in accordance with City approved construction drawings, specifications and manufacturer's recommendations.

b. Materials Delivery and Storage

Deliver materials to site undamaged. Store and protect materials on site in a manner that prevents damage. Materials shall be placed and stored so that water will drain and not accumulate.

I. Timing Sequence for Playground Installation

1. The following order shall be adhered to for the construction/reconstruction of any playground:

a. Surveying and staking of curb and subgrade, and subgrade finishing.

b. Installation of concrete vertical curb.

c. Installation of new or replacement equipment and footings.

d. Installation of playground sub drain system.

e. Installation of cast-in-place surfaces over any concrete foundations or aggregate base, as required on approved plans.

f. Fill playground area with fill material as required on approved plans.

g. Repair and/or replace sod and irrigation system around playground.

810.3 Athletic Fields

Athletic fields, including but not limited to football, soccer, softball, and baseball fields, shall comply with the following general requirements:

A. Slopes of fields shall be uniform. Significant grade breaks in field area shall not occur. Laser grading shall be employed.

B. Slopes of fields shall be between one and one-half (1.5) to two (2) %.

C. Athletic fields intended for programmed sports play shall be laser graded.

810.4 Tennis Courts and Basketball Courts

Courts shall conform to the following minimum construction standards:

A. Courts shall have a base of post-tensioned concrete.

B. Tennis courts shall have an all-weather, non-fading, glare-free strongly bonded surface finish. Paint shall not be permitted as a surface finish. The Senior Landscape Architect shall approve colors. Chain-link tennis court fencing shall be bonded vinyl-clad, dark green or black in color, as approved by the Senior Landscape Architect . Chain-link fencing framework shall be sized to support wind loads associated with windscreens.

810.5 Trails and Sidewalks

All multiple use trails and sidewalks shall be designed and constructed in accordance with "Guide for the Development of Bicycle Facilities," AASHTO at a design speed of 30 miles per hour and signed with City approved signage.

A. Multiple use trails and sidewalks shall be constructed per Section 100, 500 and 600 of these Standards and Specifications.

B. Multiple use trails shall be designed and constructed per Detail 800-5 and 800-6

C. Trails and sidewalks shall be constructed of concrete unless otherwise approved by the City. Concrete shall be a minimum of six (6) inches thick and shall be made of concrete with a compressive strength of 4,500 psi at 28 days using three-fourths (¾) inch aggregate, four (4) inch maximum slump, five (5) to eight (8) % air content, and a water/cement ratio of not more than 0.45, using cement in conformance with Subsection 602.1 of these Standards and Specifications. All concrete shall have an approved synthetic fiber added at a rate of one and one-half (1.5) pounds per cubic yard with three-fourths (¾) inch to one (1) inch length fibers required to reduce cracking. All concrete control joints shall be saw cut not less than 25% and no more than 33% of the slab thickness, at regular intervals. Provide expansion/ construction

joints every 100 feet minimum and saw cut joints every 10 feet minimum. Concrete surfaces shall receive a medium broom finish with the direction of broom strokes being perpendicular to the length of the trail.

D. Alternative trail materials such as crushed granite or other crusher fines may be allowed as surfacing, if approved by the Senior Landscape Architect.

E. No trail shall cross an arterial or collector road at mid-block at grade. All crossings shall be approved through the Development Permit approval process.

810.6 Open Space Areas

Minimal structures such as, but not limited to, restrooms, open pavilions, directional and name signs and impervious areas (such as parking areas and trails) may be located thereon. Benches located along trails in open space areas shall be black in color (reference appropriate section). Open space areas disturbed during construction practices shall be at the minimum, rehabilitated with native vegetation.

810.7 Rights-of-Way and Median Landscaping

A. Consider the location of buried and overhead utilities for plant material selection and spacing.

B. Refer to City of Thornton plant list for acceptable street tree species, especially for salt tolerant plant materials suitable for streets treated with Magnesium Chloride in winter.

810.8 Recreation Facility Lighting

A. Playgrounds, Trails, & Parks

LED lights shall be utilized on playgrounds, trails, pedestrian underpasses and parks. A photometric lighting plan shall be included in the approved construction drawings.
A light fixture shall be required at each at grade trail intersection with a public or private street. In addition, one (1) light fixture shall be required along each 300 linear feet of trail or sidewalk, or as warranted by safety concerns and as determined through the development review process.

B. Tennis Courts

All tennis court lighting shall use metal halide lamps. The minimum standard for uniformity shall be one (1) to three (3). No area on the court should be less than one-third (1/3) of the brightest illumination point on the court. In addition, to assure smoothness of lighting across the court, there shall be no variation in light greater than one (1) % per foot. All tennis court lighting shall meet "recreational" standards established at 38 initial foot-candles resulting in 30 maintained foot-candles using an 80% maintenance factor to determine light levels to be maintained on the court for the extended life of the lighting system (e.g. 38 X 0.80 = 30). There shall be one (1) transformer and a simple service entrance with two (2) circuits and individual breakers for each fixture to avoid gang failure of the lights and make it easier to locate problems that may occur.

D. Unless otherwise required, all light fixtures shall be mounted on an 18-foot metal or fiberglass pole.

810.9 Shelters

A. General Provisions

1. Complete manufacturer's literature and technical data shall be submitted to the Building Division. Literature must include address of manufacturer's physical facility and manufacturer's telephone number.

2. Certification shall be submitted to the Building Division via a transmittal properly identified with project name, location, date, certification of manufacturer's compliance with the requirements specified herein signed and sealed by a PE registered in the State of Colorado. Data shall be specific to the project indicating exactly what will be supplied, with no exceptions.

3. A complete set of shop drawings shall be submitted. Said drawings shall be signed and sealed by a PE registered in the State of Colorado. Drawings shall be specific to the project indicating specifically what will be supplied and not of a general nature, with no exceptions.

4. Samples, certifications, and specification sheets on roof decking, beams, panels, welding, columns, facia, interior finish, exterior siding, and footing design based on site specific soil analysis shall by submitted for review and approval prior to ordering.

5. Fabrication using open "I" beams, open "CEES", or open channels shall not be accepted. Only tubular structural members shall be allowed to minimize moisture permeation and ensure structural integrity. Tapered columns shall not be accepted.

6. Foundation and anchor bolt configurations shall be the same design as that of the specified structure as shown on approved plans. Surface mounting with a minimum of four (4) high strength hidden anchor bolts per column shall be the only accepted method.

7. A two (2) year warranty shall be provided by the Responsible Party for workmanship and materials.

8. The structure shall be as depicted on approved plans. It shall be designed in strict accordance with the IBC as adopted by the City, using a minimum snow load of 30 pounds per square foot (psf), with a minimum wind load based upon a 90 mile per hour wind speed, and a seismic (earthquake) load based on Category B.

9. All structural framing of the structure shall be tubular steel with no place for bird nesting or moisture accumulation. All connections shall be field welded by certified welders to minimize moisture permeation.

10. All tubular steel members of the structure shall be designed in strict accordance with the requirements of the AISC specifications and the American Iron and Steel Institute (AISI) specifications for cold formed members.

11. All structural field connections for the structure shall be designed and made with high strength bolted connections using structural bolts as required by a State of Colorado licensed PE.

12. All shop-welded connections of the structure shall be designed and made in strict accordance with the requirements of the American Welding Society (AWS) specifications. Structural weld shall be in accordance with AWS requirements.

13. Any steel frame parts not primed and finished with powder-coating at the factory shall be prime painted at the factory with a rust inhibitive modified alkyd primer according to Steel Structures Painting Council (SSPC-SP2) as outlined in AISC 6.5. The structural steel shall be thoroughly cleaned upon arrival on the job site by the Responsible Party. Prior to erection, the primer coating may be checked for uniform coverage and thickness. If the minimum thickness of primer is not found, additional primer shall be added in the field, as determined by the Senior Landscape Architect. The frame shall be finish painted in the field with a weather resistant paint compatible with primer used. The finish paint shall be supplied and applied by the Responsible Party, or designated contractor. Color shall be as shown on approved plans. Finish paint shall show no signs of "runs," discoloration, bleaching, or fading.

14. At least one (1) photocell-controlled, peak-mounted light fixture and at least two (2) exterior grade 120 VAC outlets shall be provided per shelter. All shelter electrical outlets shall be recessed and lockable with all wiring conduit interior to the column.

15. A separate permit from the City's Building Inspection Division must be obtained.

B. Roof Pitch

The roof pitch shall be at least 6:12 and no more than 8:12.

C. Frame

1. Columns shall be square or round tubular structural steel.

2. The compression ring, tension members, and truss members shall be a structural steel tube.

D. Roof System

1. Roof panels for the structure shall be not less than 24-gauge painted standing seam metal roof decking with one and one-fourth (1¼) inch high ribs, 12 inches on the center. They shall be precut into panels corresponding to the length from eave to ridge. Angles shall be precut. Ribs shall run with the pitch of the roof for proper drainage.

2. Panels and matching trim shall be pre-painted with a Kynar 500 paint system or approved equal..

3. A complete trim package shall be supplied. Unless otherwise specified, trim parts shall be a minimum of 26-gauge galvanized steel painted.

4. Ridge trim shall be as follows:

a. Panel end caps shall be pre-bent to a "U" shape to fit over ridge end of roof panels. The inside of caps shall match the roof color.

b. Eave splice channels shall be provided to fit behind "J" channel butt joints to create strength at the joint and maintain a straight eave line.

c. Special "J" channel corner trim shall be provided which fits over the main "J" channel to simplify final detailing of corners.

E. Surface Mounting on Concrete Foundation

The shelter shall be set on prepared footings. Footings will be constructed in accordance with local codes and specific site conditions. The structure shall be attached to the top of the footing by use of anchor bolts as required by a State of Colorado licensed PE and torqued to a tightness required by the applicable ASTM standards. The bolts shall be furnished by the manufacturer. The Responsible Party shall submit shop drawings signed and sealed by a State of Colorado registered PE for all footings for columns.

F. Timing of Construction

1. Installation of structure and footings for columns must take place before pouring any concrete slab.

STAKING: INSTALL 6' METAL T-POST STAKES OUTSIDE PLANTING PIT IN UNDISTURBED MULCHED SOIL. USE #12 GAUGE GALVANIZED WIRE.

ALLOW FOR SOME TRUNK MOVEMENT

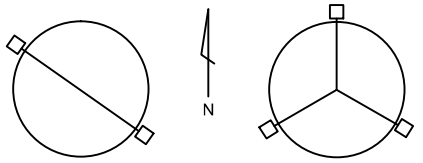
ATTACH TO 2" NYLON STRAPS THROUGH METAL GROMMETS, WITH 1/2" x 15" WHITE PVC SLEEVE ON EACH WIRE.

NYLON STRAPS SHALL BE LONG ENOUGH TO ACCOMMODATE 1-1/2" OF TRUNK GROWTH.

ADD PROTECTOR CAP TO TOP OF POST.

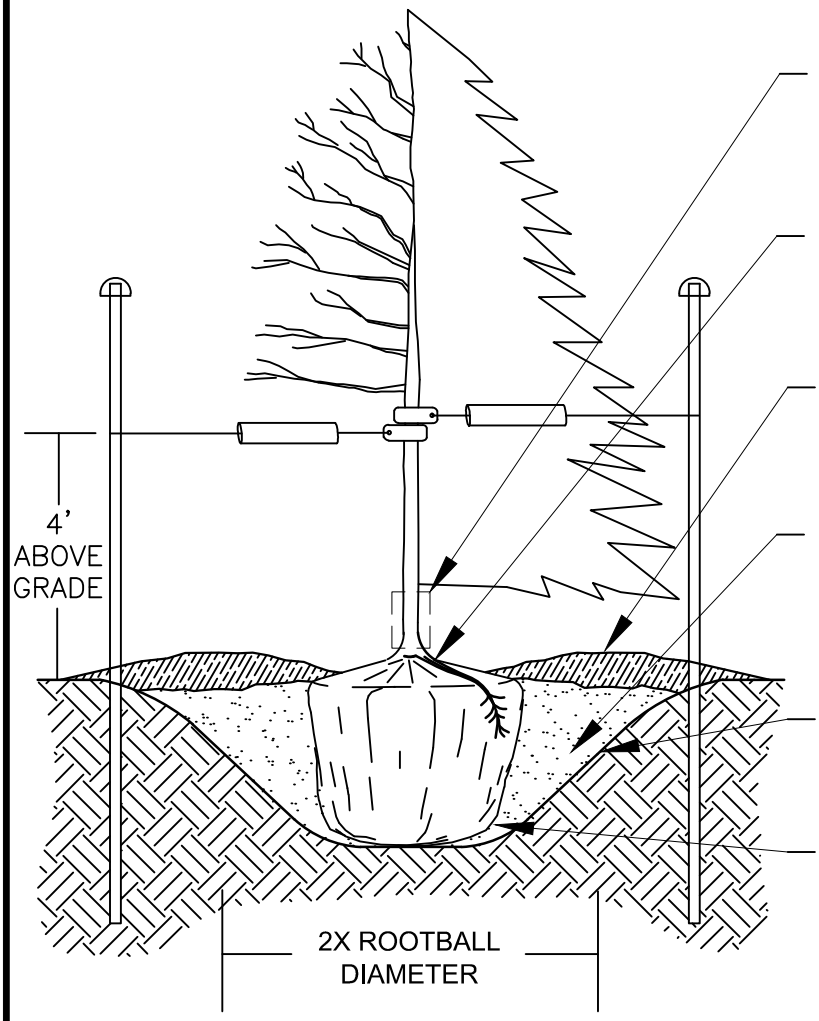
WRAP TREES TO FIRST BRANCH IF PLANTED IN THE FALL. DO NOT WRAP IF PLANTED IN SPRING.

TREE STAKING PLAN VIEW



3" OR LESS CALIPER

MORE THAN 3" CALIPER & ON ALL EVERGREENS



INSTALL TRUNK PROTECTOR, DESIGNED TO EXPAND WITH TRUNK GROWTH (DECIDUOUS ONLY).

PLANT TREE SUCH THAT FIRST ORDER MAJOR ROOT IS 1" TO 2" ABOVE GRADE AND TRUNK FLARE IS VISIBLE.

SPECIFIED MULCH (4" DEPTH X 6' DIAMETER) PULLED BACK 6" FROM BASE OF TRUNK.

BACKFILL PIT WITH MIXTURE OF 2/3 EXISTING SOIL AND 1/3 APPROVED AMENDMENT. WATER THOROUGHLY WHILE BACKFILLING. DO NOT COMPACT OR TAMP.

SIDE SLOPES OF PLANTING HOLE SHALL BE 1:1. ROUGHEN SIDES OF PLANTING PIT PRIOR TO SETTING.

PLACE ROOTBALL ON UNDISTURBED SOIL TO PREVENT SETTLEMENT. REMOVE ENTIRE WIRE BASKET, ALL ROPE, TWINE AND BURLAP FROM ROOTBALL AND TRUNK.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

DECIDUOUS AND EVERGREEN TREE PLANTING DETAIL

ISSUED:
MARCH 1996
REVISED:
APRIL 2010

DRAWING NO.
800-1A

ARRODRIGAR: INSTALAR ESTACAS METÁLICAS EN FORMA DE T DE 6' FUERA DEL HOYO DE PLANTACIÓN EN TIERRA SIN DISTURBAR CUBIERTA DE MANTILLO. USE ALAMBRE GALVANIZADO DE ANCHO #12.

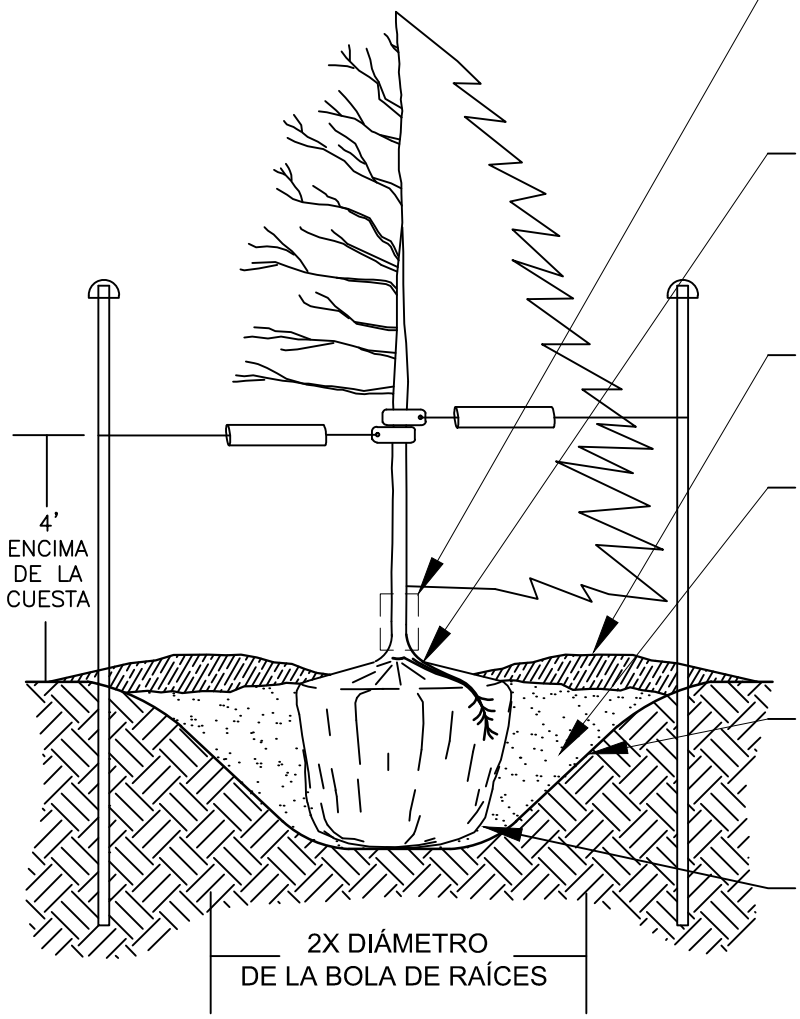
DEJE ESPACIO PARA QUE EL TRONCO SE PUEDA MOVER

PONER CORREAS DE NYLON DE 2"A TRAVÉS DE OJALES METÁLICOS, CON UNA MANGA DE PVC BLANCA DE ½"X 15"EN CADA ALAMBRE.

LAS CORREAS DE NYLON SERÁN LO SUFICIENTEMENTE LARGAS PARA PERMITIR QUE EL TRONCO CREZCA 1 –½"

AGREGAR TAPA PROTECTORA A LA PARTE DE ARRIBA DE LA ESTACA.

ENVOLVER LOS ÁRBOLES HASTA LA PRIMERA RAMA SI SE PLANTA EN EL OTOÑO. NO ENVOLVER SI SE PLANTA EN LA PRIMAVERA.



INSTALAR PROTECTOR PARA EL TRONCO, DISEÑADO PARA EXPANDIRSE CON EL CRECIMIENTO DEL TRONCO (SÓLO DECIDUO)

PLANTAR EL ÁRBOL DE TAL MANERA QUE LA PRIMERA RAÍZ PRINCIPAL ESTÉ 1"A 2" ARRIBA DE LA CUESTA Y EL ENSANCHAMIENTO DEL TRONCO SEA VISIBLE.

MANTILLO ESPECIFICADO (4" DE PROFUNDIDAD X 6" DE DIÁMETRO) RETIRADO 6"DE LA BASE DEL TRONCO.

VOLVER A LLENAR EL HOYO CON UNA MEZCLA DE 2/3 DE LA TIERRA EXISTENTE Y 1/3 DE LA ENMIENDA APROBADA. RIEGUE BASTANTE CON AGUA MIENTRAS SE VUELVE A LLENAR. NO COMPACTAR O APISONAR.

LOS LADOS DE LAS CUESTAS DEL HOYO PARA PLANTAR SERÁN 1:1. PONER RUGOSO LOS LADOS DEL HOYO DE PLANTACIÓN ANTES DE COLOCAR.

PONER EL CEPELLÓN EN TIERRA SIN DISTURBAR PARA PREVENIR QUE SE ASIENTE. QUITE TODA LA CESTA DE ALAMBRE, TODA LA SOGA, CUERDA Y ARPILLERA DEL CEPELLÓN Y EL TRONCO.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

DECIDUOUS AND EVERGREEN TREE PLANTING DETAIL

ISSUED:
MARCH 1996
REVISED:
APRIL 2010

DRAWING NO.
800–1B

ARRODRIGAR: INSTALAR ESTACAS METÁLICAS EN FORMA DE T DE 6' FUERA DEL HOYO DE PLANTACIÓN EN TIERRA SIN DISTURBAR CUBIERTA DE MANTILLO. USE ALAMBRE GALVANIZADO DE ANCHO #12.

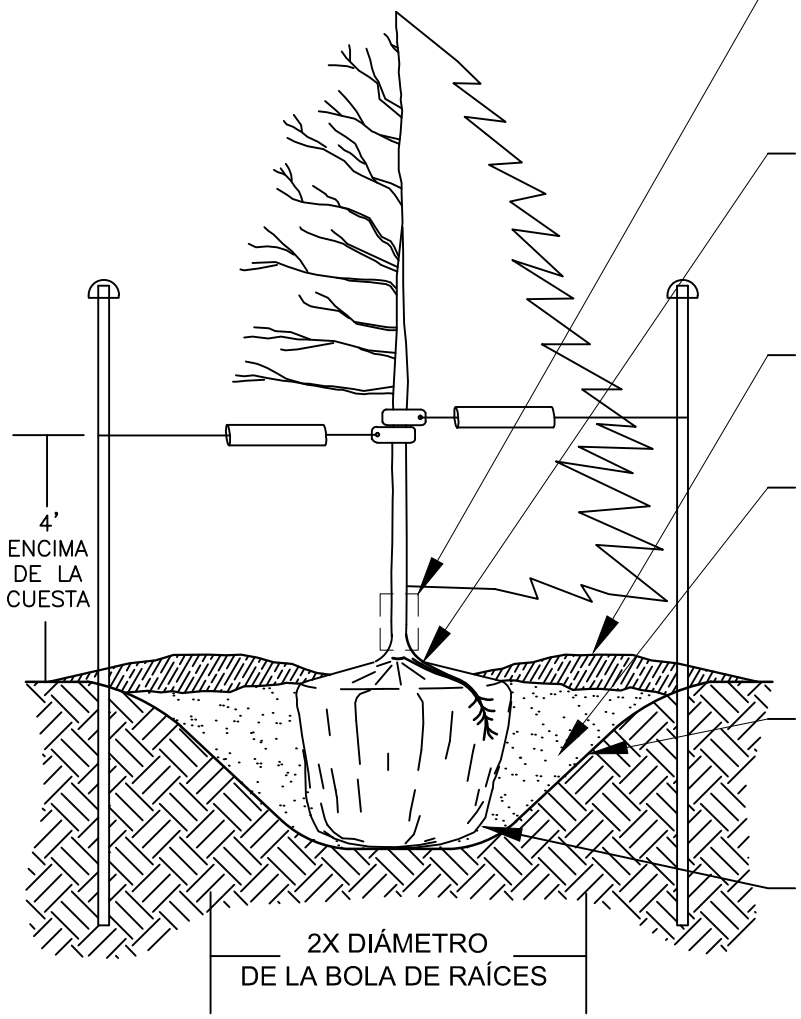
DEJE ESPACIO PARA QUE EL TRONCO SE PUEDA MOVER

PONER CORREAS DE NYLON DE 2"A TRAVÉS DE OJALES METÁLICOS, CON UNA MANGA DE PVC BLANCA DE ½"X 15"EN CADA ALAMBRE.

LAS CORREAS DE NYLON SERÁN LO SUFICIENTEMENTE LARGAS PARA PERMITIR QUE EL TRONCO CREZCA 1 –½"

AGREGAR TAPA PROTECTORA A LA PARTE DE ARRIBA DE LA ESTACA.

ENVOLVER LOS ÁRBOLES HASTA LA PRIMERA RAMA SI SE PLANTA EN EL OTOÑO. NO ENVOLVER SI SE PLANTA EN LA PRIMAVERA.



INSTALAR PROTECTOR PARA EL TRONCO, DISEÑADO PARA EXPANDIRSE CON EL CRECIMIENTO DEL TRONCO (SÓLO DECIDUO)

PLANTAR EL ÁRBOL DE TAL MANERA QUE LA PRIMERA RAÍZ PRINCIPAL ESTÉ 1"A 2" ARRIBA DE LA CUESTA Y EL ENSANCHAMIENTO DEL TRONCO SEA VISIBLE.

MANTILLO ESPECIFICADO (4" DE PROFUNDIDAD X 6" DE DIÁMETRO) RETIRADO 6"DE LA BASE DEL TRONCO.

VOLVER A LLENAR EL HOYO CON UNA MEZCLA DE 2/3 DE LA TIERRA EXISTENTE Y 1/3 DE LA ENMIENDA APROBADA. RIEGUE BASTANTE CON AGUA MIENTRAS SE VUELVE A LLENAR. NO COMPACTAR O APISONAR.

LOS LADOS DE LAS CUESTAS DEL HOYO PARA PLANTAR SERÁN 1:1. PONER RUGOSO LOS LADOS DEL HOYO DE PLANTACIÓN ANTES DE COLOCAR.

PONER EL CEPELLÓN EN TIERRA SIN DISTURBAR PARA PREVENIR QUE SE ASIENTE. QUITE TODA LA CESTA DE ALAMBRE, TODA LA SOGA, CUERDA Y ARPILLERA DEL CEPELLÓN Y EL TRONCO.

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

DECIDUOUS AND EVERGREEN TREE PLANTING DETAIL

ISSUED:
MARCH 1996
REVISED:
APRIL 2010

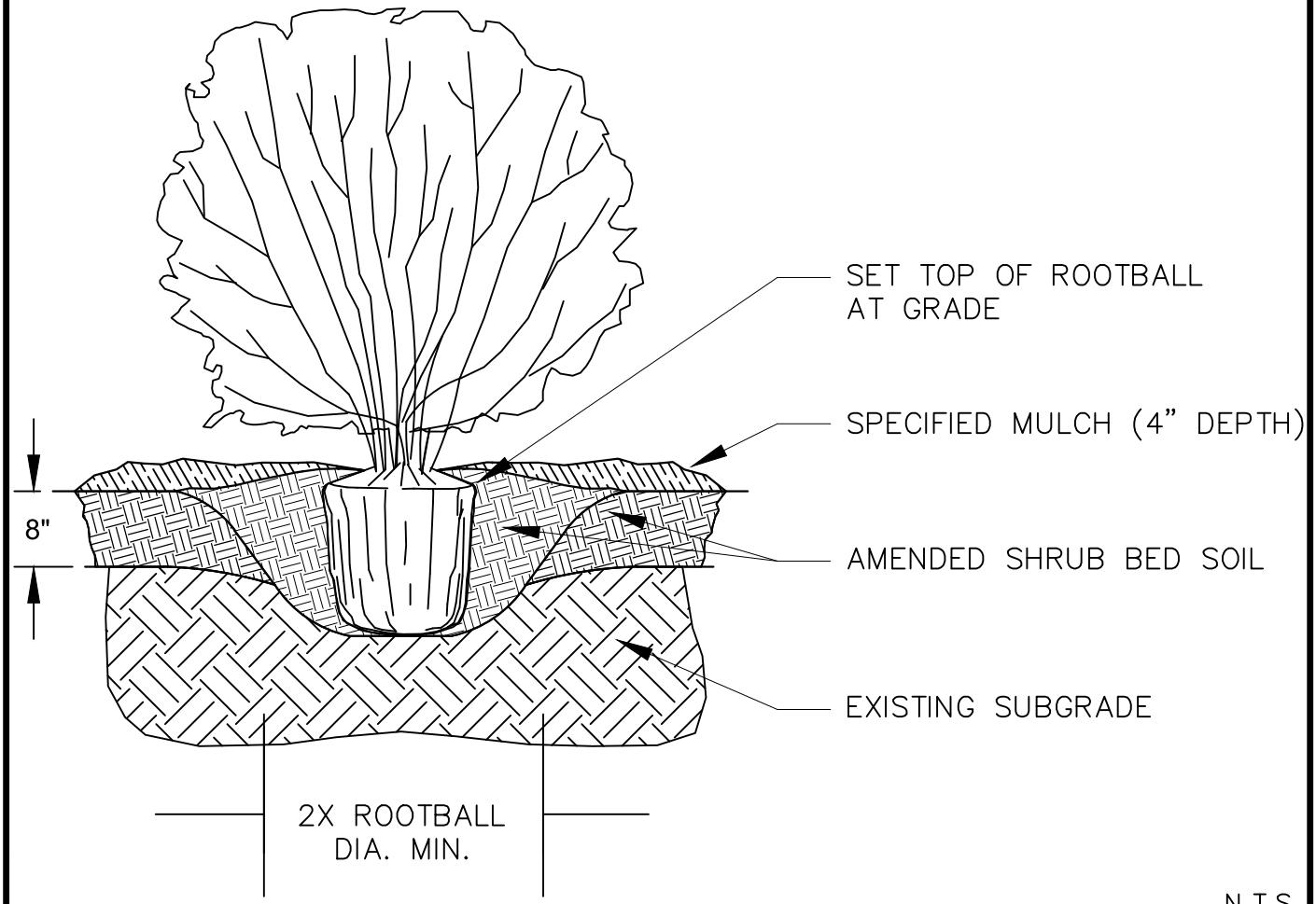
DRAWING NO.
800–1B

PLANT SHRUBS 1/2 MATURE WIDTH OR 4' FROM EDGE OF WALK, CURB OR EDGING.

ENTIRE SHRUB BED AREA SHALL BE AMENDED WITH 4 CUBIC YARDS (6 CUBIC YARDS FOR CITY MAINTAINED PROJECTS) OF CLASS I OR CLASS II COMPOST PER 1000 S.F. TILLED TO DEPTH OF 8".

IF PLANT IS ROOT BOUND AND HAS CIRCLING ROOTS, SHEAR 1/2" OF THE ROOTMASS OFF OF ALL SIDES AND BOTTOM.

DO NOT PLANT SHRUBS HIGHER THAN SURROUNDING GRADE. BACKFILL SOIL SHOULD BE PULLED OVER TOP OF ROOTBALL (NO MORE THAN 1") TO PREVENT MOISTURE WICKING AND TO ALLOW ROOTS TO GROW INTO SURROUNDING SOIL.



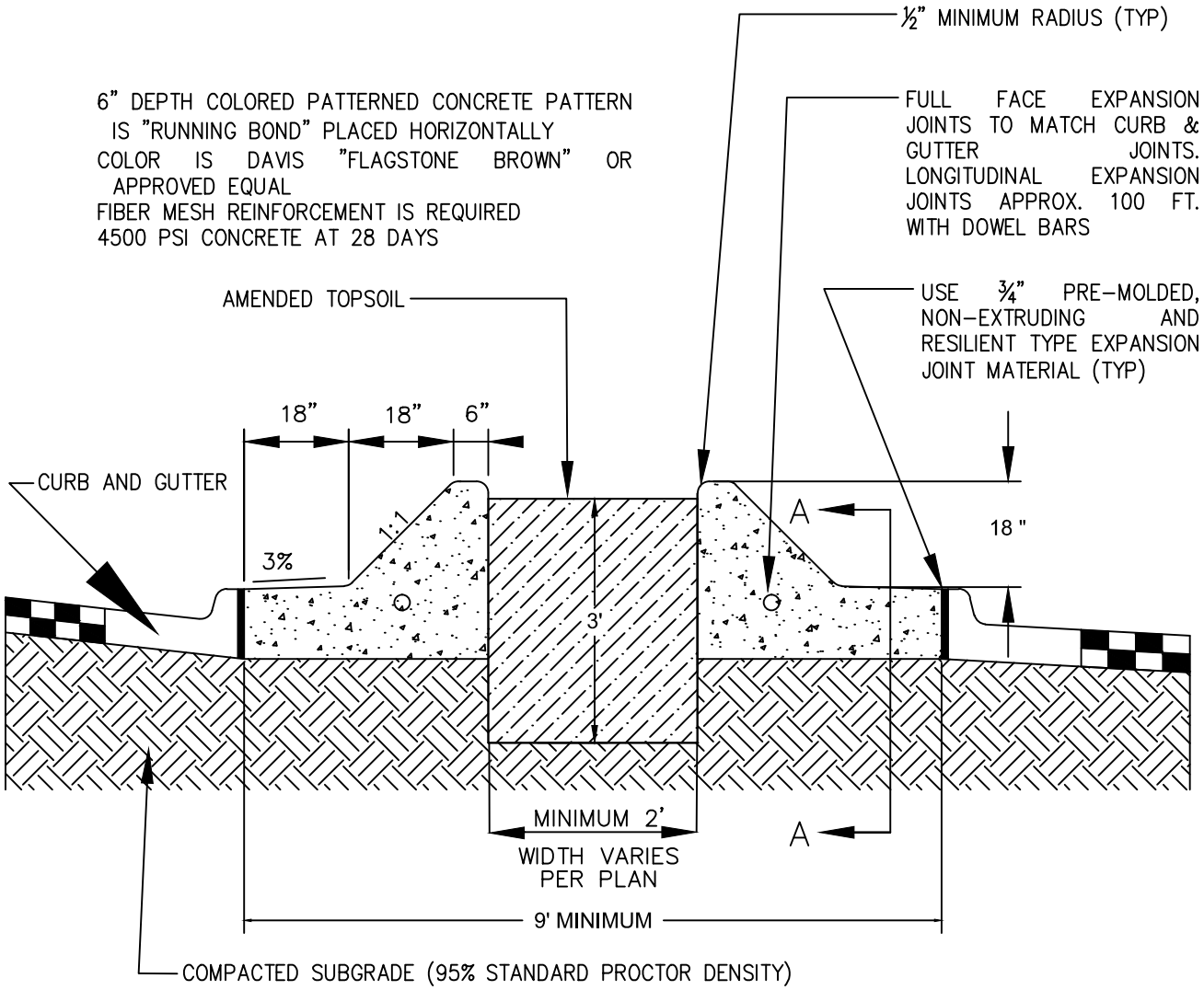
N.T.S.

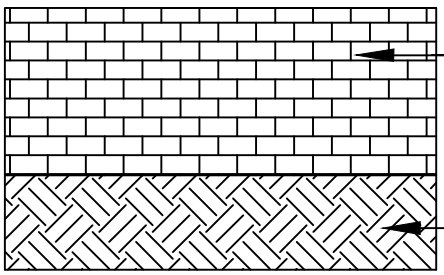
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SHRUB PLANTING DETAIL

ISSUED:
MARCH 1996
REVISED:
APRIL 2010

DRAWING NO.
800–2





SECTION A–A

N.T.S.

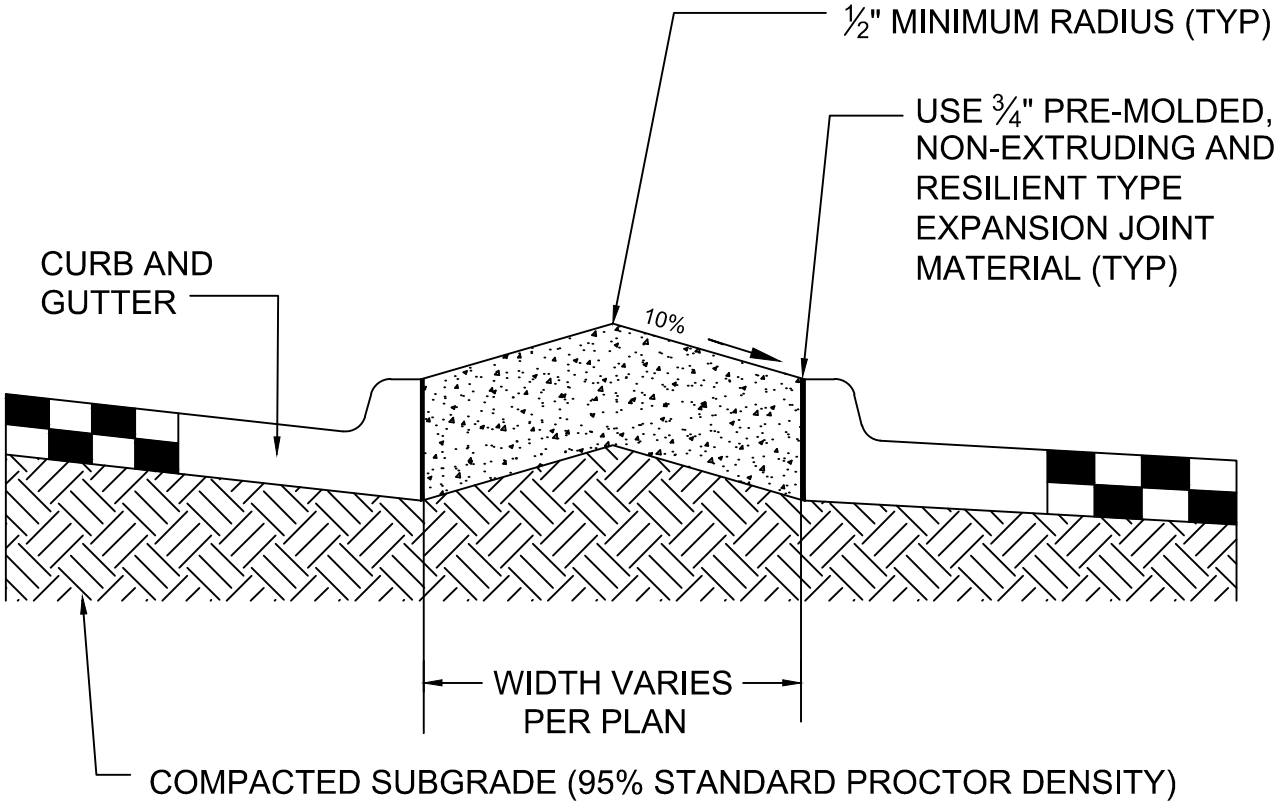
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

LANDSCAPED MEDIAN (ARTERIAL)

ISSUED:
JUNE 2003
REVISED:
APRIL 2010

DRAWING NO.
800–3

6" DEPTH COLORED PATTERNED CONCRETE PATTERN IS "RUNNING BOND" PLACED HORIZONTALLY COLOR IS DAVIS "FLAGSTONE BROWN" OR APPROVED EQUAL FIBER MESH REINFORCEMENT IS REQUIRED
4500 PSI CONCRETE AT 28 DAYS



N.T.S.

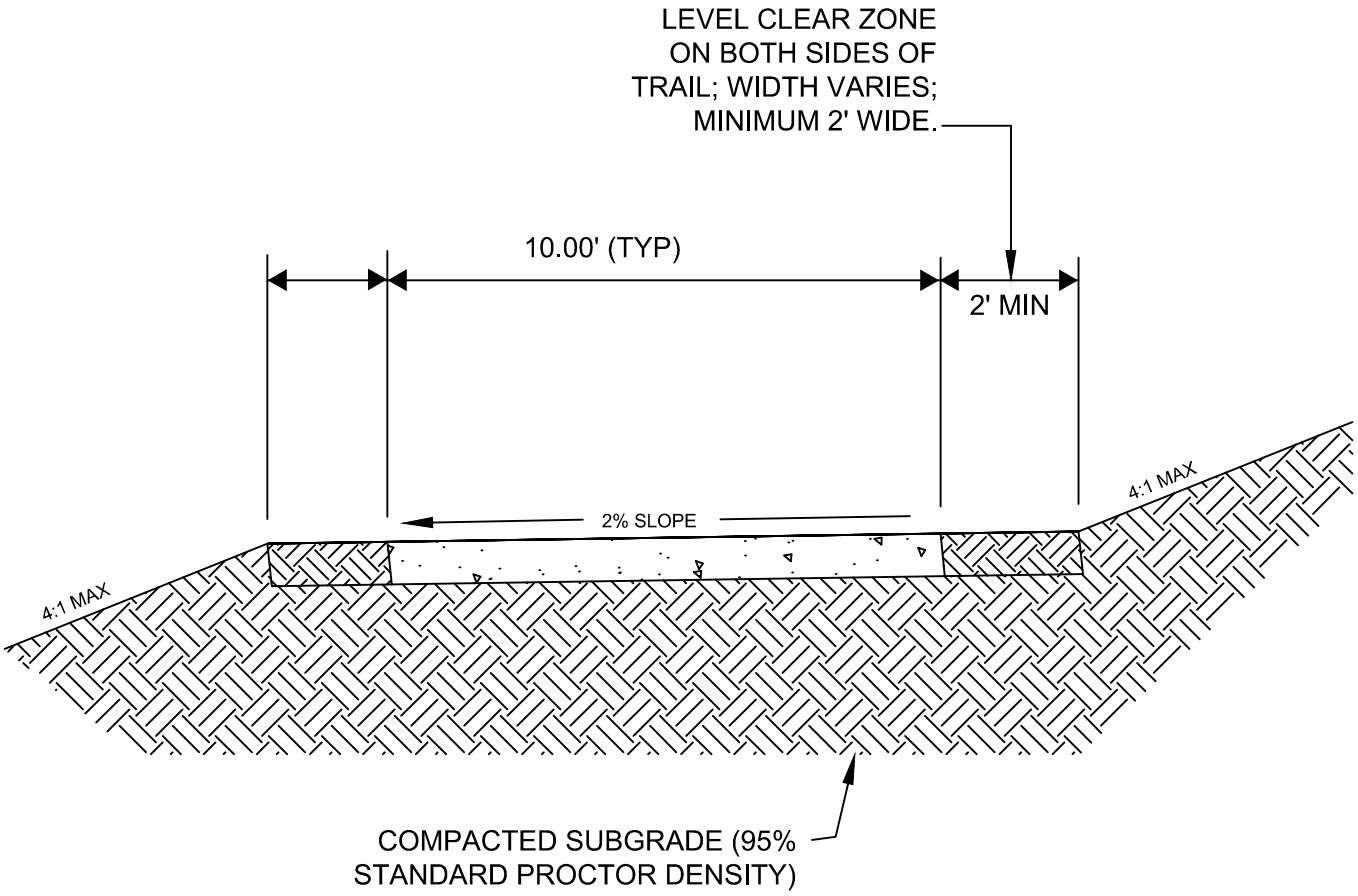
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

PAVED MEDIAN

ISSUED: JUNE 2003
REVISED: JAN 2012

DRAWING NO. 800–4

6" DEPTH
SAWCUT JOINTS EVERY 10' AND EXPANSION JOINTS EVERY 100'
FIBER MESH REINFORCEMENT IS REQUIRED
4500 PSI CONCRETE AT 28 DAYS



N.T.S.

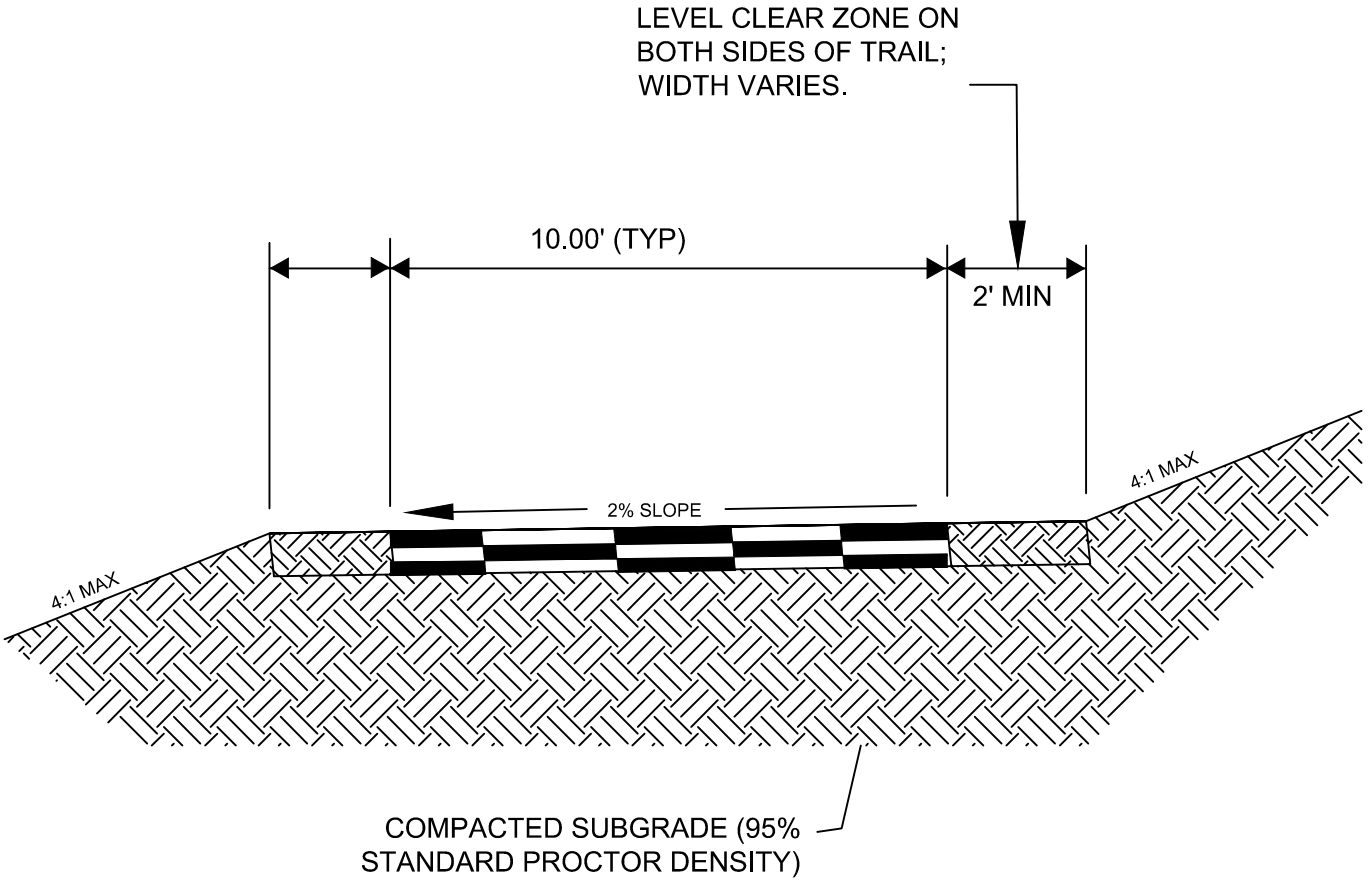
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CONCRETE TRAIL TYPICAL SECTION

ISSUED:
JUNE 2003
REVISED:
APRIL 2010

DRAWING NO.
800-5

6" DEPTH TRAIL
2" LIFTS W/FABRIC BETWEEN LIFTS
SX BASE
HIGH OIL CONTENT TOP LIFT



N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

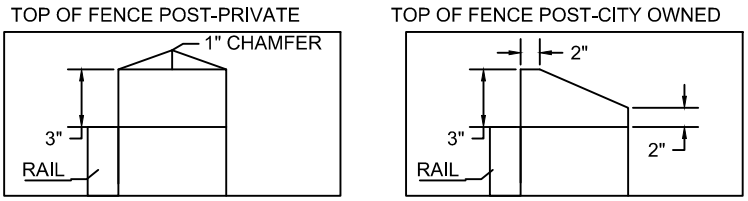
ASPHALT TRAIL TYPICAL SECTION

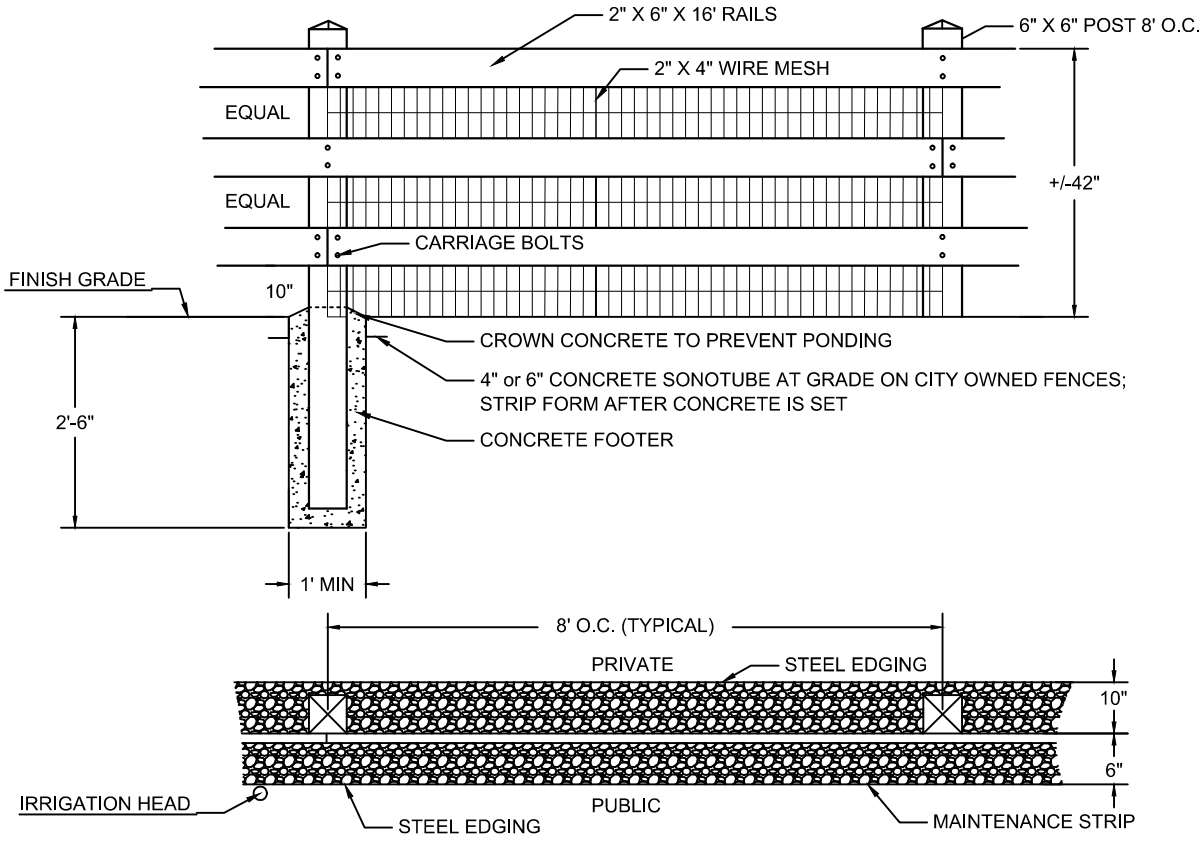
ISSUED:
JUNE 2003
REVISED:
APRIL 2010

DRAWING NO.
800-6

MATERIALS

- POST AND RAILS: DIMENSIONAL CUT GRADE 1 CEDAR
- RAILS: 2" X 6" X 16'; ALTERNATE JOINTS (CHAMFER ENDS AT CORNER & ENDS).
- WELDED WIRE FABRIC (WHEN REQUIRED): 14 GAUGE 2" X 4"; SANDWICH FABRIC BETWEEN POST AND RAILS, ATTACH WITH FENCE STAPLES TO BACKSIDE OF FENCE EVERY 24 INCHES.
- CARRIAGE BOLTS: 1/2" X 6" GALVANIZED; COUNTERSINK NUTS; SHEER BOLTS EVEN WITH POST; FILE ENDS SMOOTH.
- MAINTENANCE STRIP: CRUSHER FINES OR UP TO 1–1/2" ROCK UNLESS OTHERWISE APPROVED TO A DEPTH OF 3 INCHES. LOCATE ALL IRRIGATION HEADS OUTSIDE OF MAINTENANCE STRIP.
- STAIN: CITY OWNED FENCES SHALL BE STAINED; APPLY TWO COATS OF APPROVED EXTERIOR, SEMI–TRANSPARENT OIL STAIN TO WOOD; DIAMOND VOGEL AG–SERIES GRAIN STAIN OR EQUAL.





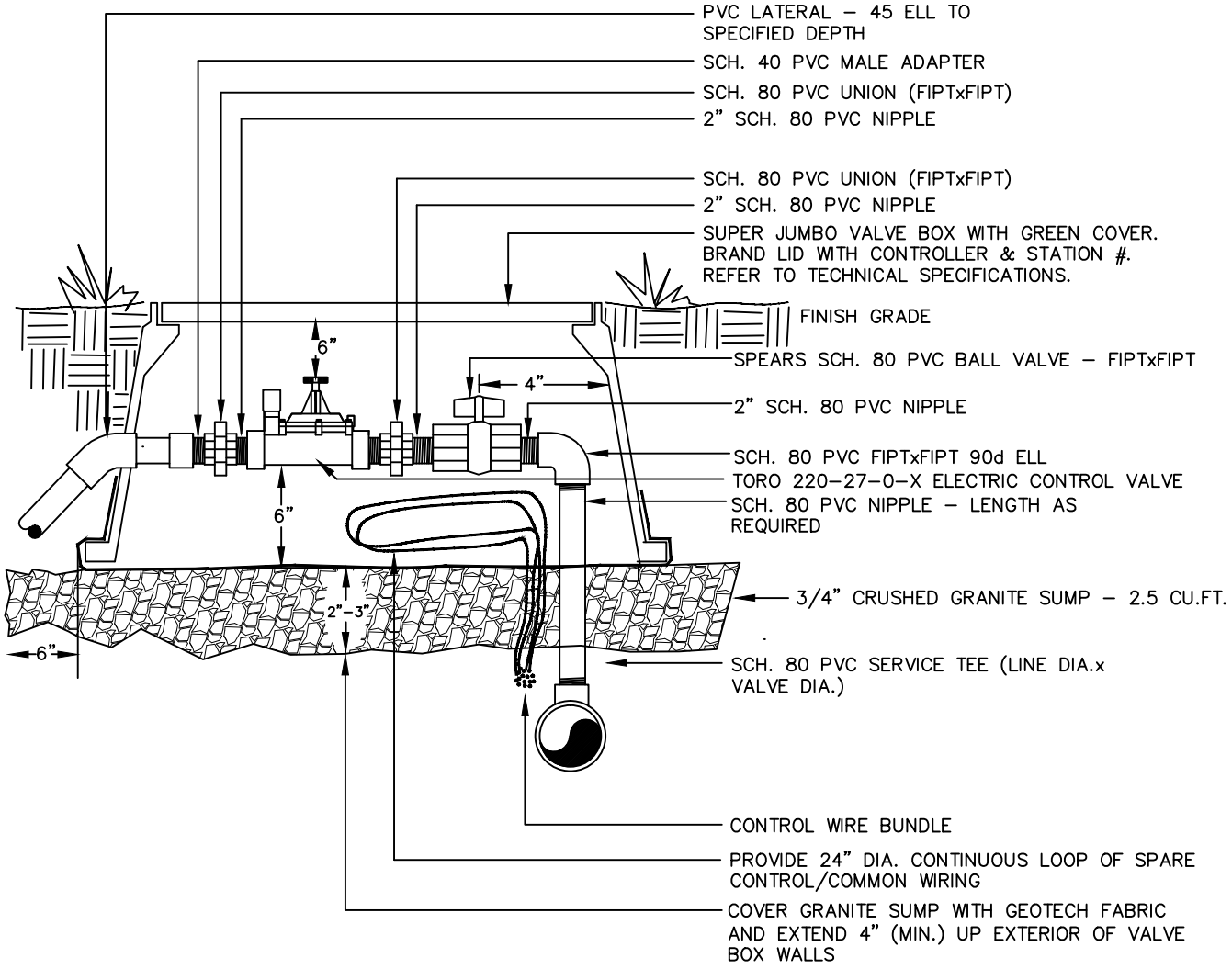
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

OPEN 3–RAIL FENCE WITH MAINTENANCE STRIP

ISSUED:
APRIL 2010
REVISED:
APRIL 2010

DRAWING NO.
800–7



NOTES:

1. DIAMETERS OF BALL VALVES, PVC FITTINGS, AND NIPPLES SHALL EQUAL ELECTRIC CONTROL VALVE DIAMETER
2. VALVE BOXES SHALL BE INSTALLED PARALLEL OR PERPENDICULAR TO ADJACENT SIDEWALKS AND HARD SURFACES WHERE APPLICABLE
3. USE BRAND NAMES SPECIFIED OR APPROVED EQUAL
4. BALL VALVE IN SEPARATE BOX FOR VALVES THAT ARE 3" OR GREATER

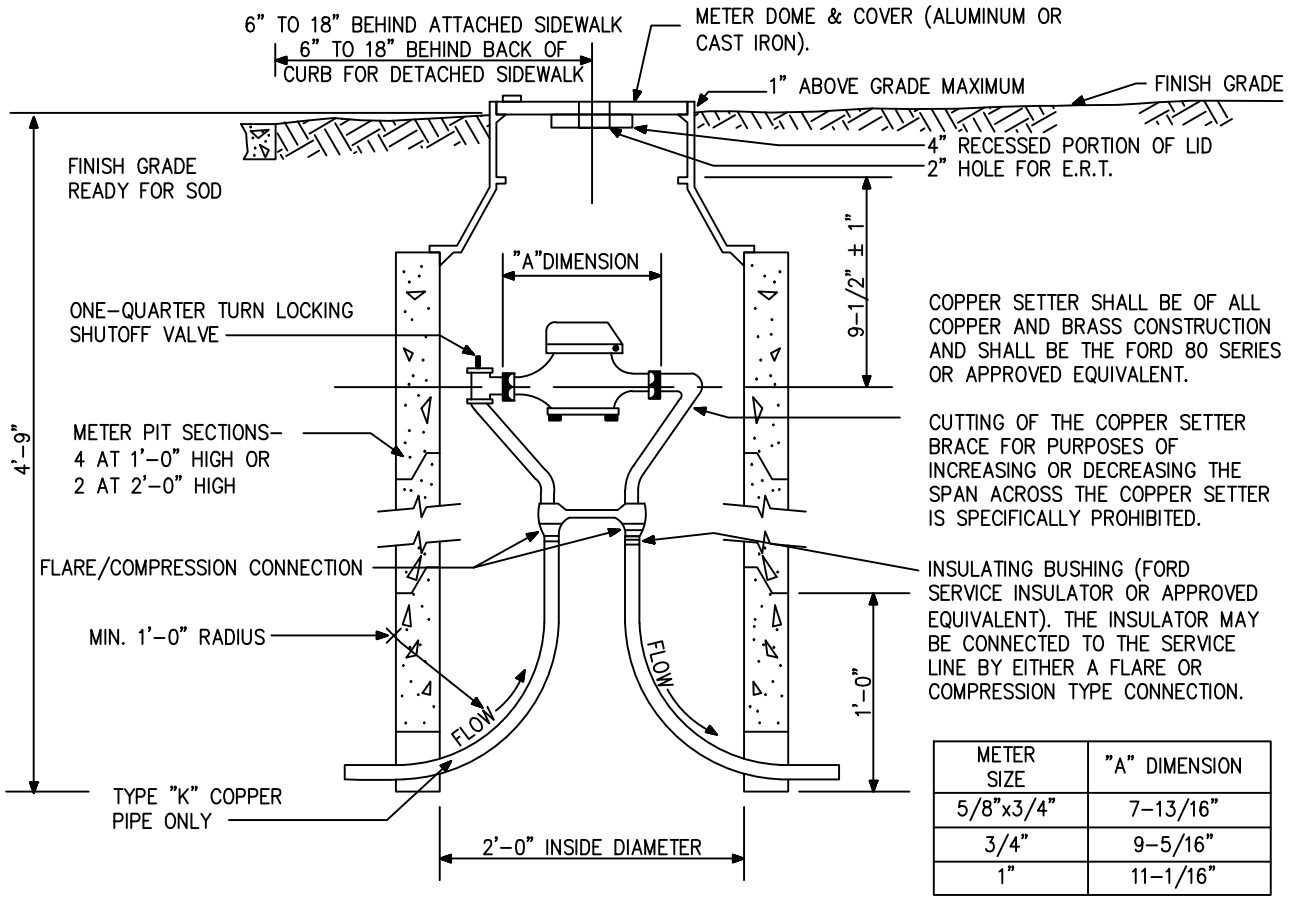
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

AUTOMATIC CONTROL VALVE

ISSUED:
APRIL 2010
REVISED:

DRAWING NO.
800-8



METER SIZE	"A" DIMENSION
5/8"x3/4"	7-13/16"
3/4"	9-5/16"
1"	11-1/16"

IF SERVICE LINE IS A DIFFERENT SIZE THAN THE METER, THEN THE REDUCTION SHALL OCCUR OUTSIDE THE METER PIT.

WATER METER PITS, COPPER SETTERS, DOMES AND COVERS SHALL BE INSTALLED BY THE RESPONSIBLE PARTY. THE WATER METER SHALL BE INSTALLED BY THE CITY. METER PITS MAY NOT BE INSTALLED IN ANY TYPE OF VEHICULAR OR PEDESTRIAN TRAFFIC ZONE WITHOUT THE APPROVAL OF THE DEVELOPMENT ENGINEERING MANAGER. IN THE EVENT A METER PIT IS INSTALLED WITHIN A VEHICULAR OR PEDESTRIAN TRAFFIC ZONE, A TRAFFIC RATED DOME SHALL BE INSTALLED BY THE RESPONSIBLE PARTY AT THE SOLE EXPENSE OF THE RESPONSIBLE PARTY.

IF INSTALLATION IN A RESIDENTIAL DRIVE IS PERMITTED, THE CONCRETE JOINT PATTERN SHALL CONSIST OF JOINTS ALLOWING THE LEAST AMOUNT OF DAMAGE TO THE SURROUNDING CONCRETE AS POSSIBLE.

METER PITS SHALL BE CONSTRUCTED OF CONCRETE OR PLASTIC. PLASTIC METER PITS SHALL BE MID-STATES PLASTIC, MODEL NO. MS202448B OF DFW PLASTICS, MODEL NO. 2048 B OR EQUAL AS APPROVED BY THE DEVELOPMENT ENGINEERING MANAGER. PLASTIC METER PITS SHALL MEET SAME DIMENSION REQUIREMENTS AS THE CONCRETE PITS. THE INTERIOR OF THE PLASTIC METER PITS SHALL ALSO BE WHITE.

METER PITS GRADE ADJUSTMENT SHALL BE MADE UTILIZING CONCRETE RINGS. THE TRENCH FLOOR UNDER THE CONCRETE RINGS SHALL BE COMPACTED EARTH. COPPER SERVICE PIPE ENTERING AND LEAVING THE PIT BENEATH THE BOTTOM CONCRETE RING SHALL BE OF SUFFICIENT LENGTH SO AS TO MEET THE DEPTH SPECIFICATIONS WHEN THE COPPER SETTER IS INSTALLED. THE PIT SHALL NOT BEAR ON THE SERVICE PIPE. UNDER NO CIRCUMSTANCES SHALL THE SERVICE PIPE ENTER AND EXIT ON THE SAME SIDE OF THE PIT.

WATER METER PIT INSTALLATIONS SHALL NOT BE GIVEN FINAL INSPECTION OR THE WATER METER INSTALLED UNTIL FINAL GRADING HAS BEEN COMPLETED. AFTER THE CITY HAS MADE THE FINAL INSPECTION, ANY NECESSARY GRADE ADJUSTMENTS TO THE PIT SHALL BE THE RESPONSIBILITY OF THE RESPONSIBLE PARTY.

THE USE OF CONCRETE RISER RINGS FOR THE PURPOSE OF DOME HEIGHT ADJUSTMENT IS PERMITTED PROVIDED SPECIFICATIONS ARE MET AFTER THE INSTALLATION IS COMPLETED (FOR PLASTIC METER PITS RISERS SHOULD BE PER MANUFACTURER'S RECOMMENDATION). THE USE OF BROKEN RINGS OR WOOD SHIMS UNDER THE DOME IS SPECIFICALLY PROHIBITED.

GALVANIZED PIPE AND FITTINGS ARE SPECIFICALLY PROHIBITED. SEE DETAIL 200-15 FOR CORROSION PROTECTION INFORMATION.

WATER SERVICE LOCATIONS SHALL BE MARKED WITH A "V" ON THE CURB. SANITARY SEWER SERVICE LOCATIONS SHALL BE MARKED WITH AN "X" ON THE CURB. MARKINGS SHALL BE NEATLY STAMPED , CHISELED OR SAWCUT, NOT PAINTED.

N.T.S.

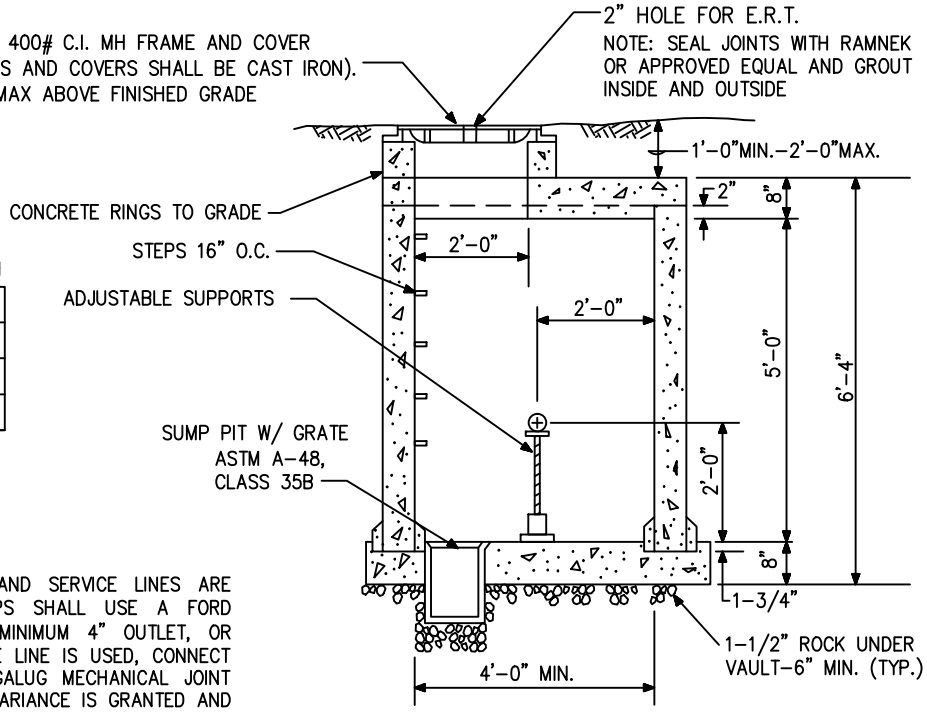
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD IRRIGATION METER PIT DETAIL 5/8" X 3/4", 3/4" & 1" METERS ONLY

ISSUED:
APRIL 1992
REVISED:
JAN 2012

DRAWING NO.
800-9

SIZE	LAYING LENGTH
1–1/2" COMPOUND	13–1/2"
2" TURBINE	10–3/4"
3" TURBINE	12–1/4"
4" TURBINE	14–1/4"



VAULT PROFILE

ALL IRRIGATION WATER CONNECTION TAPS AND SERVICE LINES ARE REQUIRED TO BE A MINIMUM OF 4". TAPS SHALL USE A FORD STAINLESS STEEL TAPING SLEEVE WITH A MINIMUM 4" OUTLET, OR APPROVED EQUIVALENT. IF C900 PVC SERVICE LINE IS USED, CONNECT IT TO THE TAPPING SLEEVING USING A MEGALUG MECHANICAL JOINT RESTRAINT OR APPROVED EQUIVALENT. IF A VARIANCE IS GRANTED AND A SMALLER TAP AND SERVICE LINE IS APPROVED, THEN REFER TO WATER SERVICE INSTRUCTIONS IN DETAILS #200–14, 17A, & 18B.

CORPORATION STOPS SHALL BE AWWA TAPER THREAD TO COPPER CONNECTION OF PACK JOINT AND SHALL BE A FORD TYPE F600 OR AN APPROVED EQUAL. TAPS SHALL BE MADE BY THE RESPONSIBLE PARTY.

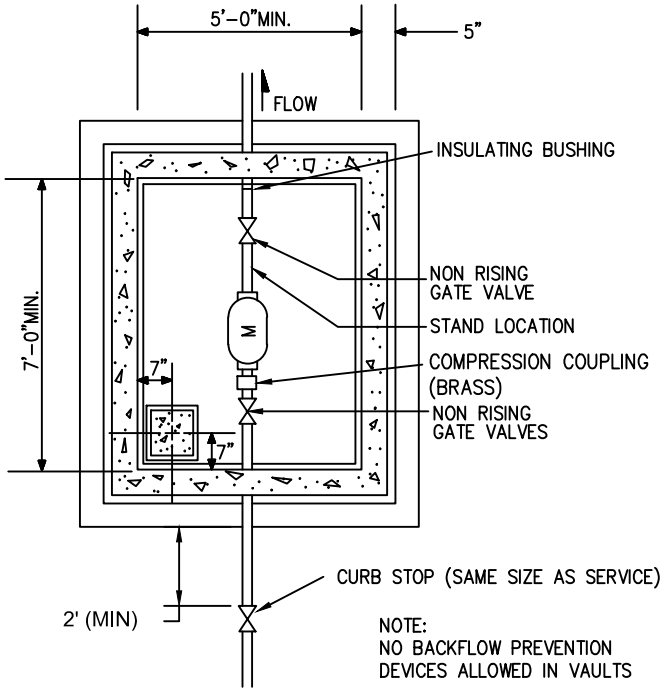
A MINIMUM 4" GATE VALVE CONFORMING TO DETAIL #200–6A/B OF THESE STANDARDS AND SPECIFICATIONS SHALL BE INSTALLED ON EVERY IRRIGATION SERVICE BETWEEN THE WATER MAIN AND THE METER, WHICH IS AT A POINT AT OR NEAR THE PROPERTY LINE. THE VALVE SHALL BE ACCESSIBLE THROUGH A TYLER 6860 3–PIECE VALVE BOX WITH STANDARD OVAL BASE AND A DROP LID.

INSIDE THE METER PIT, PIPE SHALL BE TYPE K CLASS, RIGID COPPER PIPE. THE METER VAULT PIPING SHALL BE OF THE SAME INSIDE DIAMETER AS THE METER ORIFICE. ANY SERVICE PIPE MATERIAL CHANGES SHALL OCCUR OUTSIDE THE METER VAULT.

JOINTS SHALL BE OF A SWEAT COPPER DESIGN. SOLDER USED IN CONNECTION OF THE JOINTS SHALL BE OF A LEAD CONTENT OF 0.20 OR LESS.

GATE VALVES SHALL BE AWWA APPROVED GATE VALVES OF BRASS CONSTRUCTION. THE VALVES SHALL BE COUNTERCLOCKWISE OPEN. REFER TO SUBSECTION 204.1(D) OF THESE STANDARDS AND SPECIFICATIONS. VALVES LOCATED IN VAULTS SHALL HAVE HANDWHEELS IN LIEU OF A TWO (2) INCH SQUARE OPERATING NUT.

WATER SERVICE LOCATIONS SHALL BE MARKED WITH A "V" ON THE CURB, AND SEWER SERVICE SHALL BE MARKED WITH AN "X". MARKINGS SHALL BE NEATLY STAMPED, CHISELED OR SAWCUT, AND SHALL NOT BE PAINTED.



VAULT PLAN

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD IRRIGATION METER SETTING VAULT DETAIL FOR 1–1/2", 2", 3" & 4" METERS

ISSUED:
APRIL 1992
REVISED:
JAN 2012

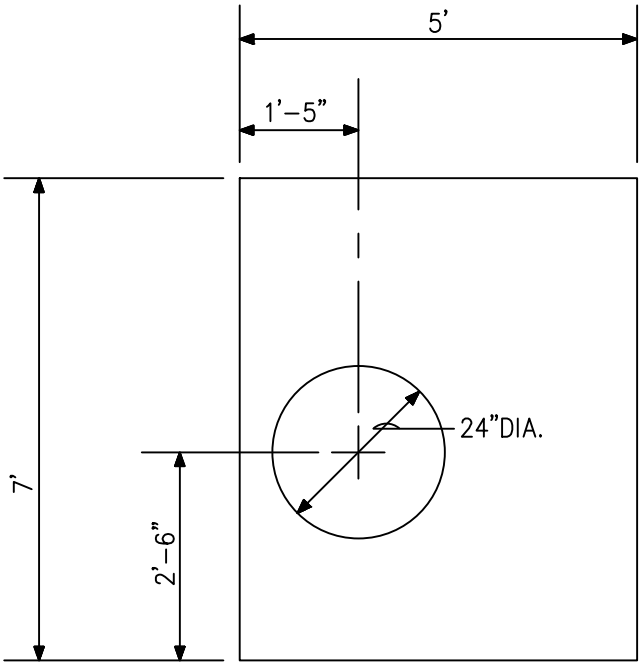
DRAWING NO.
800–10A

METER VAULT LIDS AND COVER SHALL BE CAST IRON.

PIPE SHALL BE TYPE K CLASS, RIGID COPPER PIPE. THE METER VAULT PIPING SHALL BE OF THE SAME INSIDE DIAMETER AS THE METER ORIFICE. JOINTS SHALL BE OF SWEAT COPPER DESIGN. SOLDER USED IN CONNECTION OF THE JOINTS SHALL BE OF A LEAD CONTENT OF 0.20 OR LESS. THE OUTLET SIDE OF THE COPPER SETTERS SHALL BE ISOLATED FROM THE SERVICE LINE WITH A FORD SERVICE INSULATOR OR APPROVED EQUIVALENT.

GATE VALVES SHALL BE AWWA APPROVED GATE VALVES OF BRASS CONSTRUCTION. THE VALVE STEMS SHALL BE OF NON-RISING DESIGN. VALVES SHALL BE COUNTERCLOCKWISE OPEN, AND SHALL HAVE HANDWHEELS IN LIEU OF A TWO (2) INCH SQUARE OPERATING NUT. VALVES SHALL BE INSTALLED BOTH UPSTREAM AND DOWNSTREAM OF THE WATER METER WITHIN THE VAULT.

BRASS UNIONS OF A COMPRESSION TYPE SEALING DESIGN SHALL BE INSTALLED BETWEEN THE GATE VALVE AND THE WATER METER, EITHER UPSTREAM OR DOWNSTREAM OF THE METER TO FACILITATE REMOVAL OF THE WATER METER FROM THE SERVICE LINE.



ROOF SLAB

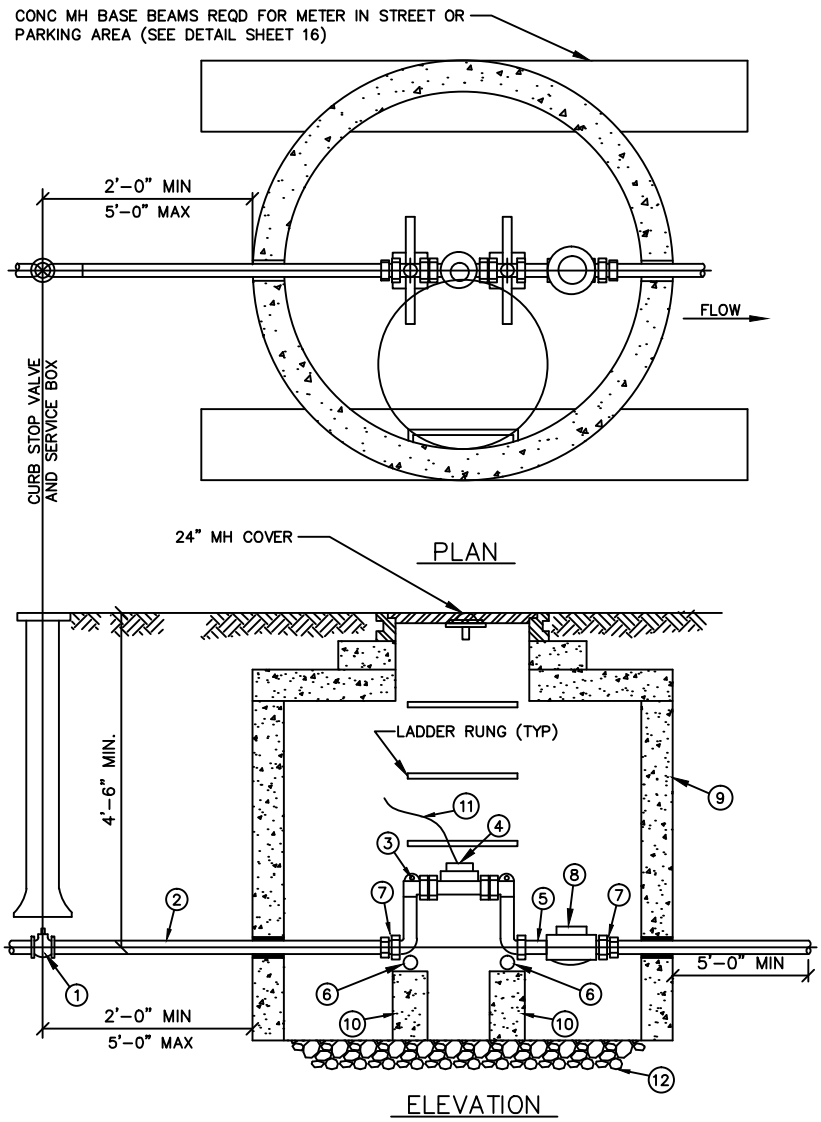
N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STANDARD IRRIGATION METER ROOF SLAB DETAIL FOR 1-1/2", 2", 3", & 4" METERS

ISSUED:
APRIL 1992
REVISED:
APRIL 2010

DRAWING NO.
800-10B



NOTES:

1. METER VAULT SHALL BE INSTALLED IN LANDSCAPED AREA UNLESS APPROVED BY METER INSPECTOR.
2. CURB STOP SHALL BE 24" TO 60" FROM THE INLET SIDE OF THE METER VAULT, IN LANDSCAPED AREA.
3. FOR VAULT INSTALLATIONS IN ROADWAYS AND DRIVEWAYS, WHEN APPROVED, MH BASE BEAMS ARE REQD. METER VAULT MAY NOT BE INSTALLED IN PARKING AREA.
4. NO CONNECTIONS OF ANY TYPE, PIPE BENDS, OR CHANGES IN PIPE SIZE ARE PERMITTED INSIDE THE VAULT.
5. METER SHALL BE FURNISHED WITH ELECTRONIC DIGITAL REGISTER OR ELECTRONIC ENCODED REGISTER AND AN ITRON PIT ERT. IN SPECIAL CIRCUMSTANCES, REMOTE ERT MAY BE REQD (SEE SHEET 50), TO BE INSTALLED ON NEARBY BUILDING OR POST.
6. JOINTS INSIDE METER VAULT SHALL BE THD OR SHALL BE SOLDERED WITH 95-5 TIN/ANTIMONY SOLDER IN ACCORDANCE WITH ASTM B 32.
7. DISTANCE BETWEEN RUNGS, CLEATS AND STEPS SHALL NOT EXCEED 12" AND SHALL BE UNIFORM THROUGHOUT THE LENGTH OF THE LADDER.
8. VAULT WALL PENETRATIONS SHALL BE GROUTED WITH CONC.
9. COPPERSETTER OR METER YOKE SHALL BE NO MORE THAN 12" HIGH.

SIZE	LAYING LENGTH
1 ½" COMPOUND	13-1/2"
2" TURBINE	10-3/4"

DETAILS:

1. CURB STOP
2. TYPE K COPPER TUBING
3. 12" COPPERSETTER / METER YOKE WITH BYPASS
4. METER UNIT
5. 3" NIPPLE BETWEEN COPPERSETTER AND CHECK VALVE
6. 1" x 23" PIPE
7. IRON PIPE TO FLARE COUPLING FROM INLET SIDE OF COPPERSETTER AND OUTLET SIDE OF CHECK VALVE
8. CHECK VALVE (CHECK VALVES ARE NOT REQUIRED WHERE A BACKFLOW PREVENTION DEVICE IS INSTALLED)
9. 48" CONC MH WITH FLAT LID
10. CONC BLOCK SUPPORTS 4" x 4" x 24"
11. SIGNAL WIRE TO ITRON ERT
12. 1 ½" FRACTURED ROCK BEDDING OR CONCRETE FLOOR WITH DRAIN HOLE

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

1.5IN & 2IN IRRIGATION METER SETTING VAULT DETAIL

ISSUED:
MARCH 1996
REVISED:
APRIL 2010

DRAWING NO.
800-10C

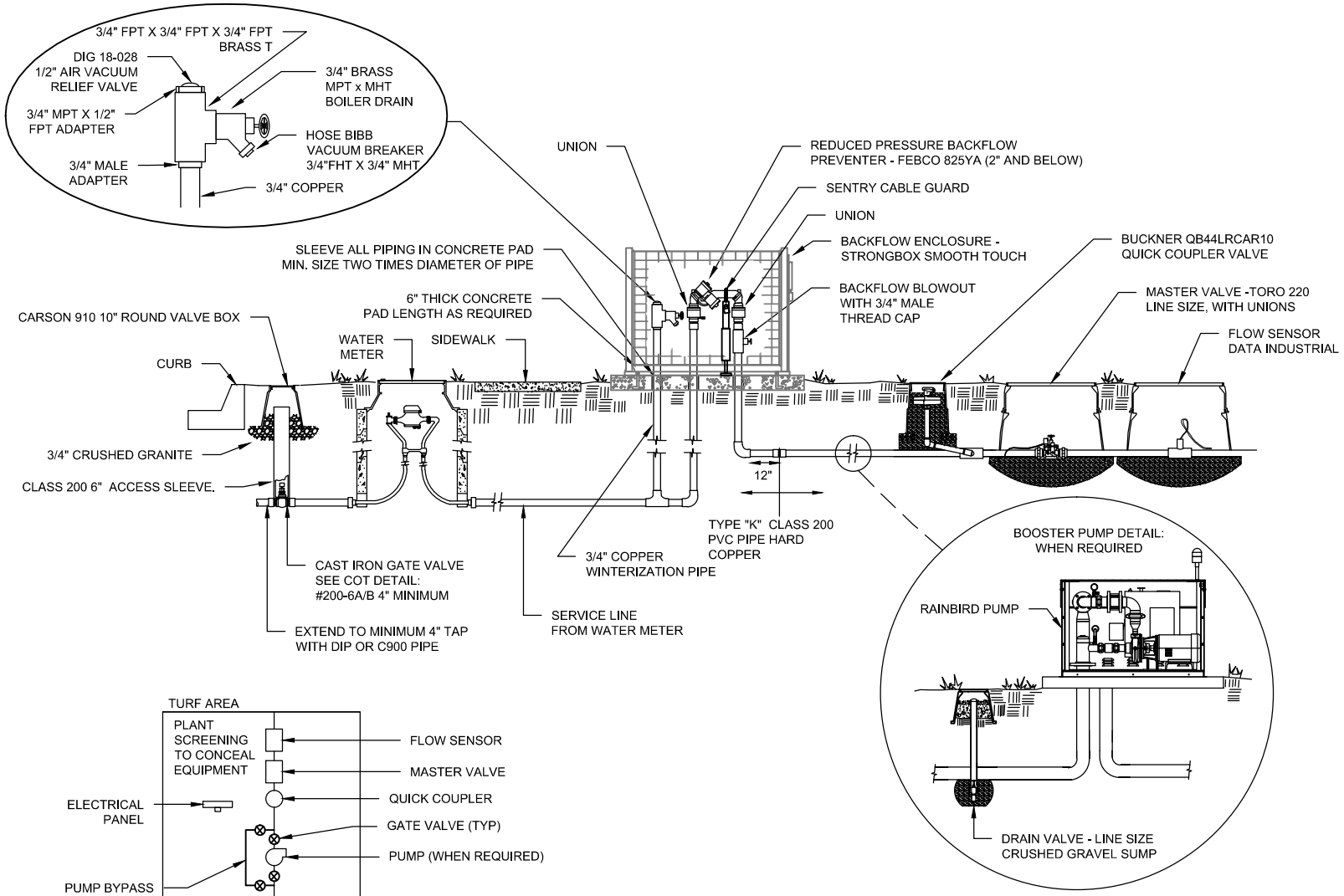
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

1" & SMALLER IRRIGATION METER
POINT OF CONNECTION DETAIL

ISSUED: APRIL 2010
REVISED:

DRAWING NO. 800-11A

N.T.S.



NOTE:

- CONCRETE PAD PENETRATION TO BE 1" LARGER THAN SLEEVING DIAMETER.
- REFER TO ENCLOSURE INSTRUCTIONS FOR CONCRETE PAD DIMENSIONS.
- ALL VALVES AND FITTINGS INCLUDING RPZ SHALL MATCH SIZE OF THE SERVICE LINE FROM METER. SEE TABLE 800-1&2 IN THESE STANDARDS AND SPECIFICATIONS FOR MORE INFORMATION.
- SEE DETAIL 800-9 FOR SPECIFIC METER SETTING REQUIREMENTS.
- SEE SECTION 800 OF THE WRITTEN SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS OF COMPONENTS.
- EXTEND CRUSHED GRAVEL SUMP 6" BEYOND THE PERIMETER OF EACH ACCESS BOX FOR SUPPORT AND DRAINAGE.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

1.5" & LARGER IRRIGATION METER POINT OF CONNECTION DETAIL

ISSUED: APRIL 2010
REVISED:

DRAWING NO. 800–11B

N.T.S.

NOTE:

CONCRETE PAD PENETRATIONS TO BE 1" LARGER THAN SLEEVE DIAMETER.

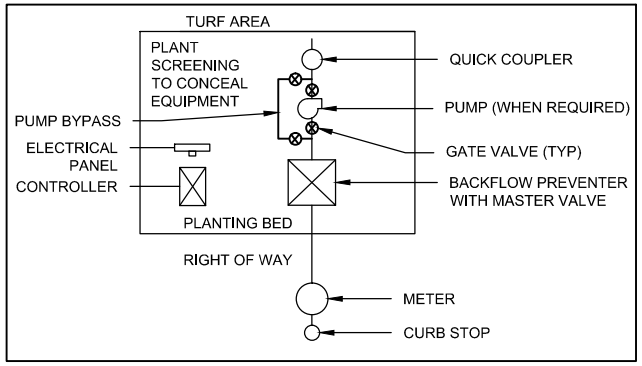
REFER TO ENCLOSURE INSTRUCTIONS FOR CONCRETE PAD DIMENSIONS.

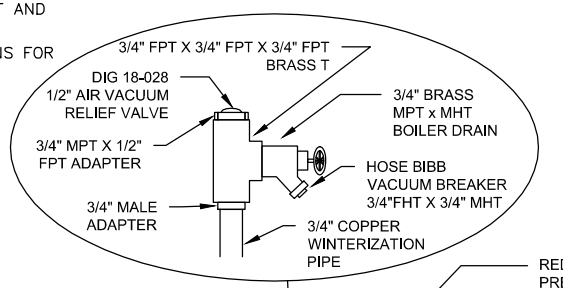
ALL VALVES AND FITTINGS INCLUDING RPZ SHALL MATCH SIZE OF THE SERVICE LINE FROM METER. SEE TABLE 800 – 1 & 2 IN THESE STANDARDS AND SPECIFICATIONS FOR MORE INFORMATION.

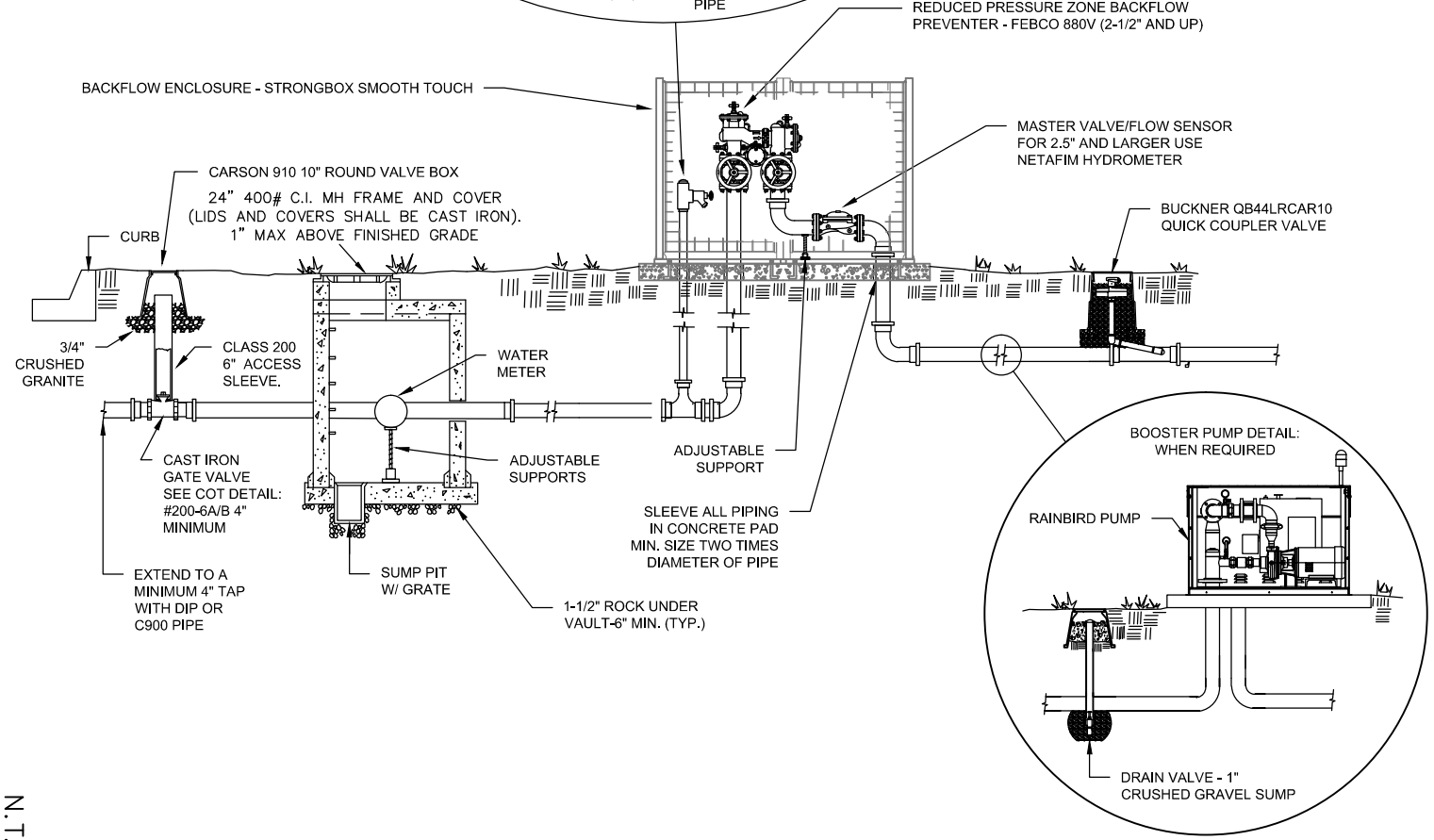
SEE DETAIL 800–10A & 10B FOR SPECIFIC VAULT AND METER SETTING REQUIREMENTS.

SEE SECTION 800 OF THE WRITTEN SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS OF COMPONENTS.

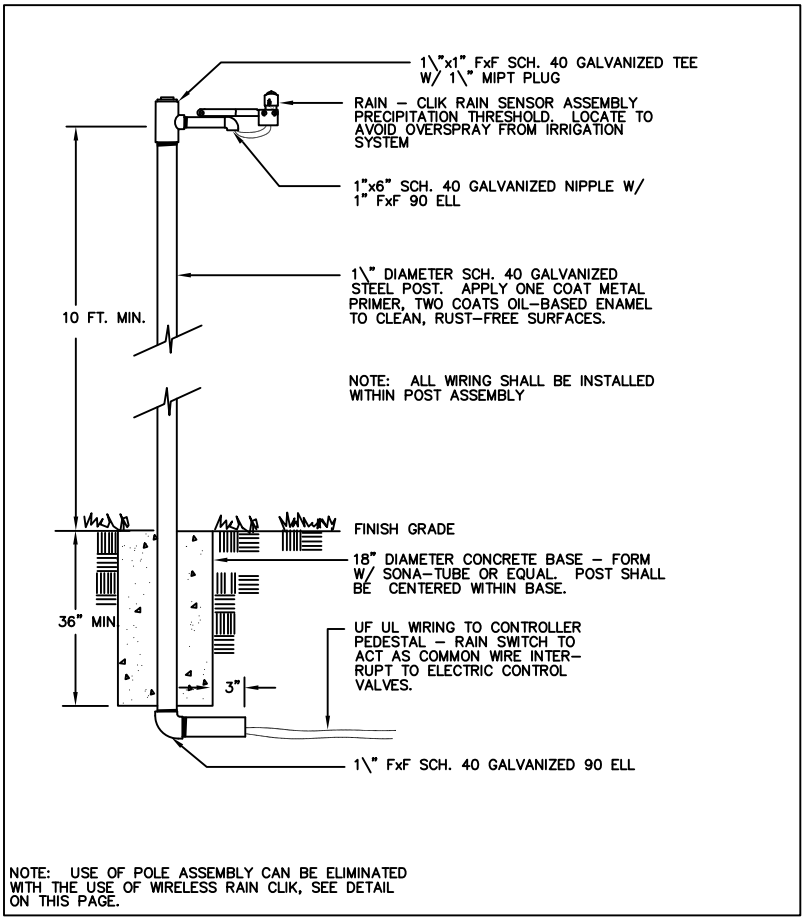
EXTEND CRUSHED GRAVEL SUMP 6" BEYOND THE PERIMETER OF EACH ACCESS BOX FOR SUPPORT AND DRAINAGE.



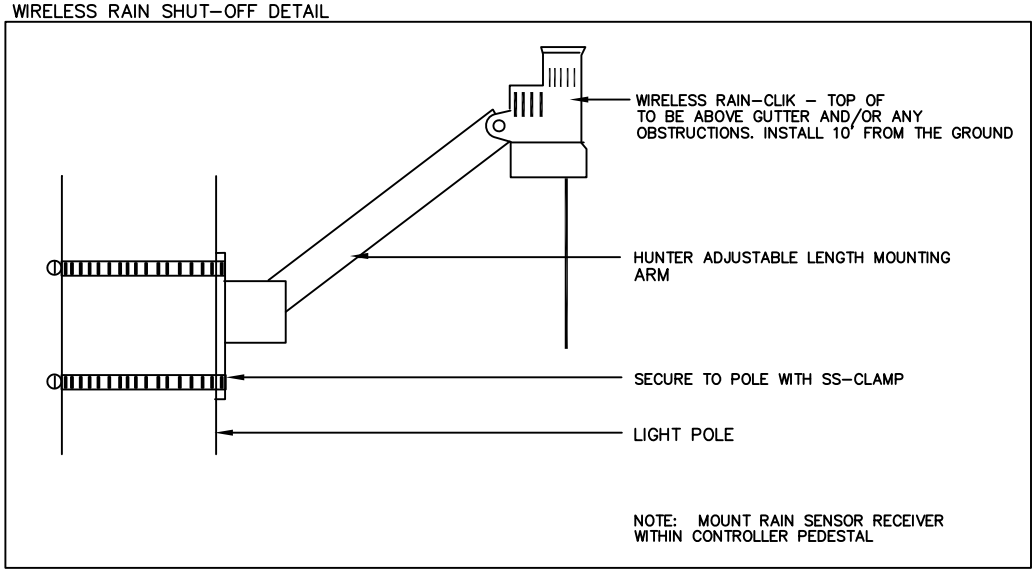




RAIN SHUT–OFF DETAIL WITH POLE ASSEMBLY



WIRELESS RAIN SHUT–OFF DETAIL



N.T.S.

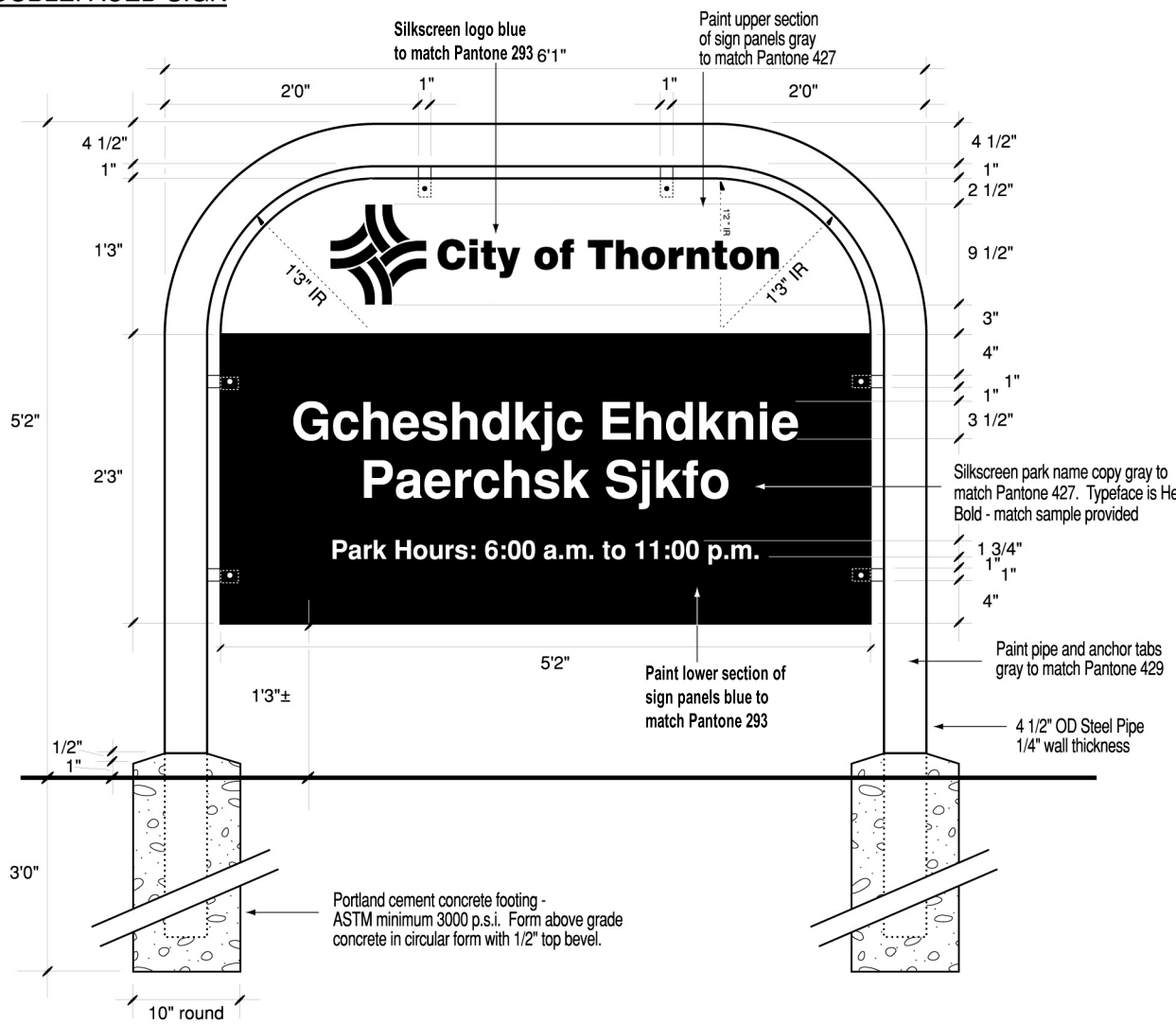
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

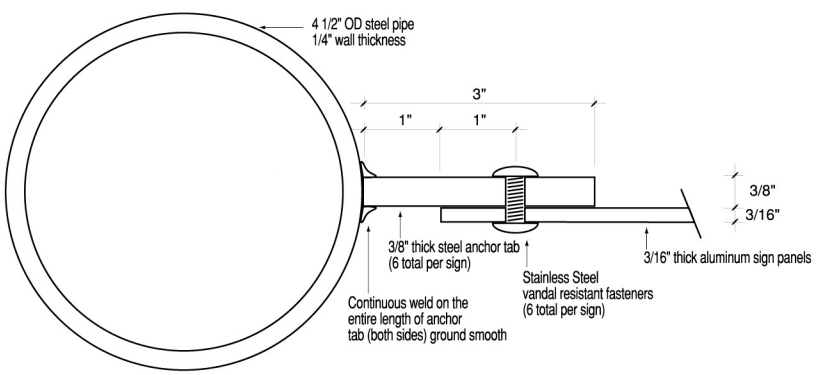
RAIN SHUT–OFF SWITCH DETAIL

ISSUED:
APRIL 2010
REVISED:

DRAWING NO.
800–12

DOUBLEFACED SIGN





PAINT SPECIFICATIONS

Primers:

Aluminum: Pre-treatment coating consisting of Polyvinyl Butyrate Resin and Zinc Chromate Corrosion Inhibiting Pigments, to be activated with an Acid Etch Compound. Applied directly to metal surfaces to provide corrosion resistance and adhesion.

Steel: Two part Lead/Chromate free Corrosion Inhibiting Epoxy/Polymide Primer.

Paint:

All paint to be specified should be an Ultraviolet Inhibited Aliphatic Isocyanate/Acrylic Polyol system engineered for extreme color and gloss retention. Follow manufacturers instructions for paint thickness.

ATTACHMENT DETAIL

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

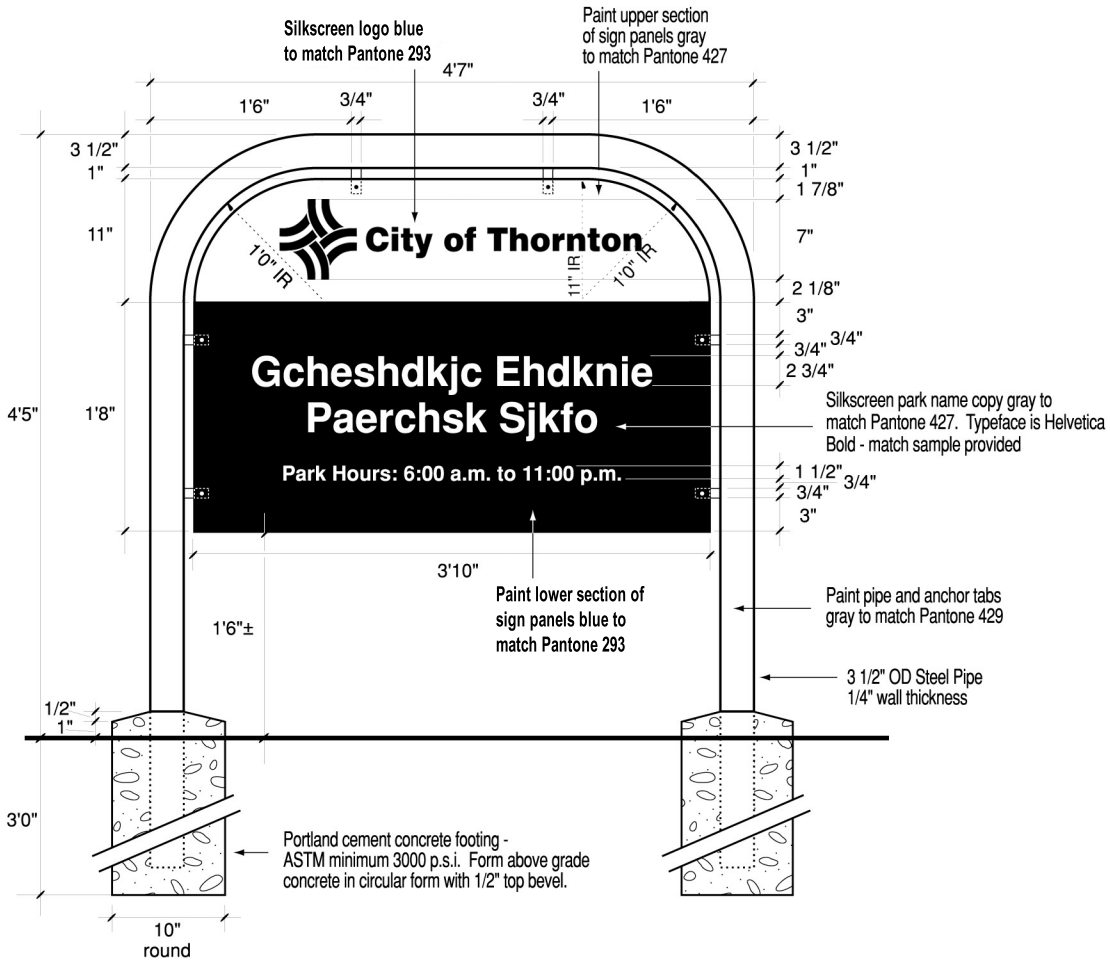
PARK SIGN A

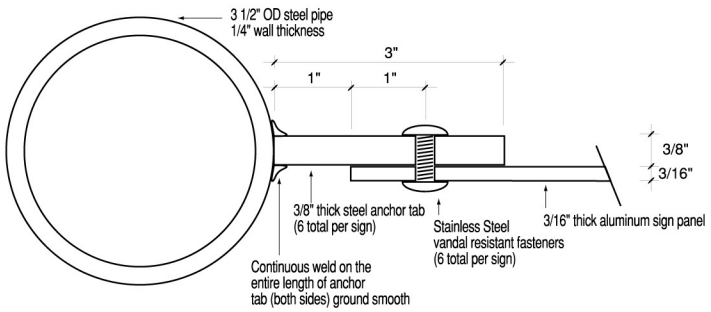
ISSUED:

REVISED:

DRAWING NO.
800-13

DOUBLEFACED SIGN





PAINT SPECIFICATIONS

Primers:
Aluminum: Pre-treatment coating consisting of Polyvinyl Butyrate Resin and Zinc Chromate Corrosion Inhibiting Pigments, to be activated with an Acid Etch Compound. Applied directly to metal surfaces to provide corrosion resistance and adhesion.

Steel: Two part Lead/Chromate free Corrosion Inhibiting Epoxy/Polymide Primer.

Paint:
All paint to be specified should be an Ultraviolet Inhibited Aliphatic Isocyanate/Acrylic Polyol system engineered for extreme color and gloss retention. Follow manufacturers instructions for paint thickness.

ATTACHMENT DETAIL

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

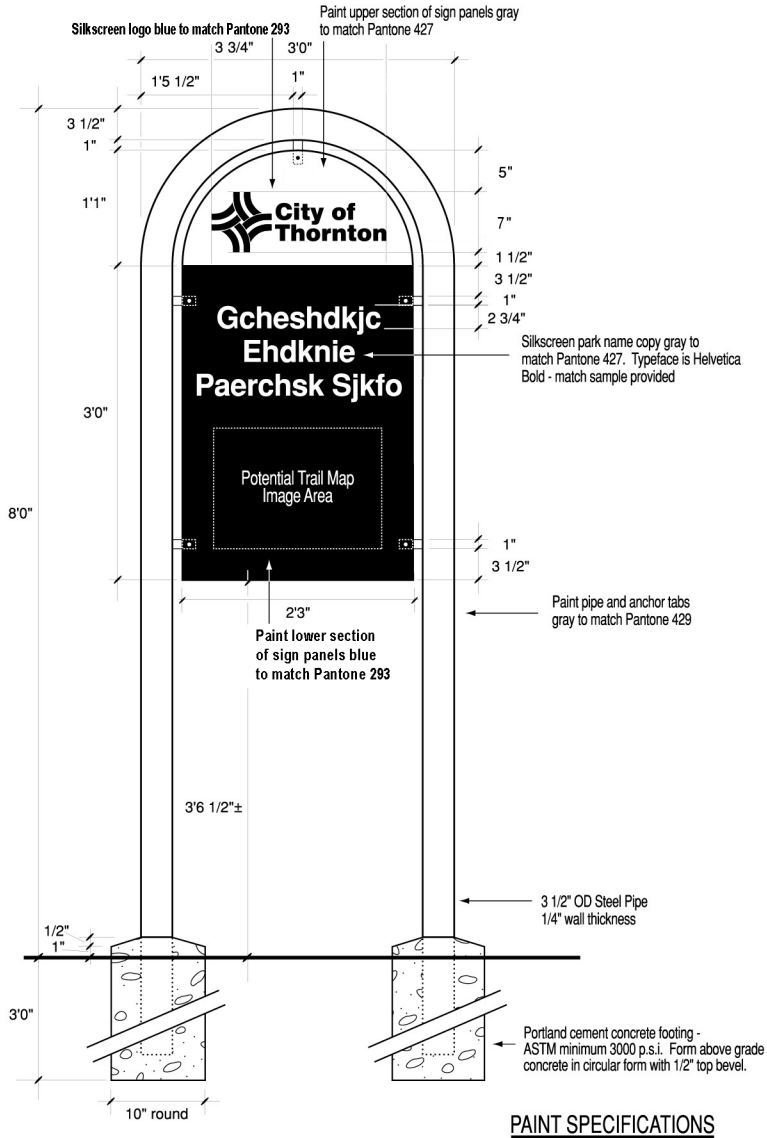
PARK SIGN B

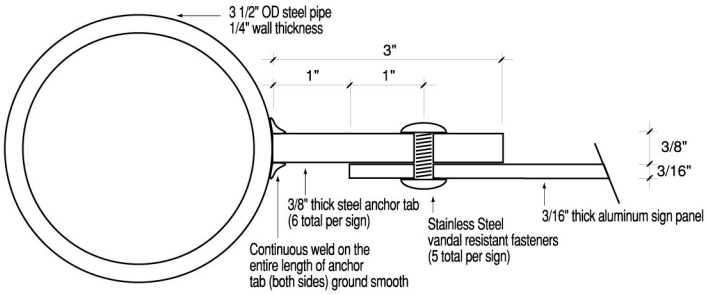
ISSUED:

REVISED:

DRAWING NO.
800-14

DOUBLEFACED SIGN





PAINT SPECIFICATIONS

Primers:

Aluminum: Pre-treatment coating consisting of Polyvinyl Butyrate Resin and Zinc Chromate Corrosion Inhibiting Pigments, to be activated with an Acid Etch Compound. Applied directly to metal surfaces to provide corrosion resistance and adhesion.

Steel: Two part Lead/Chromate free Corrosion Inhibiting Epoxy/Polymide Primer.

Paint:

All paint to be specified should be an Ultraviolet Inhibited Aliphatic Isocyanate/Acrylic Polyol system engineered for extreme color and gloss retention. Follow manufacturers instructions for paint thickness.

ATTACHMENT DETAIL

N.T.S.

CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TRAIL SIGN

ISSUED:

REVISED:

DRAWING NO.

800-15