ENGINEERING DESIGN
STANDARDS AND SPECIFICATIONS

ADOPTION DATE

Q3 2025

Table of Contents

SECTION 100 TITLE, SCOPE, AND GENERAL CONDITIONS

Section 100.00 General

Section 101.00 Title

These regulations shall be known as the Littleton Engineering Design Standards and Specifications, ("LEDS"), 2025 Edition, and may be cited as such. They shall be referenced herein as the "Standards and Specifications" or "LEDS."

Purpose. The purpose of these Standards and Specifications is to provide minimum acceptable standards to safeguard life, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use, location, and maintenance of all public infrastructure and private improvements of common ownership including, but not limited to, sanitary sewer systems, storm drainage systems, streets or roadways, landscaping, irrigation, open space, parking lots and appurtenances. These Standards and Specification consider user needs and safety for all modes of transportation throughout the design and construction process.

The purpose of these Standards and Specifications is also to ensure that the City receives public facilities which are constructed with the care and materials such that the facility meets or exceeds the normal service life and quality requirements consistent with industry standards and to insure that when said facilities are transferred to the City's ownership that they will be free from all defects and in suitable working order to provide the service capabilities anticipated with such a facility in a sustainable manner.

Severability. If any provision of these Standards and Specifications is held invalid or unenforceable, said provision shall have no bearing on the effectiveness of the rest of these Standards and Specifications, and the remaining provisions of these Standards and Specifications shall continue in full force and effect.

Section 102.00 Scope of Work

The provisions of these Standards and Specifications shall apply to the construction, enlargement, alteration, moving, removal, conversion, demolition, repair, and excavation of public improvements or common facilities specifically regulated herein except where an approved plan specifically states otherwise. The provisions of these Standards and Specifications apply to all construction related to public improvements or common facilities. Contractors will use the City provided estimating templates to provide accurate estimates for project construction as well as any agreed upon change orders.

Alterations, additions, or repairs to existing improvements shall comply with all requirements of these Standards and Specifications, unless specifically exempted by the City Engineer in writing. In circumstances in which the City Engineer is unavailable, authority shall be given to an Authorized Agent of the City Engineer. Refer to Section 152.02 for these definitions.

Section 103.00 Federal, State, County, and City of Littleton Rules, Regulations, and Ordinances

The Contractor shall be responsible to be fully informed of, and shall comply with all applicable laws, ordinances, rules, regulations and orders of the city, county, state, federal or public bodies having jurisdiction affecting the work.

The Contractor and its Surety shall indemnify and save harmless the City, its officers, agents, employees, successors and assigns from all suits, demands, actions, or claims of any nature whatsoever brought or made against the City, its officers, agents, employees, successors or assigns from any injuries or damages sustained by any person, firm or corporation or property or resulting from or arising out of any neglect in safeguarding the work; or through the use of unacceptable materials in the construction of the improvement; or as a result of any act or omission by the Contractor; or from the use, misuse, storage or handling of explosives; or on account of any claims or amounts recovered for any infringement of patent, trademark or copyright; or from any claims or amounts arising or recovered under Worker's Compensation laws, or any other law, by-law, ordinance, order or decree. Moneys due to the Contractor under and by virtue of the work, as shall be considered necessary by the City, may be retained, or in case no money is due, the Contractor's Surety Bond shall be held until such suit(s), action(s), or claim(s) for injuries or damages have been settled and satisfactory evidence has been furnished to the City. Should conflicts be identified between these Standards and Specifications and other governing codes and requirements, the most restrictive provisions shall apply.

Section 104.00 Changes to the Standards and Specifications

All codified policy changes to these Standards and Specifications shall be made by City Council through resolution and incorporated herein. These Standards and Specifications may be amended as new technology is developed and/or if experience gained in the use of these Standards and Specifications indicate a need for revision. The City shall have full power and authority to promulgate rules, regulations, or new standards of a technical nature, which rules, regulations, or standards shall be effective immediately upon their approval and certification by the City Engineer. It is the responsibility of the Consultant/Contractor/Developer to obtain all revisions to these Standards and Specifications. Changes made for clarification, easier interpretation, operation of facilities, or standards may be made by the City Engineer provided no codified policy(s) is affected by the change(s).

Section 105.00 Specifications by Reference

All specifications, i.e., ASTM, ACI, etc. made a portion of these Standards and Specifications by reference shall be as contained in the Littleton City Code or when absent the latest published edition. Throughout these Standards and Specifications, any section referenced shall be deemed to include all subsections of that section. Any portion of these Standards and Specifications that may be applicable to any other section, whether referenced or not, shall apply.

Section 106.00 Supervision and Discipline by Contractor

The Contractor will supervise and direct all work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the work in accordance with the Contract Documents. The Contractor will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will employ and maintain on the work site a qualified supervisor or superintendent who shall have been designated in the City's Permit System by the Contractor as the Contractor's representative at the site. The supervisor shall have full authority to act on behalf of the Contractor and all communications given to the supervisor shall be as binding as if given to the Contractor. The supervisor shall be always present on the site as required to perform adequate supervision and coordination of the work.

Contractor shall employ resources for completing work to full completion in the manner and time required by the Contract or Permit. All workers shall have the necessary skill and experience to perform the work assigned to them. When workers are primarily conversant in a language other than English, each crew shall have at least one person that is fluent in both English and the primary language of the workers.

The Contractor shall always enforce strict discipline and good order among employees and shall avoid employing on the Project anyone unskilled in the work assigned.

Any person employed by the Contractor or subcontractor who does not perform the work in a proper and skillful manner shall be removed, at the written request of the City Engineer, by the Contractor or subcontractor and shall not be employed on the Project without the written approval of the City Engineer. Should the Contractor continue to employ, or again employ such person or subcontractor, the Project Manager may withhold all payments which are or may become due, or the Project Manager may suspend the Work until such orders are complied with.

All equipment used on the Project shall be of size and mechanical condition to meet requirements of the work and to produce a satisfactory quality of work. Equipment used shall not cause injury to the roadway, adjacent property, or other roadways. Any damage to any adjacent infrastructure or private property caused by the Contractor, whether intentional or not, shall be repaired by the Contractor at their sole cost and expense.

Section 107.00 Drawings, Specifications, Conflicts, and Discrepancies

The intent of the drawings and specifications is that the Contractor shall furnish all labor, materials, tools, equipment, incidentals and transportation necessary for the proper execution of the work in accordance with the Approved Plans and/or Contract Documents to complete the Project in an acceptable manner, ready for use, occupancy or operation by the City.

In case of conflict between the drawings and specifications, the approved project specific documents shall govern. Figured dimensions on drawings shall govern over scaled dimensions, Detailed Drawings shall govern over General Drawings, and Special Conditions shall govern over Standard Specifications, or Standard Special Provisions, unless otherwise directed by the Contract Documents.

Any discrepancies between the drawings and specifications and site conditions; or any inconsistencies, errors, omissions or ambiguities in the drawings or specifications; or any errors or omissions in the layout as given by survey points and instructions shall be immediately reported.

For Capital Improvement Projects, these discrepancies shall be reported to the City's Project Manager, in writing, via an RFI, who shall promptly verify and correct such inconsistencies or ambiguities in writing.

For Development projects, these discrepancies shall be reported to the Engineer of Record responsible for the design of the improvements, in writing, who shall submit any necessary revisions to the City through eTRAKiT under the approved Record Number after coordination with the City Inspector and Review Engineer.

Work performed by the Contractor after such discovery, until authorized shall be done at the Contractor's sole risk.

Section 108.00 Alternative Construction

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. Alternate equivalent or superior materials or methods shall be submitted for approval to the City Engineer. Sufficient evidence and proof of equivalency or superiority shall be submitted to substantiate the alternate.

The applicant shall submit to the City using the Variance Request Form and follow the sequence of approvals within that form. The Variance Request Form shall be submitted by the design engineer. The document(s) approving the variance and granting a modification shall be placed in the project files.

A. Criteria of Approval of Engineering Variance

Variances from these Standards and Specifications or the Storm Drainage Design and Technical Criteria Manual (SDCM) are considered an extraordinary form of relief and are highly disfavored. Nevertheless, the City recognizes that in certain limited instances, it may be exceptionally difficult to both conform to these Standards and Specifications and maintain the special character of Littleton. In such situations, a variance may be sought. Variances will be considered on a case-by-case basis. The procedures of this criteria shall apply to requests for engineering variances from the LEDS or the SDCM or submittal requirements herein.

B. Submittal Requirements

Variance requests shall be submitted to the City Engineer in writing and shall be accompanied by the Variance application fee through eTRAKiT. Failure to submit payment of the applicable fee shall cause the Variance application to be summarily denied. To support the requested variance, the applicant must provide the following:

1. Details identifying the standard or submittal requirement from which the applicant seeks a variance and including a description of conditions and constraints that prevent the applicant from meeting the requirements of the LEDS. The application must provide specific reference to applicable sections of the LEDS relevant to the proposed variance request.
2. Alternate criteria or standards that are proposed to comply with the intent of existing criteria. Additionally, the applicant must provide documentation, including necessary calculations, analyses, and other relevant information supporting the alternate criteria.
3. The supporting documentation, calculations, and analyses must be signed and stamped by an engineer licensed in the State of Colorado.
4. Describe potential mitigation measures and the extent to which they reduce project impact. Mitigation measures must address each impact with reasonable assurance that the impact will be reduced in the short term, long term and cumulatively.
5. A complete description of the cumulative impacts of the proposed variance and similar potential variances for similar properties in the City. The

applicant must provide a description of potential adverse impacts of the proposed variance on City infrastructure and other neighboring properties.

6. Any other information that would support the validity of the variance.
7. Additional information that may be required by the City Engineer and only upon their request.

C. Criteria Of Approval. The following criteria must be met prior to approval of a Variance request.

1. The variance applicant is unable to comply with the underlying standard or submittal requirement.
2. The variance addresses a unique condition not experienced by other property owners of the same classification in the same zoning district.
3. The variance sought:
    i. Represents the least deviation from these Standards and Specifications or submittal requirement that will afford relief.
    ii. Does not increase costs of maintenance and repair of public infrastructure or other public facilities.
    iii. Meets the intent of the LEDS and SDCM.
    iv. Does not cause property damage to adjacent properties.
    v. Ensures access and safe traffic flow will not be compromised; and
    vi. Does not cause undue adverse impact to public safety, health, welfare and environment.

The City Engineer may, at their discretion, utilize a third party (or third parties) to provide expertise or input when reviewing a variance application. In such situations, the variance applicant shall be subject to additional fees as adopted by the Littleton City Code.

D. Disposition of Variance

Upon receipt and review of a complete application for a variance, the City Engineer will review the application and provide a disposition either requesting additional information, approving, denying, or approving with modifications or conditions. If a variance application is denied, the applicant shall be prohibited from submitting a variance request seeking the same or significantly similar relief absent a showing of significantly changed circumstances.

Section 109.00 Additional Project Requirements

It is recognized that the requirements contained in these Standards and Specifications are not necessarily sufficient for all plans, specifications and contract administration purposes. Accordingly, the City Engineer is authorized to develop and/or approve additional requirements and procedures necessary for the satisfactory completion of the work.

Section 110.00 Control of Work

Section 110.01 City Authority

The City Engineer has the authority to stop the work whenever such stoppage may be deemed necessary. The City Engineer has authority to resolve issues regarding the quality and acceptability

of materials furnished, performance of the work, interpretation of the plans and specifications, and acceptable fulfillment of the requirements of these Standards and Specifications.

Section 110.02 Authority and Duties of the City Inspector

The City Inspector is authorized to observe and inspect all work and all material furnished. Observations and inspections may include all procedures and the preparation, fabrication, testing, and installation of materials to be used. The City Inspector is not authorized to revoke, alter, or waive any requirements of these Standards and Specifications. The City Inspector is authorized to call the attention of the Contractor to any failure of the work or materials to conform to these Standards and Specifications. The City Inspector is also authorized to issue a "Correction Notice" when inspection of the project reveals violation(s) of these Standards and Specifications or deviation from project Quality Control Plan and objectives. The City Inspector shall have the authority to reject substandard and non-conforming materials and faulty methods until any questions at issue can be resolved by the City Engineer.

The City Inspector shall not act as foreman or perform other duties for the Contractor. Any guidance, opinion, direction, or instruction that the City Inspector may give the Contractor shall not be construed as binding upon the City Engineer or the City in any way or release the Contractor from fulfilling all the requirements of these Standards and Specifications. The presence or absence of the City Inspector shall not relieve the responsibility or the obligation of the Contractor.

The City of Littleton, and its representatives, shall always have reasonable and safe access to the work whenever it is in preparation or progress, and the Contractor shall provide proper facilities for such access and inspection.

Section 110.03 Interpretation

These Standards and Specifications are composed of written engineering standards, materials specifications and Detail Drawings. The interpretation of any section, or of any conflict(s) between section(s), when appropriate, shall be made by the City Engineer, and documented in the Project File. This interpretation by the City Engineer shall be binding and controlling in its applications.

Section 110.04 Liability

The City Engineer is charged with the enforcement of these Standards and Specifications, acting in good faith and without malice in performing their duties. The City Engineer shall not be personally liable for any damage that may accrue to persons or property as a result of any act or by reason of any act or omission in the discharge of their duties.

Section 111.00 Enforcement

Section 111.01 Stop Work Order

If work is being done contrary to the provisions of these Standards and Specifications, the City Engineer, may issue a written order to stop the work. The written stop work order shall be served on any persons engaged in doing or causing the work to be done and documented on the permit. The stop work order shall specify the alleged violation(s). Upon receipt of the stop work order, all work shall cease immediately until authorized to proceed by the City Engineer.

Section 111.02 Suspension of Work

In case of Suspension of Work for any reason, the Contractor shall take precautions, as necessary, to prevent injury or damage to the public, public infrastructure, and the project, to provide for

adequate drainage and to install necessary barricades, signs, or other facilities, at their expense, as directed by the City Engineer and as required by these Standards and Specifications. Necessary precautions shall be taken before the Contractor leaves the job site.

In the event that the Contractor is ordered by the City, in writing, to suspend work for some unforeseen cause not provided for in the Contract Documents, and over which the Contractor has no control, the Contractor may be reimbursed for actual money expended on the job during the period of shutdown. No allowance will be made for lost profits. The period of shutdown shall be computed from the date set out in the written order for work to cease until the date of the written order for work to resume. Claims for such compensation shall be filed with the City within 10 (ten) days of the date of written order to resume work, or such claims will not be considered. The Contractor shall submit with its claim substantiating papers covering the entire amount shown on the claim. The City shall take the claim under consideration, and may make such investigations as are deemed necessary, and shall be the sole judge as to the equitability of such claim and such decision shall be final.

Notwithstanding any provisions of the Contract Documents to the contrary, no provision of this Section shall be construed as entitling the Contractor to compensation for delays due to inclement weather, delays due to failure of the Surety, for suspensions made at the request of the Contractor, or for any other delay provided for in the Contract Documents, Specifications, Special Provisions, Bid Schedule, Contract, Change Order or Field Order.

Section 111.03 Removal of Unauthorized and Unacceptable Work

The following shall be considered "unauthorized work," and shall be neither measured nor paid for by the City, and may need to be removed at the Project Manager's discretion:

i) Work performed beyond the lines and grades shown on the approved plans, or as given, except as provided within the Contract Documents; or
ii) Work performed without giving timely notice to the Project Manager so the Project Manager may elect to be present to observe the work in progress; or
iii) Any extra work or unclassified work performed without prior written City authority and price agreement, as outlined in Section 300.

Further, all work which does not conform to these Standards and Specifications and the approved plans shall be considered unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness or any other cause found to exist prior to Final Acceptance and Release from Warranty of the work. Unacceptable work shall be immediately repaired, or if it cannot be satisfactorily repaired, shall be removed and replaced at the expense of the Contractor, in a manner acceptable to the City. This expense includes reasonable costs for the total and complete restoration of all disturbed surfaces to a condition acceptable to the City. Any work done without required permits (Section 144.00) or contrary to the instructions of the City Engineer shall be considered unauthorized and may be ordered removed.

In the event that the Contractor fails to satisfactorily repair or remove and replace rejected, unauthorized or condemned work after receiving notice from the Project Manager, the City may, at its sole discretion, recover for such defective work on the Contractor's Surety Bond, by action in court having proper jurisdiction over these matters, or the City may employ labor and equipment and satisfactorily repair or remove and replace such work and charge the cost of the same to the Contractor, which cost shall be deducted from any payments due to the Contractor.

Section 111.04 Violations and Penalties

It shall be unlawful for any person, firm, or corporation to construct, enlarge, alter, repair, move, improve, remove, excavate, convert, demolish or operate on public improvements or common facilities, or permit the same to be done, in violation of these Standards and Specifications. Penalties shall apply as set forth in the Littleton Charter and City Code.

Section 112.00 No Waiver of Legal Rights

Littleton shall not be precluded or stopped 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 Contractor, 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.

Section 113.00 Contractor's License

Any person(s) performing work City-owned or managed property (whether or not open to the public), on public infrastructure or within the right-of-way is required to obtain a Contractor License as set forth in the Littleton City Code.

Section 114.00 Performance Guarantee

Any person performing work that requires a Permit per Section 144.00 Permits and Inspections, shall provide a payment and performance guarantee as set forth in Littleton City Code.

Section 115.00 Use of Littleton Rights-of-Way (ROW)

All work performed in Littleton Rights-of-Way shall conform to these Standards and Specifications and the Littleton City Code.

Section 116.00 Requirements of Other Jurisdictions

Where proposed street construction affects other agencies such as the CDOT, adjacent cities and counties, Special Districts (as defined in the Littleton City Code), railroad companies, or ditch companies, said construction shall be subject to the review of said agencies. Generally, where more than one requirement is imposed, the more restrictive requirement shall govern. Exceptions will be authorized in writing by the City Engineer.

Section 117.00 Work Conditions

Section 117.01 Working Hours

All work on the project shall be completed in such a manner as to avoid unnecessary inconvenience to the general public and occupants of neighboring property. Work within the public ROW shall be limited to the following hours: 7:00 a.m. to 7:00 p.m. on residential streets/alleys and 8:30 a.m. to 3:30 p.m. on collector and arterial streets, unless otherwise noted and approved by the City. No work, cleanup, set-up, or other work-related activity will be allowed outside of these hours, unless it is authorized by the Public Works Director.

No work is permitted on Saturday, Sunday or City/Federal Holidays, without written approval by the City. The Contractor shall submit a written request to the City to perform overtime work

outside of allowable working hours or to conduct a closure of any public right-of-way. Road closure requests shall follow the City's established process outlined in the Littleton City Code. The Contractor shall be responsible for paying any additional fees associated with after-hours work.

Littleton observed holidays generally include New Year's Day, Martin Luther King, Jr. Day, Presidents' Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Thanksgiving Day, Day After Thanksgiving, Christmas Day, and as may be amended on the City's calendar online.

Work on private property shall comply with the working hours defined in Section 7-3-5 of the City Code.

Section 117.02 Ensuring Public Safety

The Contractor shall be solely and completely responsible for conditions of the work site(s), including safety of all persons and property during performance of the work. The Contractor shall fully comply with all applicable Federal, State and local laws, and rules and regulations governing safety of the public and workers. The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions on its own responsibility reasonably necessary to protect the life and health of employees on the job and the safety of the public, and to protect property in connection with the performance of the work. Materials stored on the site shall be so placed and the work shall, at all times, be so conducted as to cause no greater obstruction to traffic than is considered necessary by the Project Manager.

When, in the sole opinion of the City, the Contractor has not taken sufficient precautions for the safety of the public, the protection of the work to be constructed, or structures on adjacent property, which may be damaged by processes of construction due to such neglect, and/or an emergency may arise and immediate action is considered necessary in order to protect public safety, the City, with or without notice to the Contractor or the Developer, may provide suitable protection by causing such work to be done and material to be furnished and placed as the City may consider necessary and adequate.

The cost and expense of such work and material so furnished shall be borne by the Contractor or Developer and shall be paid upon presentation of reasonable cost invoices.

The performance of such emergency work under the direction of the City shall in no way relieve the Contractor of responsibility for damages which may occur during or after such precaution has been taken.

Section 118.00 Final Cleanup

Upon completion of the work, the Contractor shall remove from the project area all machinery, equipment, surplus and discarded materials, rubbish, and temporary structures, and leave the project area in a neat and presentable condition. The Contractor shall restore all work that has been damaged by their operations, to general conformity with the specifications for the item or items involved, including adjacent streets and properties to as good or better condition than existed prior to construction.

Final cleanup shall include inspection of the interior of all manholes, stormwater inlets and facilities within the construction limits, for construction materials, dirt, stones, or other debris deposited therein by the activities of the Contractor, and removal of sediment and/or debris. Erosion control measures shall be removed and properly disposed of after final stabilization, as defined in the Littleton SDCM, is achieved.

Section 119.00 Control of Materials

Section 119.01 Samples and Tests

Any work, in which untested and uninspected materials are used, shall be performed at the Contractor's risk and may be considered as unacceptable and unauthorized work. Whenever there is insufficient evidence of compliance with the provisions of these Standards and Specifications or evidence that any material or construction does not conform to the requirements, the City Engineer may require the Contractor to perform tests to demonstrate compliance. Test methods shall be as specified by the Standards and Specifications. If there are no specified test methods for the proposed alternate, the City Engineer will determine test procedures. All tests shall be made by an agency approved by the City Engineer and test reports provided directly to the City upon completion.

To determine if materials comply with contract requirements and these Standards and Specifications, samples may be collected and/or tests performed at the source or job destination, at the discretion of the City Engineer. Collection of samples and completion of tests shall be in accordance with relevant ASTM standard protocols, adopted and in effect on the date of the Contractor's proposal, except where methods and procedures for sampling and testing materials are otherwise set forth in these Standards and Specifications.

The Contractor shall furnish, at their expense, all samples, tests and reports required by the City and shall provide such facilities for collecting and forwarding them. When requested by the City Engineer, a written statement providing the origin, composition and process of manufacture of a material shall be provided by the Contractor. On CIP projects, the City shall provide technical personnel for QA testing of the work and materials, to ascertain that the completed work complies in all respects with the requirements of the Contract Documents, the approved construction plans and reports.

Section 119.02 Storage of Materials

Materials shall be stored to assure the preservation of quality, fitness and suitability of the work. Stored materials shall be subject to inspection at any time prior to use in the work and shall meet all requirements of these Standards and Specifications at the time they are used. Materials shall be stored in a manner that facilitates inspection. Any additional storage space required shall be provided by the Contractor at their expense.

Section 119.03 Defective Materials

Materials not in conformance with the Contract Documents or these Standards and Specifications shall be considered defective and shall be rejected. Rejected materials shall be removed from the work site within seventy-two (72) hours of written notice.

Section 120.00 Quality Assurance and Quality Control

Quality Assurance is the process followed by Littleton Inspectors to assure compliance of each project to the City Standards and Specifications. *Quality Control* is the process that shall be implemented by the Contractor and the independent project inspectors provided by a Certified Materials Testing Agency (Independent Testing Agency), or other entity as approved by the City.

The Contractor and the Independent Testing Agency shall prepare project specific documentation that will comprise the Quality Control Plan (QCP) as part of the overall project Quality Assurance Program prior to the preconstruction conference. The QCP shall include at a minimum:

1. A summary of the Contractor's methods and procedures to ensure quality control for all major aspects of the work. The summary should discuss roles and responsibilities of key project personnel, qualifications of personnel, equipment to be used, project oversight, and any other project specific strategies to ensure high quality construction.
2. The Certified Materials Testing Agency shall submit a testing plan which includes the work to be observed, required inspections, and required tests, including test type and frequency, on all major aspects of the work.
3. Qualifications of the materials tester - minimum qualifications and required certifications are listed in Section 403.00 - Qualifications for Testing Agency of these Standards and Specifications.
4. Worksheet or other form on which data will be recorded - the worksheet shall include, at a minimum, the location of test taken, result of test, date taken, testing standard used, testing equipment, test result, and retake information for failing tests. For pipe backfill operations, test locations must also be shown on the approved utility profile plan.
5. The name of the professional engineer responsible for review and approval of the test reports.

The frequency of testing as required in Section 404.00 - Minimum Testing Requirements of these Standards and Specifications shall be the minimum Quality Assurance requirements.

Section 121.00 Non-Compliance with the Quality Assurance Program

Provided that ninety (90) percent or greater of all initial tests have passed, the Quality Assurance Program is considered satisfactory, and no action will be required. If less than ninety (90) percent but greater than seventy-five (75) percent of all initial tests have passed, the Littleton Inspector will conduct a field meeting to be attended by:

1. Developer's or General Contractor's Project Manager and field representative
2. Developer's or General Contractor's Testing Agency's Project Supervisor (P.E.) and Technician
3. Contractor's Quality Control Manager, the Superintendent and the Foreman of the crew doing the work

The purpose of the meeting will be to discuss and determine the cause of the low rate of passing tests and to determine a course of corrective action. Testing frequency shall be increased by twenty-five (25) percent until ninety (90) percent or more of the tests meet the specifications and requirements at the cost of the Contractor.

If less than seventy-five (75) percent of all initial tests have passed, production will be suspended, and the Littleton Inspector will conduct a field meeting to be attended by:

1. Littleton City Engineer
2. Developer's or General Contractor's Project Manager and field representative
3. Developer's or General Contractor's Testing Agency's Project Supervisor (P.E.) and Technician
4. Contractor's Quality Control Manager, the Superintendent and the Foreman of the crew doing the work

The purpose of the meeting will be to discuss and determine the cause of the low rate of passing tests and/or samples and to determine a course of corrective action. The Contractor's foreman and crew performing the nonconforming work may be removed from the project. Production will

remain suspended until the source of the problem is identified and corrected. Upon resumption of production, the work testing and/or sampling frequency shall be increased by fifty (50) percent until ninety (90) percent or more of the tests/samples meet the specifications and requirements for at least three (3) working days.

Section 122.00 Protection of Public, Private and Utility Interests

City owned utilities shall be protected in conformance with Sections 500, 600, and 700 of these Standards and Specifications. Required separations for installation shall be in conformance with Sections 500, 600, and 700 of these Standards and Specifications. Private utilities shall be protected as required by the Owner. Damage to private utilities shall be repaired as required by the Owner.

Section 123.00 Littleton Utility Easements

All stormwater and sanitary sewer facilities shall dedicate public utility easements for said utilities, with a Legal Description, Exhibit, and easement language approved by the City. All stormwater and sanitary sewer facilities shall dedicate public utility easements to the City. The minimum easement for one utility is twenty (20) feet, with sufficient maneuvering area for maintenance and repairs to be performed. Additional easement width may be required based on the proposed depth of the utility and serviceability requirement needs for maintenance and repair. All newly acquired storm drainage easements shall be provided per the SDCM (latest edition), including typical easement requirements can be found in Figure 801.

Easements shall be in conformance with Section 10-6-2 of the Littleton City Code.

Section 124.00 Operation of Littleton Utility System Controls

Only Littleton qualified personnel shall operate control devices on all Littleton utility systems.

Section 125.00 Underground Facilities

Section 125.01 Locates Required for Existing Utility Systems

Prior to disturbance of soils, concrete or asphalt materials, all utility line locations shall be marked on the ground with location equipment by a certified utility locator agency. All utility locates shall be plainly marked by coded paint symbols on pavement or by marked stakes in the ground at the Contractor's expense.

Section 126.00 Subsurface Utility Engineering (SUE)

Consistent with C.R.S. §§ 9-1.5.101 et seq., stamped plans that meet, or exceed, the most current ASCE standard, and companion standard i.e. ASCE75-22, are required for all Projects that required subsurface utility engineering .

A subsurface utility plan shall be provided during the Design Phase and shall meet the requirements of C.R.S § 9-1.5-102 for all utility conflicts. For all utility crossings, both proposed and existing, QL-A is required. All other utility conflicts shall be QL-B or better. When proposed public utilities cross existing gravity sewer, written approval from the City Engineer may permit a non-invasive alternative Modified QL-A. For traffic signal pole and caisson installations, QL-A will be required.

As part of the investigation, developers shall notify 811 of the subsurface utility projects, designate utilities in the project area to meet ASCE Standard 38, complete a Subsurface Utility Engineering map, and summarize findings to identify utility conflicts.

Section 126.01 Exploratory Potholing Required for Existing Utility Systems

No directional drilling will be allowed in areas containing public utilities without a subsurface utility plan. Prior to any directional drilling for the installation of any and/or all utilities, all existing underground utility line locations, within the path of the bore, shall be exposed by exploratory potholing, Quality Level A.

Minimum information required on design plans shall meet ASCE 38-02:

- Quality Level A designation for all utility crossings,
- Quality Level B designation for all other utilities in the project area,

Stamped plans shall meet or exceed the ASCE 38-02 standard for depicting and designating the underground facility location.

During exploration, the exposed utility shall remain exposed to the Littleton Inspector to observe, confirm location and separation/clearance in accordance with Table 126.01.

Section 126.02 Permissions and Permits Required by Other Agencies

Prior to City of Littleton Permit issuance, Developers/Contractors proposing to place facilities in the vicinity of existing public, private or utility infrastructure shall provide a written agreement or permit from the responsible managing agency to the City. This shall include, but not be limited to Special Districts, irrigation ditches, railroads, the CDOT, the CDPHE, the USACE, South Suburban Parks and Recreation, communication utilities, gas and electric utilities, and neighboring governmental entities.

Any work performed on a State Highway must be approved and permitted by CDOT. Traffic control requirements are to be reviewed and approved by CDOT. Any detours from a State Highway onto City of Littleton streets must have approval from the City Engineer prior to the detour being implemented.

For more information, refer to Section 400 Soils and Earthwork of these Standards and Specifications and NPDES for permit requirements.

Section 126.03 Utility Separation Requirements

During installation, the exposed utility shall remain opened to the Littleton Inspector to confirm separation/clearance of the new installation per the accepted Construction Drawings or these LEDS. Per these Standards and Specifications, all horizontal utility separations shall be in accordance with Table 126.01. Modifications from these horizontal separation requirements can only be approved through the variance process as outlined in Section 108.00. Other than fiber optic and irrigation lines, all utilities shall have a minimum separation of eighteen (18) inch vertical separation.

Table 126.01 – Horizontal Utility Separation

	Water	Sewer	Storm	Electric/Telecommunications, and/or Gas
Water		10 ft	5 ft	5 ft
Sewer	10 ft		10 ft	10 ft
Storm	5 ft	10 ft		5 ft
Electric/Telecommunications, ad/or Gas	5 ft	10 ft	5 ft	18 inches

After confirmation of the required separation of the new bore and the existing utility, the exploratory pothole shall be repaired per Section 911.03 Exploratory Pothole/Core Repair and/or 1010.02 Exploratory Pothole/Core Repair of these Standards and Specifications.

Section 127.00 Public Convenience and Safety

Fire hydrants shall always be visible and accessible to the Fire District from the street. No obstructions shall be placed within ten (10) feet of a fire hydrant.

Unless otherwise specified, the Contractor shall give written notice to property owners adjacent to proposed work and to the proper authorities in charge of streets, waterlines, gas lines, electric service, cable television and other conduits, railroads, poles, manholes, catch basins and all other property that may be affected by the Contractor's operations, at least seventy-two (72) hours before breaking ground. The Contractor shall not hinder or interfere with any person in the protection of such property, or the operation of utilities at any time. The Contractor shall obtain all necessary information (including field locations, which may include exploratory potholing) regarding existing utilities, and shall protect said utilities from damage, and shall avoid unnecessary exposure of utilities that could cause injury to the public. The Contractor shall obtain all necessary information regarding the planned installation of new utilities, cables, conduits and transformers. The Contractor shall make proper provisions and give proper notification so that new utilities and equipment can be installed without unnecessary inconvenience to the public.

Section 127.01 Interruption of Services

Before starting site work, the Contractor shall plan and coordinate the disconnection or interruption of all services: such as water, sewer, cable TV, telephone, gas, electric power and traffic. Disconnection and/or interruptions shall be made in accordance with the regulations of the utility that controls the supply of the service. Whenever the flow of traffic is affected, a Traffic Control Plan shall be provided in accordance with Section 131.00 - Traffic Control, Barricades and Warning Signs of these Standards and Specifications.

The City Engineer, or the responsible Utility District shall provide a representative to be on site to observe and approve the Contractor's disconnection or interruption of sewer services. Forty-eight (48) hours prior to the interruption of service, the Contractor shall notify all users whose service shall be interrupted in order for them to make provisions for necessary water storage. The notification shall, at a minimum, include the following information:

1. Service type
2. Area affected (Location, street, block)

3. Date
4. Time of shut-down
5. Duration of shut-down
6. Contractor contact information (24-hour availability)
7. Recommendations such as storing drinking water for consumption, cooking, or toilet flushing during the outage

No line in service shall be shut down for more than a four (4) hour period at one time. Prior approval by the City Engineer is required for all shutdowns. If required by the City Engineer, temporary service shall be provided in accordance with Section 500 - Water Supply Facilities of these Standards and Specifications.

Section 128.00 Dust Mitigation

The Contractor shall take all necessary steps to control dust arising from operations, such as vehicle and equipment speeds, connected with the work. This includes, but is not limited to, mitigating the construction area by sprinkling with water, a dust palliative, windrows, or as otherwise directed by the City Engineer. The water source is the Contractor's responsibility; however, water may not be taken from tributaries, streams, or on-site detention. In the event that other occurrences require countermeasures, the City Engineer shall approve said action.

Section 129.00 Protection and Restoration Requirements

Every reasonable precaution shall be taken to prevent the damage or destruction of public or private property including, but not limited to, poles, trees, shrubbery, crops, fences, underground infrastructure and all overhead structures, wires, and cables. The Contractor shall be responsible for all damage or injury to property of any character resulting from any act, omission, neglect or misconduct in their manner, or method of executing said work, or due to its non-execution of said work, or at any time due to defective work or materials, and said responsibility shall not be released until the work has been completed and accepted by the City.

Wherever necessary, or directed by the City Engineer, the Contractor shall erect and maintain a fence or railing around any excavation or work site and place a sufficient number of work lights about the work and keep them illuminated from twilight until sunrise. Watchmen shall be employed for additional security wherever needed or required by the City Engineer.

The Contractor shall not prevent the flow of water in gutters of the street and shall use proper means to permit the flow of surface water along gutters while work is progressing.

Section 129.01 Protection of Storm Sewer Systems, Streams, Lakes and Reservoirs

The Contractor shall take all necessary precautions to prevent pollution of streams, lakes, and reservoirs with fuel, oil, bitumen, calcium chloride, or other harmful materials. Control measures must be implemented to capture pollutants, and captured pollutants must be removed and properly disposed. The Contractor shall conduct and schedule their operations to avoid or minimize siltation of streams, ditches, lakes and reservoirs. Refer to the City of Littleton SDCM, most current edition.

https://www.littletonco.gov/Government/Departments/Public-Works-Engineering/Storm-Drainage

Section 129.02 Protection of Public and Private Installations

The Contractor shall take proper precautions at all times for the protection of and replacement or restoration of streets, driveway culverts, street intersection culverts or aprons, storm drains or inlets, fences, irrigation ditches, crossings and diversion boxes, mailboxes, shrubbery, business signs, street signs, flowers, ornamental trees, driveway approaches, and all other public and private installations that may be encountered during construction. The Contractor shall have the responsibility of providing each property with access to and from the property during the time of construction. Existing driveways shall be cut, filled, and graded as required and as directed by the City Engineer to provide permanent access. It shall be at the Contractor's expense to repair or replace public or private infrastructure that was damaged during construction.

Temporary Street Signs and Business Signs shall be provided by the Contractor in the event that permanent signs need to be removed for construction purposes. Permanent Street and Business signs shall be re-installed in the same condition in which they were before removal.

Section 130.00 Existing Structures, Landscaping, and Utilities Requirements

Section 130.01 Existing Structures and Utilities to Remain

All existing poles, wires, fences, property line markers and other structures, which shall be preserved in place without being temporarily or permanently relocated, shall be carefully supported and protected from damage by the Contractor.

Underground utilities may exist within or immediately adjacent to areas of proposed construction. Per C.R.S. §§ 9-1.5.101 et seq. all projects that have an anticipated excavation footprint that exceeds two (2) feet in depth and is a contiguous one thousand (1,000) square feet or includes any utility boring are required to provide existing utility locations meeting the ASCE 38-02 standards. This requirement is for all utilities proposed in public Right-of-Way, easements, or publicly owned land. All utilities investigations in the project area are required to meet ASCE 38-02, Quality Level B designation, and with the design of utility crossings are required to meet ASCE Quality Level A designation. Stamped plans by a Colorado licensed professional engineer are required to meet or exceed ASCE 38-02 standards for defining underground facility locations.

All utility services shall be supported by suitable means so that services do not fail during construction or if settling of soils occurs. Where any shallow pipe exists or is constructed which may have been distressed by the Contractor’s construction operations, the City Engineer may require the Contractor to submit video of the pipe for inspection. Developer and Contractor shall be responsible for the repair of underground pipes, wires, or conduits damaged by them or their subcontractors.

Section 130.02 Relocation, Removal and Replacement of Existing Structures and Utilities

If the Contractor encounters structures and/or utilities in conflict with the proposed Work, the structures and/or utilities shall be relocated, or removed and replaced in-kind as approved by the City Engineer. Abandonment or removal of Littleton utilities shall be performed in accordance with **Section 408.00 - Pipe and Appurtenances** of these Standards and Specifications.

Section 130.03 Tree Protection Zone

All tree protection measures shall be installed prior to any construction activities in accordance with the Littleton Tree Manual.

Section 130.04 Protection of Landscaped and Irrigated Areas

The Developer or Contractor will be responsible for protecting all landscaping and irrigation in developed areas at all times. Any damage to the landscaping or irrigation will be restored to the original condition at the Developer's or Contractor's expense. Littleton owned landscape and irrigation areas will be inspected by the City before any approvals are made.

Section 130.05 Correcting Damage

Developer and Contractor shall be responsible for damage or destruction of all public or private property resulting from neglect, misconduct, or omission in their manner or method of execution or non-execution of work, or caused by defective work or the use of unsatisfactory materials.

The Contractor shall notify the property owner in writing of the type and extent of the damage and agree to a time schedule to repair the damage. The repair shall restore such property to a condition similar or equal to that which existed before such damage or injury was done, by repairing, rebuilding, or replacing it as may be directed, or they shall otherwise make good such damage or destruction in an acceptable manner, as determined by the City Engineer. If damage is not repaired within the time frame agreed to by the property owner and the Contractor, Littleton will have repairs made as set forth in the Littleton City Code.

Developer and Contractor shall be liable for all damage caused by storms and fire, and shall under no circumstances, start fires without first securing the necessary permits and approval of the authority having jurisdiction even though they may be ordered or required to do such burning. In burning brush, stumps, or rubbish, care shall be taken not to damage any standing trees, shrubs or other property.

Section 131.00 Traffic Control, Barricades and Warning Signs

All construction, maintenance, park or utility work being completed within the Public Rights-of-Way shall have a Traffic Control Plan (TCP) approved by the City Engineer. The TCP is a plan for guiding and handling traffic safely through the construction work zone. The TCP shall provide safe methods for movement of pedestrians, bicyclists, and motorists that travel through the work zone, and a safe area for all workers engaged in construction activity. The job specific TCP will be prepared by the Contractor for review by the City Engineer in accordance with the TCP Checklist. No work shall commence without an approved TCP. Any changes to the TCP must be approved in writing by the City Engineer prior to implementation. All control devices shall be installed and maintained in accordance with these Standards and Specifications, the "Manual on Uniform Traffic Control Devices" (MUTCD), latest editions, and CDOT Standard Plans for Traffic Controls for Highway Construction, latest editions.

Where the Contractor's work requires a full closure of any public street, road, highway, alley, trail or sidewalk, the Contractor shall apply for a ROW Permit. Requests shall be submitted to the City Engineer at least five (5) days in advance of the requested work date.

Requirements contained in the above referenced manuals and Standards and Specifications shall be strictly enforced during the progress of the work. Where the control and maintenance of traffic has not been performed as specified in the Special Conditions and/or the Contractor does not

conform to the Standards and Specifications established by the City of Littleton, the City Engineer, may issue a Stop Work Order.

The Contractor shall be responsible for obtaining applicable permits as outlined in Section 126.02 Permissions and Permits Required by Other Agencies and Section 144.00 Permits and Inspections of these Standards and Specifications. The Contractor shall:

1. Provide timely notification to, and coordination with, all affected agencies including, but not limited to the following:
    a. Utility Companies
    b. RTD
    c. CDOT
2. Inform occupants of impacted properties of access limitations made necessary by the work;
3. Schedule and expedite the work to cause the least inconvenience to the public;
4. Furnish, install and maintain required traffic control devices and facilities, as required throughout the life of the contract, including periods when the work is not underway;
5. Provide flagging persons and Uniformed Traffic Control (UTC) when required. Automated Flagger Assistance Devices (AFADs) are not accepted;
6. Ensure that survey crews and other employees working in or adjacent to a traveled roadway wear personal protection equipment as required;
7. Provide adequate safeguards for workers and the general public;
8. Patrol the construction site as required to ensure that all devices are in place and operating at all times; and
9. Remove traffic control devices when they are no longer needed.

Once the TCP is approved by the City Engineer, the Contractor is solely responsible for the installation, maintenance, and inspection of the construction zone. The Contractor will keep a signed copy of the TCP at the work area during work hours. The work area shall be understood to include all open trenches, other excavations, material piles, equipment, obstructions, detours and other temporary roadways, and other similar hazards within or related to the project. The TCP will be available for inspection by City or State personnel. All traffic control signs that are not applicable to the given circumstance shall be removed, covered, or turned around so they do not face traffic and pose a hazard. The Contractor shall correct any deficiencies noted by the City immediately. The Contractor must remove all traffic control within forty-eight (48) hours after job completion. If the Contractor does not comply, is not available, or cannot be found, the City may make such corrections as set forth in Section 8-1-3 of the Littleton City Code.

Projects that affect traffic on arterial and/or collector streets may require the use of a Uniformed Traffic Control (UTC) officer on the job site to direct traffic as directed per the City Engineer. When the normal operation of a traffic signal must be interrupted, UTC shall be used to direct traffic. Any expense incurred during this operation shall be borne by the Contractor. Work shall be scheduled and expedited in a manner to cause the least inconvenience to the public.

Intersection, alley, and driveway access shall be maintained at all times. If closure of an intersection is necessary, it shall be done at the approval of the City Engineer and shall be closed for a minimum amount of time. The Contractor shall coordinate driveway closures with property owners with final approval by the City Engineer.

Unless otherwise approved by the Traffic Control Plan, construction operations are limited to one-half (½) of the roadway at any time. Maintenance activities in arterial and collector streets shall be planned and scheduled to minimize interference with traffic.

All temporary traffic lanes shall be a minimum of ten (10) feet in width unless otherwise authorized. In addition, lane clearance shall be a minimum of five (5) feet from an open excavation and two (2) feet from a curb or other vertical obstruction. Barricades shall be used to separate the traffic lanes from an open excavation if the five (5) feet minimum lane clearance cannot be maintained. Barricades shall be painted, kept clean, weighted, and the face material shall be retro-reflective. All signs (warning, regulatory, etc.) shall be kept clean and shall be replaced when the face is damaged. These sign faces shall be retro-reflective. All signs shall be removed or turned away from the roadway immediately after they are no longer applicable, especially when left at the job site overnight.

Traffic cones are for daytime use only. Barricading devices with lights shall be used for all work that is left overnight. When lights are used, steady burn lights shall be used for delineation and channelization. Flashing lights shall be used to denote a specific hazard.

Under certain conditions the use of temporary pavement markings shall be required in addition to the devices used for delineation. This shall be shown on the TCP and the City Engineer will determine the extent of the striping. When temporary markings are used, the existing markings shall be completely removed from the roadway. Painting the existing markings black will not be accepted. Temporary markings shall be installed by the Contractor. The temporary markings shall be removed when the construction is completed, and the permanent markings shall be reinstalled by the Contractor.

A suitable surface shall be provided for temporary traffic lanes in work areas. When traffic is diverted from existing pavement, a temporary surface shall be provided, as approved by the City Engineer, Fire Department, and any other applicable agencies.

Construction equipment not actively engaged in construction, employee vehicles, and official vehicles of the agency shall not be parked in the vicinity of the work in such a manner as to further restrict traffic flow. Vehicles and equipment in continuous or frequent use may be operated or parked in the same traffic lane as the work obstruction. Construction spoils or materials may be similarly stored in this area or on the nearby roadway or sidewalk area, provided that four (4) feet of sidewalk is kept clear for pedestrian use. To prevent the spoil bank from occupying too great a space at its base, toe boards may be used to keep it two (2) feet from the edge of the excavation on one side and two (2) feet from the edge of the traffic lane on the other. Spillage and mud trackage from trucks and equipment shall be cleaned up immediately. Additionally, and at the City Engineer’s discretion, the Contractor may be required to maintain safe access to other facilities including parking areas, bike and pedestrian facilities, trails, etc.

Open trenches will not be allowed after work hours, without prior approval of the Project Manager or City Inspector. Whenever necessary, trenches and excavations shall be bridged to permit an unobstructed flow of traffic.

1. Bridging shall be secured against displacement by using adjustable cleats, angles, bolts, or other devices.
2. Bridging shall be installed to operate with minimum noise.
3. The trench shall be adequately shored, to support the bridging and traffic.

4. Steel plates used for bridging shall extend a minimum of one foot beyond the edges of the trench. Temporary paving materials shall be used to feather the edges of the plates to minimize wheel impact.
5. Steel plates used for bridging shall be designed by a Colorado Registered Professional Engineer.
6. Steel plates are not to be utilized from September through May, unless specifically approved by the City Engineer.

When the work area encroaches upon a sidewalk, bike lane, walkway or crosswalk area, special consideration shall be given to pedestrian and bicyclist safety. An accessible pedestrian and bicycle route, per MUTCD standards, shall be maintained adjacent to the work area, at all times. Pedestrians shall not be diverted onto the roadway and appropriately separated from the work area. unless a detour route has been previously approved on the Traffic Control Plan by the City.

All work shall be barricaded at all times. Between sunset and sunrise, the work area shall be properly lighted, as determined by the MUTCD and documented on the Traffic Control Plan. The Contractor shall be responsible for all damages to work due to failure of barricades, signs, lights, flagging persons and watchmen.

Anytime a flagger is required to direct the flow of traffic, that flagger must be visible to traffic. Orange or Optic Yellow clothing (vest, shirt or jacket) must be worn by the flagger. For nighttime operations, this clothing must be reflectorized. The flagger shall follow the flagging procedures stated in the MUTCD. All flaggers shall be required to provide proof of having completed a flagger certification program accepted by CDOT or as approved by the Traffic Engineer. Flagger certification must be active at the time of flagging operations.

Section 132.00 Surveys and Survey Monuments

Surveys conducted for developments, capital projects, or any public projects with survey documents submitted to the City of Littleton shall follow the following survey standards established by the City of Littleton. Modifications to these standards shall only be approved through the variance process outlined in Section 108.00 of these standards.

Survey documents submitted to the City of Littleton shall specify the specific monuments from the official Littleton Control Network utilized and their respective relationships to the described property.

Section 133.00 Surveys

Surveys shall conform to Colorado Bylaws and Rules of Procedures and rules of Professional Conduct of the State Board of Registration for Professional Engineers and Professional Surveyors, latest edition. All surveys shall reference to the official Littleton Control Network, outlined by the associated Survey Control Diagram and other documentation on the City of Littleton Land Surveying webpage Land Surveying. All stations and offsets shown on the plans shall conform to the Littleton Control Network, unless otherwise noted. Only control monuments explicitly designated in the approved survey plan shall be used for construction staking and topographic surveys. Any use of additional or undocumented control is at the contractor's sole risk and must be verified by a licensed professional land surveyor before reliance.

The City of Littleton requires a survey control diagram be submitted with each plan set. Plat submissions shall show a tie to a minimum of two City of Littleton control points and require geodetic information being shown as well.

Section 134.00 Survey Monuments

Permanent survey monuments, including the replacement of monuments, range points and lot pins shall be set in accordance with the requirements of Articles 51 and 53 of Title 38, Colorado Revised Statutes, and as required by the Bylaws and Rules of Procedure of the Colorado State Board of Licensure for Architects, Professional Engineers and Professional Land Surveyors.

Section 135.00 Protection of Survey Monuments

The Developer and Contractor shall use every reasonable precaution to prevent the damage or destruction of survey monuments adjacent to or on the site. The Contractor shall protect and carefully preserve all aliquot corners, property corners, NGS, and City of Littleton survey control monumentation. Any monument that may be disturbed shall be referenced to a minimum of two points outside the limits of construction and replaced by a Colorado Licensed Professional Land Surveyor. All monuments that are damaged, disturbed, or removed by the Contractor, their employees or subcontractors, shall be restored per Section 134.00 Survey Monuments of these Standards and Specifications at the contractor, applicant, or developer's sole expense. The unauthorized removal, alteration, or defacement of any public land survey monument and/or boundary accessory is subject to penalties under Colorado Revised Statutes Title 38, including applicable fines and legal prosecution.

Section 136.00 Engineering Reports

Engineering reports shall be required for all development and City projects and submitted with each application for a permit, unless waived by the City Engineer. Engineering reports shall be prepared in conformance with the appropriate checklists that can be found on the City's website. The checklists are intended to assist in the preparation of the projects. They are minimum typical items required to demonstrate conformance with these standards. Additional items may be necessary, which will be identified during the review process.

Section 137.00 Preliminary Engineering Reports

The following preliminary engineering reports shall accompany all initial land use applications, and preliminary plat applications as noted below, unless waived, in writing, by the City Engineer:

1. Utility Report
2. Drainage Report
3. Traffic Analysis Report
4. Geotechnical Study
5. Phase I Environmental Assessment Report

Section 138.00 Final Engineering Reports

At a minimum, the following final reports shall accompany all final private development planning applications or engineering submits for construction as noted below, unless waived, in writing, by the City Engineer:

1. Utility Report
2. Drainage Report

3. Traffic Analysis Report
4. Geotechnical Studies
5. Construction Traffic Routing Plan

Any approval or acceptance by the City shall not result in any liability to the City for any claim, suit, loss, damage, or injury resulting from the implementation or use of the approved documents and shall not act as a waiver of the Developer/Contractor's breach of these Standard and Specifications or of any City rights or remedies herein.

Section 139.00 Plans and Specifications

Littleton requires that plans, computations and specifications be prepared and designed by a Colorado licensed Professional Engineer and landscape plans by a Colorado licensed Landscape Architect. Modifications to these requirements shall be approved in writing by the City Engineer. All plans and reports shall be computer generated.

Section 140.00 Construction Plans Approval

Construction Plans shall conform to the Civil Construction Drawings Checklist. All construction plans shall be reviewed for general conformance with the Standards and Specifications prior to approval by the City Engineer. Engineering design shall remain the responsibility of the professional Design Engineer. Approved plans shall be void if a ROW permit is not issued within one year following plan approval.

Section 141.00 Digital Data Conformance

An unlocked AutoCAD digital copy of the approved construction plans and as-built PDF plans are required. Confirm version acceptability with the City of Littleton's Engineering Division, including the following requirements:

1. "X-referenced" files shall have the "reference type" as "Attachment" and the "path type" as "relative path" and be referenced to the official City of Littleton Survey Control Network.
2. Basis of Bearing. The Basis of Bearing statement shall fully describe which two City of Littleton Control Points were selected to establish the State Plane grid bearings used for construction drawings. Specify the State Plane grid bearing, and Modified State Plane distances between these two Control Points and state the method used to derive the bearing (i.e., assumed, astronomic, geodetic, grid, reference to recorded or deposited survey, etc.).
3. Benchmark Requirements. All vertical control shall be based on the NAVD88-datum described in the official City of Littleton Survey Control Network. Littleton survey standards are to be used for the design, construction, construction drawing and Record drawings. The project benchmark being used for construction shall fully describe the monument (i.e., monument material, diameter, length (if set), cap size and material, cap markings/stampings, etc.). The cover sheet shall include the above-mentioned requirements and all information needed to establish project control.
4. Littleton Survey Standards
    a. Orthometric heights are based on NAVD88 (Geoid18 being the current Geoid)
    b. State Plane coordinates are based on the Colorado Central Zone (502) NAD83(2011) (EPOCH 2010.0000)
    c. Units are US Survey Feet (SFT)

d. Land Surveys need to be at ground. Surveys shall be based upon the State Plane Coordinates as stated in (b) and shall show the "Combined Scale Factor" to convert from Grid to Ground or Ground to Grid.
e. Any modification from the City of Littleton's survey standards would need City Engineer's approval. Submit a written request with justification as to why the modification is being requested.

Section 142.00 Access to the Approved Plans

The Contractor shall keep a set of the signed approved plans on the job site for the duration of the project.

Section 143.00 Record Documents

Record Documents shall represent the "as-built" condition of all site improvements, and shall be based upon the addenda, change orders and other data furnished. Record drawings shall be a complete set of plans including all originally approved Construction Plan sheets.

Record Documents shall be prepared and submitted at the completion of the project in compliance with Section 203 Record (Documents) Drawings. If the Design Engineer responsible for the original approved engineering construction drawings is not available to prepare the Record Documents, the Professional Engineer certifying the Record Documents shall agree in writing to accept the responsibility for certifying that the completed work is in conformance with the approved plans.

Section 144.00 Permits and Inspections

The Contractor shall, without additional expense to the City, be responsible for obtaining any necessary licenses and permits, and for complying with any Federal, State, and City laws, codes, and regulations applicable to the performance of the work.

It shall be unlawful for any person, organization, firm or corporation to construct, enlarge, alter, repair, move, improve, remove, excavate, convert or demolish any public improvements or common facilities regulated by these Standards and Specifications without first obtaining a Right-of- Way Permit, Floodplain Development Permit, Sewer Permit and/or a Grading Permit for such work in accordance with the Littleton City Code, or any other applicable federal or state permits necessary for the work.

Section 145.00 Application for Permit

All City construction related permits may be found online at Littleton's website (Littletonco.gov) and shall be completed in accordance with the Littleton City Code. A permit application shall expire in accordance with the Littleton City Code. Plans and other data submitted with the expired permit application will either be returned to the Applicant or destroyed by the City.

Section 145.01 Application for Extension

The permit issuance period may be extended by the City Engineer for a period up to thirty (30) days, or the duration in which the City Engineer deems applicable to work being completed. An extension shall be based upon a written request from the Applicant showing that circumstances beyond the control of the Applicant have prevented action from being taken. A permit extension of thirty (30) days from the expiration date noted on the permit may be granted without an

additional fee. No application shall be extended more than once. To renew action on an application that has expired, the Applicant shall resubmit plans and pay the associated fees.

Section 146.00 Permit Issuance

The application, plans, specifications and other data filed by an Applicant for a permit shall be reviewed by the City. If it is found that the work described in an application for a permit, including plans and other data, conforms to the requirements of these Standards and Specifications, other pertinent laws and ordinances, and that all required fees have been paid, a permit will be issued.

The City Engineer may waive the submission of plans, calculations, etc., if they find that the nature of the work is such that a review of plans is not necessary to obtain compliance with these Standards and Specifications. Upon issuance of a permit, the approved plans and specifications shall not be changed, modified, or altered without authorization from the City Engineer, and all work shall be performed in conformance with the approved plans. One set of approved plans, specifications, and computations shall be retained by Littleton, and one set shall be maintained at the work site at all times during the progress of the work.

A pre-construction conference may be required prior to the issuance of any permits for construction. Invitees shall include the appropriate City of Littleton staff or representatives, the developer/owner, design engineer, general contractor, subcontractors and others as appropriate. The City shall be notified five (5) working days before construction is to begin. Pre-construction meetings shall be held on-site unless prior approved by the City.

The issuance of a 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 this jurisdiction. No permit presuming to give authority to violate or cancel the provisions of these Standards and Specifications is valid.

The issuance of a permit based on plans, specifications or other data shall not prevent the City from requiring the correction of errors in the 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.

Section 147.00 Permit Expiration

All work covered by the permit shall be completed by the date stated on the application. Permits shall be void if work has not commenced ninety (90) days after issuance, unless the City Engineer has granted an extension in writing. Cash escrows, letters of credit, surety bonds, or other approved forms of security deposited as a performance warranty/guarantee for individual permits will be released after voiding the permit, with administrative and any other city costs deducted.

Any Applicant holding a valid permit may apply, in writing, for an extension of the completion date noted on the permit. The request shall be based on good cause that is acceptable to the City of Littleton, in its sole discretion. The City Engineer may extend the completion date for up to six (6) months without an additional fee, if circumstances beyond the control of the Applicant have prevented completion of the work. If substantial changes have been made to the project, or more than six (6) months have lapsed after the permit expiration date, the Applicant shall apply for a new permit. Permit fees will be assessed for the new permit application.

Section 148.00 Permit Suspension or Revocation

Any permit issued under the provisions of these Standards and Specifications may be revoked or suspended in accordance with Section 8-1-3, or any other applicable sections, of the Littleton City Code.

Section 149.00 Permit Fees

The permit fee shall be calculated from unit fee rates published on the annual Fee Schedule. Fees shall be calculated on a cumulative basis. The permit fee shall be paid in full before the permit is issued. The fee for the installation of certain public utilities, i.e., underground electrical lines, gas lines, telephone cables, TV cables, etc., or construction of Littleton's Capital Improvement Projects, may be reduced or waived by the City Engineer in writing.

Section 150.00 Floodplain Permit Requirements

Floodplain work shall comply with FEMA, USACE, CDPHE, CWCB, MHFD and Littleton's floodplain regulations. Any proposed construction or other development work in the floodplain is required to have a Floodplain Development Permit per the Littleton City Code.

Refer to Littleton City Code and the City of Littleton SDCM, most current edition.

https://www.littletonco.gov/Government/Departments/Public-Works-Engineering/Storm-Drainage

Section 151.00 Inspections

All construction work for which a Right-Of-Way Permit, Floodplain Permit, Sewer Permit or Grading Permit is required shall be subject to inspection by the City.

It shall be the responsibility of the person performing the work authorized by a permit, to notify the Inspector that such work is ready for inspection by scheduling an inspection online via the City's permitting system. If a Grading Permit is issued, an initial inspection of erosion and sedimentation control measures must be scheduled, conducted, and approved by the City before the commencement of work.

It shall be the responsibility of the person requesting an inspection required by these Standards and Specifications to provide access to and means for proper inspection of all work. All work shall be inspected by the City. The City has the authority to halt construction when, in their opinion, these Standards and Specifications and/or standard construction practices and/or terms of the permit are not being followed, or the work is otherwise defective. Whenever any portion of these Standards and Specifications are violated, the Contractor will be provided written notice listing deficiencies to be corrected and whether further construction must be stopped until all deficiencies are corrected.

The City 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 Littleton City Code. The Contractor shall be present, shall have approved plans and permits available on site, and shall ensure that the work is accessible and ready for inspection. The Contractor shall not request an inspection if the work is incomplete, not ready for inspection, or when previously identified corrections have not been made.

Refer to Section 402.00 Soils and Earthwork, Section 806.03 Traffic Signals, Section 902.00 Concrete Mix Design and Construction, Section 1006.00 Roadway Inspections of these Standards and Specifications for required inspections.

The procedure for final inspection and acceptance is specified in Section 200 Development Acceptance Procedures of these Standards and Specifications.

Section 152.00 Terms, Definitions, and Acronyms

Section 152.01 Terms

Whenever, in these Standards and Specifications, the words "as ordered," "as directed," "as required," "as permitted," "as allowed," or words or phrases of like import are used, it shall be understood that the order, direction, requirement, permission, or allowance of Littleton is intended. Similarly, the words "approved," "reasonable," "suitable," "acceptable," "properly," "satisfactory," or words of like effect and import, unless otherwise specified herein, shall mean approved, reasonable, suitable, acceptable, proper, or satisfactory in the judgment of Littleton. Whenever, in these Standards and Specifications, the words "City Engineer" or "Director of Public Works & Utilities" are used, it shall be understood that the Littleton employee named therein shall be whomever is designated by the City Manager or whomever may be the Authorized Agent of the City Engineer or the Director of Public Works & Utilities.

Section 152.02 Definitions

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

1. Approved By Littleton – Shall mean approved by the Littleton City Engineer.
2. Approved Products List – Refer to Colorado Department of Transportation's Approved Products list.
3. Applicant – An individual, developer, contractor, consultant engineer or representative thereof, who applies for a permit or variance.
4. Architect – The Licensed Professional Architect-of-Record whose seal is affixed to the design plans.
5. Littleton, City of Littleton, the City – The City of Littleton, a Colorado home rule municipal corporation.
6. Bonds – Performance, labor or material payment bonds, irrevocable letters of credit. and other instruments of security furnished by the developer or Contractor and their surety in accordance with the Subdivision Agreements or other Agreements with Littleton.
7. Calendar Day – A mean solar day of twenty-four (24) hours, beginning at a mean midnight within a specified time zone and on a specific day of the year.
8. Change Order – A written order to the Contractor authorizing an addition, deletion or revision in the Work within the general scope of the Contract Documents or authorizing an adjustment in the Contract Price or Contract Time.
9. City – City can mean the organization as a whole or a representative from the organization authorized in the associated work.
10. City Code – The latest, officially adopted Littleton City Code.
11. City Engineer – Littleton's City Engineer, or an Authorized Agent.

12. Claim – A demand by either party to the Contract for something due or believed to be due from the other, attributed to the performance of the Work required by the Contract Documents which is open to challenge.
13. Common Facilities – Facilities serving or held in common title by the owners or occupants of two or more dwelling units or commercial or industrial enterprises and covered by these Standards and Specifications.
14. Contractor – An individual, partnership, corporation, company, or other legal entity who has executed the contract and in so doing is responsible to the Owner for the performance of the Work in accordance with the Contract Documents.
15. Contract Documents – The Contract in its entirety, which includes Advertisement for Bids, Information for Bidders, Special Conditions, Addenda, Bid Bond, Bid Proposal, Bid Schedule, Project Drawings, Notice of Award, Construction Contract, Performance and Payment Bond, Notice to Proceed, General Conditions, Change Order, Method of Measurement and Payment, and the City of Littleton "Engineering Design Standards and Specifications for the Design and Construction of Public Improvements".
16. Cross connection – An actual or potential connection between any part of a potable water system and an environment that would allow substances to enter the potable water system. Those substances could include gases, liquids, or solids, such as chemicals, water products, steam, water from other sources (potable or nonpotable), and any matter that may change the color or taste of water or add odor to water.
17. Days – Calendar days unless otherwise specified.
18. Development Review Engineer – The Authorized Agent of the City Engineer to review and approve public and private improvements associated with private development for compliance to these Standards and Specifications, Littleton City Code, and other adopted Manual, guidelines and references acknowledged in those adopted rules and regulations.
19. Developer – The person or persons legally responsible to Littleton for construction of improvements. For Capital Improvement Projects, Littleton is the Developer.
20. Design Engineer – The Licensed Professional Engineer-of-Record whose seal is affixed to the design plans.
21. Director of Community Development – Littleton's Community Development Director, or an Authorized Agent.
22. Director of Public Works & Utilities – Littleton's Director of Public Works & Utilities, or an Authorized Agent.
23. Drawings – The part of the Contract Documents which shows the characteristics and scope of the Work to be performed, and which have been prepared or approved by the Engineer.
24. Equipment – All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and tools and apparatus necessary for the proper construction and acceptable completion of the work.
25. Fire District – South Metro Fire Rescue.
26. Floodplain Administrator – The Water Resources Manager is the Floodplain Administrator for the City of Littleton.
27. Inspector – The Authorized Agent of City Engineer assigned to make detailed inspections of construction work with respect to compliance with these Standards and Specifications and the plans as approved by Littleton.

28. Manager of Grounds– Littleton’s Manager of Grounds, Open Space, and Natural Resources, or an Authorized Agent.
29. Measurement and Payment – A part of the Contract Documents briefly outlining the items of work, specified in the Bid Proposal, and the method to be used to determine the quantity to be paid for after installation and acceptance.
30. Modifications – A change in the requirements of the City of Littleton "Engineering Design Standards and Specifications for the Design and Construction of Public.
31. Improvements" as specified in the Special Conditions or by Addendum to the Bid Documents; or a change to the Contract accomplished through Change Order, a Written Notice or a Field Order from the Engineer or Owner.
32. Owner – The City of Littleton, Colorado, a municipal corporation acting through its Mayor and City Council, for whom the Work is to be performed.
33. Permit Coordinator – A designated City administrative coordinator who assists with the coordination, facilitation, documentation, and controlling issuance of permits through the City’s permitting system.
34. Plans – Profiles, cross sections, and drawings, and supplemental drawings, approved by Littleton, which show the locations, character, dimensions or details of the work.
35. Project – The total construction of the Work, designed by the Engineer, of which the Work performed under the Contract Documents may be the whole or a part.
36. Project Manager – The Authorized Agent of the City Engineer to serve as the City’s Project Manager.
37. Public Improvements – Those rights-of-way, easements, access rights, and physical improvements which, upon formal acceptance by the city, shall become the responsibility of the city for ownership and/or maintenance and repair, unless otherwise provided, and shall include, but not be limited, to the following: curb and gutter, asphalt pavement, concrete pavement, streets of all types, survey monuments, pavement striping, sidewalks, pedestrian/bike paths, traffic signals, street lights, highways, freeways, rights-or-way, easements, access rights, construction plans, medians, bridges, acceleration and deceleration lanes, culverts, storm drainage facilities including necessary structures, channels, water lines, sanitary sewer lines, and all other improvements, which upon acceptance by the city, are intended to be for the use of and enjoyment of the public. Private storm infrastructure is expressly excluded from this definition.
38. PVC (Polyvinyl Chloride) - A strong, tough plastic based on resins made by the polymerization of vinyl chloride or copolymerization of vinyl chloride with minor amounts (not over fifty (50) percent) of other unsaturated compounds, which are fashioned into sheets, tubing, pipe, conduit, containers, insulation, etc.
39. Authorized Agent – Assigned City or consultant personnel that have been given the authority by the City Engineer to administer the Contract Documents and enforce these Standards and Specifications.
40. Rights-of-Way – Any public street, way, place, alley, sidewalk, easement, park, square, plaza, and city-owned right-of-way dedicated to public use.
41. Request for Information (RFI) - Submitted to the City by the Design Engineer when a change occurs on a project after construction plans have been approved.
42. Shop Drawings – All drawings, diagrams, illustrations, brochures, schedules and other data which are prepared by the Contractor, a Subcontractor, manufacturer, supplier or

distributor, which illustrate how specific portions of the Work shall be fabricated or installed.

43. Special Conditions – Special directions, provisions or requirements specific to the project and not otherwise detailed or set forth in the specifications.
44. Standards and Specifications – The body of directions, provisions, and requirements contained herein, describing the method or manner of construction and the qualities and quantities of the materials and work to be furnished.
45. Subcontractor – An individual, partnership or corporation having a direct contract with the Contractor or with any other Subcontractor for the performance of a part of the Work at the site covered by these Standards and Specifications.
46. Substantial Completion – That date, as determined by the City Engineer, when the construction project or a specified part thereof is sufficiently completed, in accordance with these Standards and Specifications, so that the project or a specified part can be utilized for the purposes for which it is intended.
47. Subsurface Utility Engineering – Through Colorado legislation, a requirement or method whereby the location of underground utilities are investigated, researched, explored, and designated at differing levels, A-D, depending on the level of documentation and investigation that has been administered, to depict the horizontal and/or vertical location of utilities through the level and type of investigation applied.
48. Supplier – An individual, firm or corporation having a direct contract with a developer or Contractor or with any subcontractor for the manufacture or furnishing of any part of the supplies and/or materials to be used at or incorporated in, work at the site.
49. Traffic Engineer – Littleton's Traffic Engineer, or an Authorized Agent.
50. Work – The furnishing of all labor, material, equipment and incidentals necessary to produce the construction required by the Contract Documents, and all materials and equipment incorporated or to be incorporated in the project.
51. Working Day – Any day, exclusive of Saturdays, Sundays, and Holidays, on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed, for a major part of the daylight hours, with the normal working force.
52. Written Notice – Any notice to any party of the Contract relative to any part of the Contract in writing and considered delivered and the service thereof completed, when posted by certified or registered mail to the said party at last given address or delivered in person to said party, or an Authorized Agent on the Work.

Section 154.03 Acronyms

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

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
AIA	American Institute of Architects

AISC	American Institute of Steel Construction
APM	Asphalt Paving Mixture
ANSI	American National Standards Institute
APWA	American Public Works Association
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AWWA	American Water Works Association
AWG	American Wire Gauge, as defined in ASTM B 258 BMP Best Management Practice
BMP	Best Management Practices, commonly known as SCM
CBC	Concrete Box Culvert
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CIP	Capital Improvement Project
CLOMR	Conditional Letter of Map Revision, for FEMA regulated floodplains
CMP	Corrugated Metal Pipe
CMPA	Corrugated Metal Pipe Arch
CRS	Colorado Revised Statutes
CRSI	Concrete Reinforcing Steel Institute
CUHP	Colorado Urban Hydrograph Procedure
CWCB	Colorado Water Conservation Board
DA	Development Agreement
DIP	Ductile Iron Pipe
DRCOG	Denver Regional Council of Governments
EOPC	Engineer’s Opinion of Probable Cost
FDIC	Federal Deposit Insurance Corporation
FEMA	Federal Emergency Management Agency
FHAD	Flood Hazard Area Delineation
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
GESC	Grading, Erosion and Sediment Control

HBP/HMA	Hot Bituminous Pavement / Hot Mix Asphalt
HDPE	High Density Polyethylene
HERCP	Horizontal Elliptical Reinforced Concrete Pipe
IMSA	International Municipal Signal Association
ITE	Institute of Transportation Engineers
LED	Light Emitting Diode
LOMR	Letter of Map Revision, for FEMA regulated floodplains
MDP	Master Development Plan
MGPEC	Metropolitan Government Pavement Engineers Council
MHFD	Mile High Flood District
MHT	Method of Handling Traffic
MS4	Municipal Separate Storm Sewer System
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electric Code
NEMA	National Electric Manufacturers Association
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
NA	Notice of Award
NTP	Notice to Proceed
OSHA	Occupational Safety and Health Association
PACP	Pipeline Assessment Certification Program
PDP	Preliminary Development Plan
PE	Professional Engineer
PROWAG	Public Right-of-Way Accessibility Guidelines
PSP	Project Special Provisions
PVC	Polyvinyl Chloride
PWU	Public Works & Utilities
QAP	Quality Assurance Plan
QCP	Quality Control Plan
RAP	Reclaimed Asphalt Pavement
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
ROW	Right-of-Way

SCS	Soil Conservation Service
SCM	Stormwater Control Measure
SDCM	Storm Drainage Design and Technical Criteria Manual
SDP	Site Development Plan
SIA	Subdivision Improvements Agreement
SIP	Site Improvement Plan
SMA	Stone Matrix Asphalt
SPP	Structural Plate Pipe
SPPA	Structural Plate Pipe Arch
SPR	South Platte Renew (Wastewater Treatment Plant)
SWMP	Stormwater Management Plan
TCP	Traffic Control Plan
TMUND	Traditional Mixed Use Neighborhood Development
UNCC	Utility Notification Center of Colorado
USACE	United States Army Corps of Engineers
USDCM	Urban Storm Drainage Criteria Manual (MANUAL)
USGS	United States Geological Survey

References to external manuals, standards, and guides shall always be the latest version or edition.

SECTION 200 DEVELOPMENT ACCEPTANCE PROCEDURES

Section 201.00 Scope

The City of Littleton shall issue two types of acceptances for public improvements related to Private Development:

1.Initial Warranty Acceptance, which begins the warranty period; and

2.Final Acceptance, which ends the warranty period.

Section 202.00 Contractor Responsibilities

The Contractor shall be responsible to be fully informed of and shall comply with all sections of these Standards and Specifications, applicable laws, ordinances, rules, regulations and orders of the city, county, state, federal or public bodies having jurisdiction affecting the work.

Section 203.00 Record (Documents) Drawings

The Record Drawings shall represent the "as-built" condition of all site improvements, and shall be based upon City approved revisions to the approved documents during construction. Record Drawings shall be a complete set of plans including all originally approved Construction Plan sheets. Every sheet of the Record Drawings shall be attested to and sealed by either a Colorado Registered Professional Engineer, Colorado Registered Landscape Architect (for landscape drawings only), and/or Registered Professional Land Surveyor, and every sheet shall be stamped "Record Drawing," upon City approval of the Record Drawings.

The following information shall be included in the Record Drawings and submitted to the City prior to Initial Acceptance:

1. All approved plan revisions that have occurred since the City Engineer approved the plans.
2. For New Roadways:
    a. Surveyed elevation check at a maximum of one-hundred fifty (150) foot intervals in each flow line along the street, at each elevation breakpoint, at the PCR of each radius, at the center and ends of each cross pan and at each grade break.
    b. Surveyed elevation at the flow line on each side of storm inlets.
    c. Surveyed elevations at all design points shown on the cul-de-sac plans.
    d. All locations of pavement markings.
    e. Verification of ADA compliance at all accessibility ramps and positive drainage.
    f. Inspection reports, structural calculations and a list of finishes (colors, etc.) for all structures (culverts, underpasses, bridges, etc.)
3. Traffic Signal Rebuild or Intersection Rebuild
    a. Curb Ramp Detail Drawings
    b. Pothole Logs and Bore Logs
    c. Caisson Depths and any associate observation reports, including any observed utilities, soil types, and groundwater encountered.
    d. Signal Connectivity
        i. Lateral Connection to Fiber Backbone
        ii. Fiber Splice Diagram
    e. Cabinet diagram or notes pertaining to devices within cabinet and approved review of cabinet setup from the City
    f. Intersection Grading

4. For Sanitary Sewer and Storm Sewer:
    a. Any changes from the approved design documents in materials or pipe sizes.
    b. Surveyed elevation of all in and out inverts at manholes, inlets, and outlets. Distance between maintenance holes, and between manholes and inlets or outlets.
    c. Location of all sanitary sewer service connections.
    d. Surveyed rim elevations on all manholes and drainage inlet structures, and number of rings added during paving operations.
    e. Surveyed elevation checks every one-hundred (100) feet in all the major and minor flow lines.
    f. Horizontal and Vertical crossings of all crossed utilities.
    g. CCTV of all sewer lines.
5. Detention Ponds and Water Quality Improvements:
    a. Any changes from the approved design documents.
    b. Professional Engineer certification of the final water quality and detention facility volume and the final release rate per the Final Drainage Report.
    c. Surveyed detention and water quality facility elevations for associate volumes based on the Final Drainage Report; including WQCV, EURV, one hundred (100) year, one hundred (100) Year+ freeboard.
    d. Professional Engineer certification that all water quality features (Permanent Control Measures) were installed per the approved design documents. The certification shall include photos detailing the installation per approved plans.
6. For Water Mains :
    a. Any changes from the approved design documents in materials and/or pipe sizes.
    b. Horizontal verification of water valves, tees, crosses, and/or fire hydrants if changed from the approved design documents.
    c. Location(s) and type of restraint installed.
    d. Location of all water service connections.
7. Gas and Electric:
    a. Any changes from the approved design documents submitted for permitting.
    b. Horizontal verification of any at grade assets.
    c. Verified plan and profile of all subgrade boring or trenched lines within the city ROW.
8. Fiber Communications
    a. Any Changes from the approved design documents submitted for permitting.
    b. Horizontal verification of all at-grade installations
    c. Verified plan and profile of all subgrade boring or trenched lines within the city ROW.
9. For Public Landscaping and Irrigation Improvements:
    a. List of all plant material installed, including size and quantities (as certified by a Colorado Registered Landscape Architect).
    b. Horizontal verification of all structures.
        i. Show pertinent physical features such as sidewalks, bike paths, fences, ponds, buildings, parking lots and athletic fields.
    c. Horizontal verification of all irrigation pipes, irrigation heads, valve boxes, wiring, electrical boxes, controllers, meters and backflow protection devices.

i. Noted information shall include all pipe sizes, zone numbers, valve locations, head types, valve types and model numbers and controller types and model numbers.

An unlocked AutoCAD digital copy of the Record Drawings provided in Project Control, with referenced points matching exactly with the approved Record Drawings, is also required for Initial Warranty Acceptance.

Said Project Control shall be tied to the Colorado State Plane coordinate system, the vertical control, and state the combined scale factor as detailed in Section 142.00 Digital Data Conformance of these Standards and Specifications. It shall also include instructions to convert from one system to the other.

Section 204.00 Memorandum of Initial Warranty Acceptance

The City of Littleton shall issue an Initial Warranty Acceptance Memorandum upon acceptance of the public improvements into the Warranty Period. The two (2) year Warranty Period shall begin on the date of issue of the Initial Warranty Acceptance Memorandum.

Upon issuance of the Initial Warranty Acceptance Memorandum, maintenance of the new public improvements and facilities shall remain with the Developer/Contractor responsible for construction of the associated improvements. If a repair and/or replacement is time-sensitive for continuation of service or to protect public health, safety, and/or welfare, the City shall have the right to perform the work and invoice the Developer/Contractor. Determining if the repair and/or replacement is time-sensitive or needed for public health, safety, or welfare shall be at the sole discretion of the City. Maintenance of privately owned stormwater drainage systems, detention ponds, and water quality improvements shall remain the responsibility of the property owner or party as designated on the approved plat or Site Plan, in perpetuity.

During the two (2) year Warranty Period, the City may issue the Developer/Contractor written notice requesting repairs and/or replacements. The Developer/Contractor shall begin and complete repairs and/or replacements within the time period specified on the written notice. If the required repairs and/or replacements are not adequately completed within the time specified in the written notice, the City of Littleton may make the repairs and/or replacements and draw upon the Developer's warranty performance guarantee for Development Projects or the Contractor’s Performance Bond for City Projects.

Section 205.00 Duration and Scope of Warranty Period for Public Improvements and Facilities

The Warranty Period for public improvements and facilities shall be two (2) years with additional requirements shown in Section 210.00 Final Acceptance by the City of these Standards and Specifications. Remedied work shall carry the same warranty as the original work, starting from the date of acceptance of the replacement or repair.

Note that this does not reflect any additional manufacturer's warranty for specific equipment per equipment specifications and other warranties expressed or implied by law. Further, subcontractors’, manufacturers’, and suppliers’ warranties and guarantees shall be deemed obtained and enforced by the Contractor for the benefit of the City without the necessity of separate transfer or assignment of said warranty.

The Contractor specifically waives all the provisions of Chapter 8 of Article 20 of Title 13, C.R.S. regarding defects in the work under the Contract Documents.

Section 206.00 Development Project Warranty Performance Guarantee

Surety is required for all Development Projects that construct public improvements. Surety shall be provided in the amount of the Cost of Improvements, plus twenty five (25%) percent.

Upon issuance of the Initial Warranty Acceptance Memorandum, the City may release a portion of the performance guarantee, provided that the balance of the performance guarantee is sufficient to fund incomplete improvements and possible warranty replacements and repairs. A minimum of twenty (25) percent of the certified public improvements costs shall be held by the City throughout the warranty period, unless otherwise stated in a development agreement or as required by the City.

Section 207.00 Contractor's Performance and Payment Bond

The Public Improvement Guarantee shall remain in full force and effect through the two (2) year guarantee and warranty period on City projects.

Section 208.00 Initial Warranty Acceptance

Initial Warranty Acceptance is issued by the City Engineer and will establish a Warranty Commencement Date in writing to begin the two (2) warranty period.

A. Initial Warranty Acceptance Process & Inspections

Upon completion of the construction of public improvements, the City Inspector will notify the Development Review Engineer that the project is ready for initial warranty inspections. The Development Review Engineer will notify all applicable City Divisions/Departments to inspect the project for initial warranty.

Please note that a complete (all pages), draft set of the drawings (Contractor's redline as-built set) shall be submitted to the City of Littleton pursuant to the requirements outlined in this Section. In addition, the following documents are required:

1. Any applicable test reports need to have been submitted and approved; the reports will require a stamped, signed and dated cover sheet by the civil engineer stating that they have reviewed all test reports and confirm that they meet the City of Littleton Engineering Design Standards and Specifications.
    a. Any existing site soils investigation reports, as well as soil classifications and swell consolidation testing for imported materials to be utilized as engineered fill.
    b. Sub-Grade testing reports on all trenches and/or sub-grade for public improvements
    c. Asphalt density testing reports for all public improvements
    d. Concrete (compressive strength) testing reports for all public improvements
2. The detention pond certification letter and spreadsheet, along with any other related documentation have been submitted and approved. If there is an underground detention pond, please submit an installation conformance letter & spreadsheet of drain times. The letter shall be stamped, signed and dated by the civil engineer.

3. Any applicable structural shop drawings, inspections, evaluations, or as-builts must be stamped, signed and dated by a structural engineer and shall be submitted to the City for approval.
4. A Final Sworn Affidavit of Certified Construction Cost (for Development Projects).
5. All required CCTV video of installed storm sewer and/or sanitary sewer piping for the project. This includes all public and private improvements.
6. Unconditional lien waivers from all contractors and subcontractors that were part of the construction of the public improvements for the project. If the Developer is unable to provide unconditional lien waiver(s), then Developer shall certify to the City, in a form acceptable to the City Attorney, that the Developer has resolved all claims and made payment for all contracts, bills, invoices, purchase orders etc. that were made in connection with the construction of the Public Improvements.
7. Bill of Sale for all Public Improvements installed.
8. Any other items or Special Provisions required by a development agreement or as directed by the City.

Additional documents may be required at the discretion of the City Engineer. For example, non-destructive deflection testing that complies with Section 1011.00 Pavement Acceptance Testing of these Standards and Specifications shall be required prior to inspection for Initial Warranty for roadways.

The Developer/Contractor will be notified in writing of all outstanding punch list items needed to be completed. For most projects, punch lists can be provided by the City within twenty-one (21) days.

Within ten (10) calendar days of receipt of this punch list, the Developer/Contractor shall begin making corrections. All deficiencies shall be corrected by the Developer/Contractor within thirty (30) calendar days of receipt of the punch list. Upon completion of the punch list items, the Developer/Contractor will notify the City to arrange reinspection of the project. If all punch list items are not corrected within thirty (30) calendar days, Littleton has the right to draw funds from the performance guarantee on file to self-perform corrections.

A request for an extension is required to be made in writing to the City to process and to be approved by the City Engineer before the thirty (30) day period has expired. Such requests for extension shall include why the extension is being requested and an estimated timeframe for completion. Littleton will review such requests and respond within seven (7) days. After the Developer has corrected the deficiencies, the City Inspector will perform a follow-up Initial Inspection. When the public improvements have been approved and accepted by all applicable City Divisions/Departments, the City of Littleton will issue an Initial Acceptance Memorandum to the Developer/Contractor within fourteen (14) days.

Private stormwater conveyance and water quality may also be inspected. Prior to the Initial Warranty inspection from the City of Littleton, all temporary structures (excluding erosion control measures), debris, mud and waste materials shall be removed unless otherwise required by the Grading Permit.

All variances from the approved construction plans shall be supported by documentation including written approval of the City Engineer. All related testing certifications and other supporting documentation shall be submitted to the City to process for review and approval by the City

Engineer. All required certifications shall contain the signature and seal of a Colorado Registered Professional Engineer.

Section 209.00 Initial Warranty Maintenance Responsibilities

A. Utility Maintenance

The City's utility maintenance during the warranty period is generally limited to flushing. Utility preservation operations (including, but not limited to, leak repair and replacement of faulty fittings) during the warranty period are considered repair operations and are the responsibility of the Developer/Contractor. Before the issuance of Final Acceptance/Release from Warranty, those preservation operations will be checked and if needed, done at that time.

B. Roadway Maintenance

The City's streets/roadway maintenance during the warranty period is generally limited to street sweeping and snow plowing. Pavement preservation operations including crack sealing, patching, or asphalt surface sealing during the warranty period are considered repair operations and are the responsibility of the Developer/Contractor. All repair means and methods shall be discussed and approved by the City Engineer prior to commencing warranty repair operations, and the appropriate permits obtained. Tree lawns are the responsibility of the property owner. Before the issuance of Final Acceptance/ Release from Warranty, those preservation operations will be checked and if needed, done at that time before final surface treatment (slurry seal, cape seal or overlay) is completed.

C. Parks, Landscape, and Irrigation Maintenance

The City's park/open space, irrigation, and landscaping maintenance during the warranty period is generally limited to mowing, watering, trash removal, and snow plowing of park sidewalks and structures. The Developer/Contractor shall be responsible for mowing operations and shall provide the City with a watering schedule during establishment. Irrigation and landscaping preservation operations including irrigation system blow out at winter shut down, spring turn on, and the replacement of dead plant material and trees are considered repair operations, and are the responsibility of the Developer/Contractor. Before the issuance of Final Acceptance/Release from Warranty, those preservation operations will be checked and if needed, done at that time. Once turf has been deemed established, the City will take over responsibility for mowing operations.

D. Stormwater Water Quality Maintenance

The City does not conduct maintenance on water quality structures during the warranty period. Landscaping preservation operations including installation of temporary irrigation, and the replacement of dead plant material and trees are considered repair operations and are then responsibility of the Developer/Contractor. Before the issuance of Final Acceptance/Release from Warranty, those preservation operations will be checked and if needed, done at that time.

Section 210.00 Final Acceptance

The warranty period does not expire until all warranty repairs and replacements have been made and approved in writing by Littleton.

A. Final Acceptance/Release from Warranty Inspection

Within three (3) months before the end of the warranty period, the Developer/Contractor shall send a final acceptance inspection request to all applicable City Divisions/Departments to inspect the project for final acceptance by the City of Littleton. At least sixty (60) days prior to the expiration of the warranty period, the Developer/Contractor will be notified in writing of punch list items needed to be completed and will have thirty (30) days to complete the punch list items. Follow-up inspections may reveal additional items to be corrected within the warranty period. Upon completion of the punch list items, the Developer/Contractor will notify the City to arrange reinspection of the project.

Within ten (10) calendar days of receipt of this punch list, the Developer/Contractor shall begin making corrections. All deficiencies shall be corrected by the Developer/Contractor within thirty (30) calendar days of receipt of the punch list. If all punch list items are not corrected within thirty (30) calendar days, Littleton has the right to draw funds from the performance guarantee on file to self-perform corrections.

A request for an extension is required to be made in writing to the City to process and to be approved by the City Engineer before the thirty (30) day period has expired. Such requests for extension shall include why the extension is being requested and an estimated timeframe for completion. Littleton will review such requests and respond within seven (7) days.

After the Developer has corrected the deficiencies, the City will perform a follow-up Final Acceptance Inspection. For most projects, inspections can be completed within fourteen (14) days. When the public improvements have been approved and accepted by all applicable City Divisions/Departments, the City of Littleton will issue a Final Acceptance Memorandum to the Developer/Contractor within fourteen (14) days.

The above-mentioned time schedules may be extended only under special circumstances and with the written approval of the City Engineer.

After the public improvements have passed the Final Acceptance/Release from Warranty inspection or the City of Littleton has drawn upon the escrow and completed the public improvements, the City shall prepare a Final Acceptance Memorandum to be signed by the City Engineer. For most projects this can be completed within fourteen (14) days. Final Acceptance shall be issued, the warranty period shall expire, and the City will release the balance of the Public Improvement Guarantee.

SECTION 300 CONTRACTOR RESPONSIBILITIES

Section 300.00 Contractor Responsibilities

The Contractor shall be responsible to be fully informed of and shall comply with all sections of these Standards and Specifications, applicable laws, ordinances, rules, regulations and orders of the city, county, state, federal or public bodies having jurisdiction affecting the work.

Section 301.00 Scope

This section applies to all work completed under City contracts associated with Capital Improvement Projects. The intent of this section is to specify measurement and payment methods to be used for the construction that is typical among most City Capital Improvement Projects.

This section shall cover details pertaining to measurement units and methods, partial payments, retainage withholding and release, and details on what is considered to be part of the Work. Additionally, this section covers modifications and substitutions of costs and prices should the need arise.

Section 302.00 General Requirements

This section intentionally left blank.

Section 303.00 Procurement and Contracting Requirements

Procurement and contracting for the construction of capital and other improvements shall follow procedures set forth in the Purchasing Ordinance in the Littleton City Code.

Section 303.01 Taxes

The City of Littleton is not subject to taxation. With the exception of being exempt from City sales and use tax, the Contractor will pay all applicable sales, use and other similar taxes required by the laws of the State of Colorado and as set forth in the Littleton City Code. Where a project is exempt from such tax, the amount of such tax shall not be included in any bid proposal submitted to the City. Upon written notification by the City, the Contractor shall reimburse the City in a timely manner for any taxes erroneously paid by the City.

Contractors who purchase materials that become part of the work that do not honor the exemption, and thereby who pay sales tax, will not be reimbursed for that tax payment by the City. The Contractor shall bear the risk of any added or increased taxes occurring during the performance of the work. A change in taxes shall under no circumstances entitle the Contractor to an adjustment under the Contract Documents.

In accordance with C.R.S. §§ 39-26-114 and 39-26-203, and the related regulation of the State of Colorado Department of Revenue, the Contractor shall apply to the State of Colorado Department of Revenue, and secure prior to commencing work, an exemption certificate which, when issued by the State of Colorado Department of Revenue, will enable the Contractor to purchase all materials free of State Sales and Use Taxes and Regional Transportation District (“RTD”) Tax, provided that any building permit fee shall be included in any Bid Schedule with respect to the work. Further, no City sales and/or use tax shall be included in any billing with respect to the work. This provision shall apply to all contractors, subcontractors and material suppliers. When City sales tax is paid to licensed City vendors for materials, which become part of the work by a Contractor, the City of Littleton will refund that tax to the Contractor upon receipt of an application

from the Contractor at the conclusion of the work. Accompanying the application must be the material receipt(s) displaying a description of the item(s) purchased, date of purchase, amount of purchase, tax paid and any other documentation and information which may be required by the City to substantiate the payment and validate a refund.

Section 303.02 Notice to Proceed

The Contractor understands and agrees that all work required under City contracts shall not commence until a Notice of Proceed is issued, and shall be fully completed, as set forth in the Contract Documents. The Contractor acknowledges and understands that the Contractor maintain a rate of progress in work that will result in completion in accordance with the Contract Documents, and to that end, the Contractor agrees to proceed with all due diligence to complete all work in a timely manner.

Section 303.03 Preconstruction Conference

A meeting of City project personnel, Contractor project personnel and other stakeholders will be held prior to the beginning of construction of all projects, at which topics pertinent to the successful prosecution of the work will be discussed.

Section 303.04 Value Engineering Change Proposals (VECP) by the Contractor

The Contractor is encouraged to develop and offer proposals for improved construction techniques, alternative materials, and other innovations. Proposals must provide a project comparable to the City's original design either at lower cost, improved quality, or both. Bid prices shall not be based on the anticipated approval of a Value Engineering Change Proposal (VECP). VECPs shall be submitted only by the successful bidder after contract award. Net cost savings shall be split equally between the Contractor and the City. Any delay to the project due to a VECP submittal and review shall be considered within the Contractor's control and will be non-excusable with the exception of those delays that are approved as part of the VECP. The Contractor shall have no claim against the Owner for additional costs or delays resulting from the rejection or untimely acceptance of a VECP.

A. Submittal of Conceptual Proposal

If submitting a proposal that requires a significant amount of design or other resources, the Contractor may submit an abbreviated Conceptual Proposal for preliminary evaluation which should include, at a minimum, the below items:

1. General description of the difference between the existing Contract and the proposed change, and the advantages and disadvantages of each, including effects on service life, maintenance costs, ease of maintenance, desired appearance, safety, and impacts to the traveling public or to the environment during and after construction.
2. Conceptual plans and a description of proposed changes to the Contract specifications.
3. Statement specifying the following:
    a. when a response to the conceptual proposal is required to avoid delays to the existing contract prosecution.
    b. the amount of time necessary to develop the full Proposal.

c. the date by which a Contract Modification Order must be executed to obtain maximum benefit from the Proposal.
d. the Proposal's impact on time for completing the Contract.

B. Submittal of Full Value Engineering Change Proposal

Change Proposal should include, at a minimum, the below items:

1. General description of the difference between the existing Contract and the proposed change, and the advantages and disadvantages of each, including effects on service life, maintenance costs, ease of maintenance, desired appearance, safety, and impacts to the traveling public or to the environment during and after construction.
2. A complete set of plans and specifications showing the proposed revisions relative to the original Contract. This portion of the submittal shall include design notes, construction details, and any additional documentation such as, but not limited to, surveys, geotechnical reports, documentation, or calculations and shop drawings required to complete the work.
3. The proposed plans and specifications shall be signed and sealed by a Colorado Licensed Professional Engineer.
4. A cost comparison, summarizing all the items that the proposed VECP replaces, reduces, eliminates, adds, or otherwise changes from the original Contract work, including all impacts to traffic control, detours and all other changes.
5. A description of any previous use or testing of the proposed changes and the conditions and results.
6. An estimate of any effects the VECP will have on other costs to the City.
7. A statement of life cycle costs, when appropriate. Life cycle costs will not be considered as part of cost savings but shall be calculated for additional support of the Proposal.
8. Statement specifying when a response to the proposal is required, the date by which a Contract Modification Order must be executed to obtain maximum benefit from the Proposal, and the Proposal's impact on time for completing the Contract.

Section 303.05VECP Proposal Acceptance

If the VECP is accepted, a Contract Modification Order will authorize the changes and payment. At the completion of the project, the Contractor shall furnish the City with PE-stamped Record sets, and As-Constructed plans showing the VECP work.

Section 303.06VECP Proposal Rejection

The City may reject any Proposal that requires excessive time or costs for review, evaluation, or investigation. Proposals that lower the quality of the intended project or require Right of Way acquisition will be rejected. If a VECP is rejected, the work shall be completed in accordance with the Contract at contract bid prices.

The City retains the right to utilize any accepted Proposal or part thereof on other projects without obligation to the Contractor.

Section 303.07 Changes in Contract Price or Contract Time

A. Without invalidating the Contract Documents, the Project Manager and/or City reserves and shall have the right, without notice to any Sureties, by written Change Order in the form of a Contract Amendment, to make any changes, from time to time, to the character and quantity of the work, including, but not limited to drawings, specifications, plans, or addenda, as may be considered necessary or desirable to complete fully and acceptably the work in a satisfactory manner. This includes omission of work from the Contract Documents as well.

B. Any other written or oral order (which, as used in this subsection (B), includes direction, instruction, interpretation, or determination), from the Project Manager that causes a change shall be treated as a Change Order; provided that, the Contractor gives the Project Manager written notice stating: i) the date, circumstances, and source of the order; and ii) that the Contractor regards the order as a Change Order.

C. The Contractor must assert its right to an equitable adjustment within thirty (30) days after receipt of a written Change Order under subsection (A) or the furnishing of a written notice under subsection (B), by submitting to the Project Manager a written statement setting forth the general nature and monetary extent of such claim, unless the notice period is extended in writing by the City. No proposal for an equitable adjustment shall be allowed if asserted after final payment under the Contract Documents.

D. If any change under this Section causes an increase or decrease in the Contract Price or Contract Time, whether or not changed by any formal order, the Project Manager shall make an equitable adjustment and modify the Contract Documents, in writing. Except for equitable adjustments based on defective specifications or errors in the Contract Documents, no claim for change hereunder will be allowed for any costs incurred more than twenty (20) days before the Contractor gives written notice as required. In the case of defective specifications or errors in the Contract Documents, for which the City is responsible, the equitable adjustment shall include any increased costs reasonably incurred by Contractor in attempting to comply with the defective specifications or error in Contract Documents. Reasonableness of costs shall be determined by Section 303.08.

E. *Field Order for Minor Changes*. The Project Manager may, at any time, by issuing a Field Order, order minor changes in the work not involving an increase or decrease in the Contract Price or Contract Time. If the Contractor believes that any order for minor changes in the work requires a change in Contract Price or Contract Time, the Contractor shall not proceed with the minors changes as ordered and shall, within seven (7) days of receipt of such order, notify the Project Manager in writing of the estimate of the changes in the Contract Price or Contract Time. Such estimate shall thereafter be treated as a Change Order Request.

F. *Written Change Order Required.* Any such Change Order shall set forth, in writing, with specificity, prices, scheduling requirements, time extensions, and all reasonable costs arising out of the issuance of a Change Order, except for those cost and time aspects explicitly reserved on the face of the Change Order.

G. *Changes in Contract Price*. The contract price on City projects may be changed only by a Change Order, in the form of a written Contract Amendment.

a. The value of any work covered by a Change Order or of any claim for increase or decrease in the contract price shall be determined by one or more of the following methods in the order of precedence listed below.

i. Contract Unit Prices. If a change is ordered in an item of work covered by a contract unit or lump sum price, then an adjustment in the contract price will be made based upon the increase or decrease in quantity of the contract unit or lump sum price.
ii. Agreed Prices. Adjustments in contract price for changes ordered that are not covered by contract unit or lump sum price, in which additional work is necessary for proper completion of the project, will be determined by written agreement between Contractor and City. If unable to reach agreement, the City may direct the Contractor, in writing, to proceed on the basis of extra work in accordance with Paragraph C below.
iii. Extra Work. Extra work shall only be performed by the Contractor when so directed in writing by the Project Manager. Prices for extra work shall be itemized and covered by Change Order. If the Contractor and City are unable to agree on unit prices for the extra work or if this method of pricing is impractical, the Project Manager may instruct the Contractor to proceed with work and the City will pay for extra work based on the accumulation of reasonable costs as provided below, after review, approval, and appropriation:
1. Daily Reports by Contractor. At the close of each working day, the Contractor shall submit a daily report to the City, together with applicable delivery tickets, listing all labor, materials, and equipment for that day, and for other services and expenditures. An attempt shall be made to reconcile the report daily, and it shall be signed by the City and the Contractor. In the event of disagreement, pertinent notes shall be entered by each party to explain points which cannot be resolved immediately. Each party shall retain a signed copy of the report. Reports by subcontractors or others shall be submitted through the Contractor. Contractor's daily reports shall itemize the following:
a. Labor. The report shall show the names of workers, classifications, and hours worked.
b. Material. The report shall describe, and list, quantities of materials used.

c. The report shall show type of equipment, size and hours of Operation, including loading and transport, if applicable.
d. Other Services and Expenditures. Other services and expenditures shall be described in such detail as the City may require.

2. Basis for Establishing Costs.
   a. Labor. The costs of labor will be the actual cost for wages for each craft or type of workers at the time the extra work is completed, plus employer payments of payroll taxes and insurance, health and welfare, pension, vacation, and other direct costs resulting from federal, state or local laws, as well as assessments or benefits required by lawful collective bargaining agreements. The use of a labor classification which would increase the extra work cost will not be permitted unless the Contractor establishes the necessity for such additional costs. Labor costs for equipment operators and helpers shall be reported only when such costs are not included in the invoice for equipment rental. The city may request certified payroll in order to verify the payment to each labor classification.
   b. Materials. The cost of materials, or equipment to be incorporated in the work, shall be at invoice or lowest current price at which such materials are locally available and delivered to the job site in the quantities involved, plus freight and delivery. The City reserves the right to approve materials and sources of supply, or to supply materials to the Contractor if necessary for the progress of the extra work. No markup shall be applied to any material provided by the City.
   c. Tool and Equipment Rental. No payment will be made for the use of tools which have a replacement value of $400 or less. Regardless of ownership, the rates to be used in determining equipment rental costs shall not exceed rates approved or authorized by the City at the time the extra work is performed in accordance with CDOT Standard Specifications 109.04(c). The rental rates paid shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance and all incidentals. Necessary loading and transportation costs for equipment used in performing the extra work shall be included. If equipment is used intermittently and, when not in use, could be returned to its rental source at less expense to the City than holding it at the work site, it shall be returned, unless the Contractor elects to keep it at the work site at no expense to the City. The reported rental time for equipment already

at the job site shall be the duration of its use on the extra work, commencing at the time it is first put into actual operation on the extra work.

d. Other Items. The City may authorize other items which may be required on the extra work. Such items include labor, services, material and equipment which are different in their nature from those required for the work and which are of a type not ordinarily available from the Contractor or any of the subcontractors. Extra work shall not include materials, labor, or equipment which is incidental or appurtenant to the work included in the Contract Documents. Invoices covering all such items in detail shall be submitted with the request for payment.

3. Markup
   a. Work by Contractor. The following percentage shall be added to the Contractor's costs and shall constitute the markup for all overhead and profits:
      i. Labor (1.67 x certified payroll) 15%
      ii. Materials 15%
      iii. Equipment Rental 10%
      iv. Other Items and Expenditures 10%
   b. Work by Subcontractor. When all or any part of the extra work is performed by a subcontractor, the markup established herein shall be applied to the subcontractor's actual cost of such work, to which a markup of five percent (5%) on the subcontracted portion of the extra work may be added by the Contractor.
   c. Other Causes. Any other cause which, in the sole opinion of the City, entitles the Contractor to additional time, including but not restricted to acts of the public enemy, acts of any government in either its sovereign or any applicable contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes and unforeseeable severe abnormal weather.

H. *Changes in Contract Time.*
   a. The Contractor shall perform fully, entirely, and in a satisfactory and acceptable manner, the work within the number of days stipulated in the Contract Documents. Time will be assessed against the Contractor beginning with the actual date the work is started in accordance with Notice(s) to Proceed.
   b. The contract time on City projects for completion of work may be changed only by a Change Order, in the form of a written Contract Amendment. The Contractor shall notify the City within ten (10) days from the beginning of such an event (as determined by subsection (c) below) and in writing of any occurrence or conditions which, in the Contractor's opinion, entitle him to an

extension or reduction in Contract Time. In adjusting the Contract Time, any force majeure events, such as strikes, lockouts, unanticipated delays in transportation or any condition over which the Contractor has no control, and any suspensions ordered by the City for causes not the fault of the Contractor, shall be excluded from the computation of Contract Time.

c. Any claim for increase in Contract Time may be determined by one or more of the following:
    i. When changes in the work occur.
    ii. When work is suspended by the City.
    iii. For unforeseeable causes beyond the control and without the fault or negligence of the Contractor, their subcontractor or supplier and which were not the result of their fault or negligence.
    iv. When delays in the progress of the work caused by:
        1. Any act or neglect of the City, their employees or agents.
        2. Other Contractors employed by the City.
        3. Any delay in furnishing of drawings, information or return of shop drawings by the Project Manager.
        4. Any other cause which, in the opinion of the Project Manager, entitles the Contractor to additional time, including but not restricted to acts of the public enemy, acts of any government in either its sovereign or any applicable contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes and unforeseeable severe abnormal weather.
    v. Additional time may be granted solely at the discretion of the City Engineer.

a. The Contractor shall supplement this request for an increase in Contract Time with an updated construction schedule. Such written notice shall be submitted in ample time to permit full investigation and evaluation of the Contractor's claim. Failure to provide such notice shall constitute a waiver by the Contractor of any claim.

I. *Record-Keeping.* For any Change Orders, the Contractor shall maintain, and the City or the City's representatives shall have the right to examine books, records, documents, and other evidence and accounting principles and practices sufficient to reflect properly all direct and indirect costs of whatever nature, and time extensions, claimed to have been incurred and anticipated to be incurred for the performance of Contract Documents.

Section 303.08 Payment of Change Order

A. *Reasonable Costs*.

a. The City and the Contractor (on its own behalf and on behalf of subcontractors) shall endeavor to negotiate a reasonable price and line adjustment in a Change Order on terms appropriate to the changed work. A cost is reasonable if, in its

nature and amount, it does not exceed that which would be incurred by a prudent person in the conduct of competitive business. Reasonableness of specific costs must be examined with particular care in connection with firms or their separate divisions that may not be subject to effective competitive restraint. No presumption of reasonableness shall be attached to the incurrence of costs by a Contractor. If an initial review results in a challenge of a specific cost by the City or Project Manager, the burden of proof shall be on the Contractor to establish that such a cost is reasonable.

b. What is reasonable depends upon a variety of considerations and circumstances, including: i)_Whether it is the type of cost generally recognized as ordinary and necessary for the conduct of the Contractor's business or the contract performance; ii) Generally accepted sound business practices, arm's-length bargaining, and federal, state, and local regulations; iii) Contractor's responsibilities to the City, other customers, the owners of the business, employees, and the public at large; and iv) Any significant deviations from the Contractor's established practices.

B. *Unauthorized Work*. Work performed beyond the lines and grades shown in the Contract Documents, approved Work, and Show Drawings, and Extra Work done without written authorization will be considered "unauthorized work" and the Contractor shall not receive compensation. If required by the City, unauthorized work shall be remedied, removed, or replaced by the Contractor at the Contractor's expense.

C. *Omitted Items*. For any item omitted from the work, the City will pay the Contractor a fair and equitable amount for costs incurred directly related to such item prior to the date the City's Chang Order to omit the item. No allowance will be made for lost profits in reimbursements to the Contractor for omitted items of work. Acceptable materials ordered by the Contractor or delivered to the work site prior to the date of cancellation, alteration, or suspension of the work by order of the Project Manager will be paid for at the actual cost to the Contractor and shall thereupon become the property of the City. The Contractor shall immediately submit certified statements covering all money expended in preparation for any omitted item, and shall be reimbursed for any money expended in preparation for work on any omitted item when such preparation has no value to the remaining items of the Contract Documents, or for a proportionate amount based on the total Contract price over which such preparation would ordinarily be distributed when other items are included in such preparation.

1.1.1. *Invoices*. Contractor's invoices for material, equipment rental, and other expenditures, shall be submitted with the request for payment. If the request for payment is not substantiated by invoices or other documentation, the City may establish the cost of the item involved at the lowest price which was current at the time of submission or the City may cease negotiations until such a time that satisfactory documentation is submitted. Payment will not be made for work, equipment, labor, or materials which are required under the Contract Documents and which are not specifically mentioned, indicated, or otherwise provided for in the Bid Schedule, if, in the opinion of the Project Manager, the work or materials are susceptible of classification under or reasonably inferred to be included in the Bid Schedule.

Section 303.09 Time for Completion and Liquidated Damages

A. The date of beginning and the time for completion of the work on City projects are essential conditions of the Contract Documents and the work shall be commenced on the date specified in the Notice to Proceed. The City and Contractor agree and recognize that time is of the essence for every time period set forth in the Contract Documents and that the City will suffer financial loss if the work is not substantially complete within the time set forth in the Contract Documents.

B. The Contractor will proceed with the work at such rate of progress to ensure full completion within the contract time. It is expressly understood and agreed, by and between the Contractor and the Owner, that the contract time for the completion of the work described in the Contract Documents is a reasonable time, taking into consideration the average climatic and economic conditions and other factors prevailing in the locality of the work.

C. If the Contractor fails to fully perform and complete the work in conformity with the provisions and conditions of the Contract Documents within the specified time limit for such performance and completion, or within such further time as, in accordance with the provision of these Standards and Specifications, shall be fixed or allowed for such performance and completion, the City and Contractor agree that as liquidated damages, and not as a penalty, for the delay in performance, the Contractor shall pay to the City the amount stipulated below for each and every calendar day that expires after the time set forth in the Contract Documents until the same is finally complete and ready for final payment as provided herein.

D. The general schedule of liquidated damages set forth below is an amount, agreed to by the Contractor and the City, as reasonably representing additional construction engineering costs incurred by the City if the Contractor fails to complete performance within the contract time on City projects. Final determination of Liquidated Damages shall be determined by the City's Project Manager and will reside within the executed contract documents.

Table 303.01 - Liquidated Damages Schedule

Original Contract Amount		Daily Charge
From More Than	To and Including	
$0	$150,000	$500
150,001	250,000	600
250,001	500,000	800
500,001	1,000,000	1,400
1,000,001	2,000,000	2,000
2,000,001	4,000,000	3,300
4,000,001	10,000,000	3,900

Over $10,000,000 - daily charge will increase by $300 increments for each $1,000,000 over $10,000,000.

E. The City shall be entitled to recover inspection charges and damages by deducting the amount thereof out of any moneys which may be due or may become due to the Contractor, and/or by an action at law against the Contractor or its Surety. It is understood and agreed that aside from any other penalty or damage, all costs of the Project Manager and inspection on behalf of the City may be charged to the Contractor and be deducted from any estimate or payment otherwise due and payable.

F. The City shall have the right to deduct the amount of liquidated damages from any monies due or to become due to the Contractor, or to sue for and recover compensation for damages for non-performance of the work, from the Contractor and their surety, as stipulated in the Contract Documents. Any deduction assessed as liquidated damages under this section shall not relieve the Contractor from liability for any damages or costs resulting from delays to other Contractors on the project or other projects caused by a failure of the assessed Contractor to complete the work according to contract times.

G. Permitting the Contractor to continue and finish the work or any part thereof after elapse of contract time will not operate as a waiver on the part of the City of any of its rights under the Contract Documents.

H. The Contractor shall not be charged with liquidated damages or any excess cost when a change in contract time is approved as outlined in Section 303.09 - Time for Completion and Liquidated Damages of these Standards and Specifications.

I. For CDOT-funded work, CDOT's liquidated damages provision shall govern over this Section *303.09*. In the event that CDOT does not stipulate liquidated damages, this Section *303.09* shall govern.

Section 303.10 Contractor Claims for Adjustment and Disputes

This section details the process through which a Contractor and the City (the "Parties") agree to resolve any issue that may result in a dispute. The intent of this process is to resolve issues early, efficiently, and as close to the project level as possible. Specific time frames may be extended by mutual, written consent of the Parties. At all times, whether during resolution of an Issue or a Dispute, the Contractor shall proceed without delay to perform the work as required, directed, instructed, interpreted, determined or decided by the City, without such regard to such Issue or Dispute.

In these subsections, when a time frame ends on a Saturday, Sunday, or holiday, the time frame shall be extended to the next scheduled workday. As used in this section, "day" means calendar day.

A. An “Issue” is defined as the following:

1. A discrepancy or conflict between any requirements, instructions, interpretations, decisions or directives, issued by the Project Manager and the Contract Documents;

2. Error(s) or omission(s) in the Contract Documents;

3. A difference in site condition, whether subsurface or otherwise, from what was represented in the Contract Documents. Site conditions, which an experienced and prudent Contractor could have anticipated by visiting the site, familiarizing themselves with the local conditions under which the work is to be performed, and correlating observations with the requirements of the Contract Documents, shall not be considered as an “Issue” herein.

4. Any instruction, interpretation, or directive issued by the Project Manager resulting in acceleration or deceleration of the Contractor’s performance under the Contract Documents;

5. Any delay, regardless of cause, encountered by the Contractor; or

6. Any other matter or circumstance that the Contractor believes requires a change in the Contract Documents, time for performance or deadlines, or contract amount.

B. A “Dispute” is an Issue which the Contractor and the City have not been able to resolve in a timely manner.

C. The Contractor shall be barred from pursuing any administrative, equitable, or legal remedy, and shall be conclusively deemed to have waived all such disputes or objections, for any Issue when:

1. The Contractor did not bring the Issue to the City’s attention in writing within fourteen (14) days of the Contractor becoming aware of the Issue or within fourteen (14) days of when the Contractor should have become aware of the issue; or

2. The Contractor failed to continually (weekly or as otherwise approved by both Parties) work with the City toward a resolution.

D. The process set forth in this Section 303.10 Contractor Claims for Adjustment and Disputes of these Standards and Specifications shall be exhausted in its entirety prior to the initiation of any litigation. Failure to comply with the requirements set forth in this Section bars Contractor from any further administrative, equitable, or legal remedies.

1. Prerequisites to Commencing the Dispute Resolution Process.

a. Contractor Request for Adjustment.

i. If the Contractor encounters an Issue, the Contractor shall give the Project Manager written notice of the Issue and request an adjustment or change to the Contract Documents (“Request”) within fourteen (14) days of discovering the Issue necessitating a Request. For the purposes of this section, an e-mail to the assigned Project Manager will constitute written notice.

ii. The Request must contain the following information at the time it is submitted to the City. Failure to provide all the information listed below will result in an incomplete Request that will not be considered by the City.

1. Date at time of submission;
2. Request labeled with sequential numbering if Contractor is making multiple Requests
3. A complete description of the Issue, possible Contractor actions or solutions to minimize the costs of the Request, and an estimate of the adjustment in the contract time or contract amount, as applicable; and
4. All relevant documents and materials supporting the Request.

b. Contractor's Obligations.

i. Contractor shall permit the Project Manager to examine and copy records the Project Manager may deem necessary to determine the facts or contentions involved in the Request.

ii. Contractor shall keep full and complete records and other evidence and accounting principles and practices sufficient to reflect the costs and additional time incurred for any Request.

iii. The Contractor shall retain those records until there is a final resolution of the Request or subsequent Claim, or for three (3) years after acceptance of the project, whichever is longer.

iv. Following submission of a Request, the Contractor shall diligently continue performance of its obligations under the Contract Documents to the maximum extent possible.

v. Contractor shall work with the City to negotiate an acceptable resolution to the Request.

c. Project Manager's Duties.

i. The Project Manager will maintain a record composed of all written documentation comprising the Request until there is a final resolution of the Request, subsequent Claim, or Appeal pursuant to this Section 303.10.

ii. The Project Manager shall respond in writing to any timely Request within twenty-one (21) days of receipt of the complete and itemized Request. The Project Manager shall consider all documentation and materials provided by Contractor in support of its Request. The Project Manager may reject a Request if such Request is incomplete. A lack of response from the Project Manager within the prescribed twenty-one (21) day period shall be deemed a denial of the Request.

d. If the Project Manager and Contractor agree to an adjustment or change, the Project Manager shall facilitate an amendment to the Contract Documents in accordance with the Contract Documents and any other City Code requirements. An amendment is not effective and binding until it is executed by the Parties in writing.

e. If a Request is denied by the Project Manager, in whole or in part, and the Project Manager and Contractor are otherwise unable to reach an agreement, the Issue becomes a Dispute and Contractor may initiate the Dispute Resolution Process detailed below.

2. Dispute Resolution Process. To initiate the dispute resolution process, the Contractor shall provide written Notice of Claim to the City Engineer upon fourteen (14) days of the Project Manager's denial of the Request. Claims made pursuant to this Dispute Resolution Process will not be considered unless the Contractor has first complied with the prerequisites to commencing the dispute resolution process, as set forth in **Section 1** above.

   a. Contractor shall diligently continue performance of the Contract Documents during the Dispute Resolution Process to the maximum extent possible.

   b. Written Claim. The written Claim shall be clearly titled as "Claim" and dated at the time of submission. The Claim shall be sent via certified mail addressed to the City Engineer, at 2255 W. Berry Avenue, Littleton CO 80120. All Claim(s) shall be numbered sequentially. Such Claim shall contain, at a minimum, the following:

      i. Project title and number;
      ii. Date of the event giving rise to the Dispute;
      iii. A description of the Issue and the events giving rise to the Dispute, including the original Request and the Project Manager's decision or denial;
      iv. The reasons why the Contractor believes the Request is necessary;
      v. An accounting or estimate of all additional costs associated with the Request;
      vi. Information and any necessary documentation related to the claimed increase in Contract Time; Contractor's plan for mitigating costs or delays associated with the Request.

   d. c. Extension of Time to Submit Claim(s). The Contractor may request an extension of time to submit the Claim, which extension may be granted by the City Engineer, provided that good cause is shown. Contractor shall furnish, upon request, all additional information and data that the City Engineer determines is needed to aid in resolving the Claim through negotiation or is required to complete an evaluation of the Claim.

   e. The Contractor shall submit with its Claim a notarized certificate, executed under penalties of perjury, that:
      i. The Claim is made in good faith;
      ii. All supporting data are accurate and complete to the best of the Contractor's knowledge and belief;
      iii. The amount requested accurately reflects that Contract adjustment for which the Contractor believes the City is liable; and

iv. The prices stated for material and equipment are the lowest reasonably available to the Contractor and include all available discounts.

If the Contractor is an individual, the certification shall be executed by that individual; if the Contractor is not an individual, the certification shall be executed by an officer or general partner of the Contractor.

4. City Engineer Review. The City Engineer shall review the Claim and render a written decision to the Contractor to either affirm, overrule, or modify the Project Manager's decision, in whole or in part, in accordance with all Contract Documents and the following procedure:

   i. Within twenty-one (21) days after receipt of the Contractor's Claim, or receipt of all additional information requested by the City Engineer pursuant to subparagraph 2(c)(i) above, whichever is later, the City Engineer will meet with the Contractor and the Project Manager to discuss the merits of the Claim.

   ii. The City Engineer will consider all written documents provided with the Claim and any oral presentations in support of that record made by the Contractor or the Project Manager during the meeting following receipt of Contractor's Claim.

   iii. The City Engineer will render a written decision to the Contractor within forty-two (42) days from the meeting described in subparagraph 2(d)(i) above.

   iv. Contractor shall respond to the City Engineer's decision in writing within fourteen (14) days acknowledging receipt of the decision and indicating Contractor's denial or acceptance of the City Engineer's decision.

5. If the City Engineer fails to render a written decision to the Contractor within the specified forty-two (42) day time period, or within any extended time period as agreed by the parties, the Contractor must either:

   a. Accept this as a denial of the Claim, or
   b. Appeal the Claim to the Director of Public Works in accordance with subsection E below, in the same manner as if the City Engineer had denied the Contractor's Claim.

6. If the Contractor accepts the City Engineer's denial of the Claim, the Claim is resolved, and no further action will be taken. If the Contractor does not respond within fourteen (14) days, it will be assumed the Contractor has accepted the denial.

7. If the Contractor rejects the City Engineer's denial of the Claim or a satisfactory adjustment cannot be agreed upon within thirty (30) days of the City Engineers written decision, the Contractor may further pursue resolution of the Dispute by providing written notice of Contractor's appeal of the City Engineer's decision ("Notice of Appeal") to the Director of Public Works within fourteen (14) days, in accordance with subsection 3 below.

8. If the City Engineer overrules or modifies the Project Manager's decision, in whole or in part, and/or the Contractor and City Engineer are able to reach a satisfactory adjustment, then the City Engineer or Project Manager will facilitate an amendment to the Contract Documents in accordance with the Contract Documents and any other City Code requirements. An amendment is not effective and binding until it is executed by the Parties in writing.

E. Appeal to the Director of Public Works. Contractor shall submit its written Notice of Appeal to the Director of Public Works within fourteen (14) days of Contractor's receipt of the City Engineer's decision. The Notice of Appeal shall be clearly titled as "Notice of Appeal" and dated at the time of submission. The Notice of Appeal shall be sent via certified mail addressed to the Director of Public Works at 2255 W. Berry Avenue, Littleton CO 80120. Appeals will not be considered unless the Contractor has first complied with Section 1- Prerequisites to Commencing the Dispute Resolution Process, and with Section 2 – Dispute Resolution Process.

1. Contractor may request an extension of time in writing to submit the Notice of Appeal, which may be granted by the Director of Public Works, provided that good cause is shown. In no event will the extension of time exceed twenty-one (21) days.

2. Written Notice of Appeal. All Notices of Appeal shall be numbered sequentially. Such Notice of Appeal shall contain, at a minimum, the following:

   a. Project title and number;
   b. A copy of Contractor's Request to the Project Manager;
   c. A copy of the Project Manager's Written Decision, if available;
   d. A copy of Contractor's written Notice of Claim to City Engineer;
   e. A copy of the City Engineer's written decision on Contractor's Claim, if available;
   f. A copy of all documents previously provided to the Project Manager and the City Engineer in support of Contractor's Request; and
   g. An explanation of the basis for appealing the City Engineer's Decision, which shall describe the Claim in sufficient detail to allow the Director of Public Works to evaluate the basis of and costs associated with Contract's Claim.

3. Contractor shall diligently continue performance of the Contract Documents to the maximum extent possible while an appeal is pending pursuant to this section.
4. Director of Public Works Review. Within twenty-one (21) days after receipt of Contractor's Notice of Appeal, the Director of Public Works will meet with the Contractor and City Engineer to discuss the merits of the Appeal.
    a. During this meeting, Contractor will have an opportunity to present Contractor's Request and basis for appeal to the Director of Public Works. The City Engineer will have an opportunity to present on their written decision on Contractor's Claim.
    b. The Director of Public Works will not consider any written documents, other than clarification and data supporting previously submitted documentation, which has not previously been made available to the City Engineer and properly made a part of the record.
    c. The Director of Public Works will review the appeal and will render a final written decision to the Contractor. The Director of Public Works' decision shall constitute a final agency decision. Any final agency decision rendered pursuant to this provision may be appealed as set forth in Colorado Rules of Civil Procedure Rule 106(a)(4).

F. Waiver of Claims. Failure to strictly meet any of the requirements of this **Section 303.10** in a timely and complete manner shall constitute a waiver by the Contractor and shall bar Contractor from any further administrative, equitable, or legal remedy.

G. Costs and Attorney's Fees. In the event any suit or action is initiated to enforce the terms of the Contract Documents and/or the Standards and Specifications, should Littleton prevail, Littleton will be entitled to recover from the Contractor all of its reasonable costs and attorney's fees incurred in connection with the suit or action.

Section 303.11 Default of Contract

A. *Event of Default.* The occurrence of any one or more of the following shall constitute an "Event of Default" of the Contract Documents, for which the City may, at the City's option, terminate the Contract upon written notice to the Contractor:

1. The Contractor fails to start the Work on the date given in the Notice to Proceed, or the Contractor in any way abandons the Work;
2. The Contractor's progress is insufficient to complete the Work within the specified time;
3. The Contractor's willful or deliberate failure or violation to comply with any requirement of the Contract, including the Plans and Specifications and Special Provisions, or execution of Work by the Contractor in bad faith or otherwise not in accordance with its obligations;
4. The Contractor fails to maintain any required Bonds, licenses, permits, and/or insurance as required in the Contract;
5. The Contractor fails to promptly repair, replace or remove any defects in materials or Work or any defects in materials or Work of any other nature, the correction of which has been directed in writing by the Project Manager;
6. Substantial evidence of the Contractor's collusion for the purpose of illegally procuring a Contract or perpetrating fraud in the construction of Work;
7. The Contractor files a voluntary petition in bankruptcy if a receiver is appointed for the Contractor or any of its property, or the insolvency of the Contractor;
8. The Contractor allows any final judgment against it unsatisfied for a period of 10 (ten) days or longer, and makes an assignment for the benefit of creditors;
9. The Contractor or any of its officers or employees are convicted, plead nolo contendre, enter into a formal agreement in which they admit guilt, enter a plea of guilty, or otherwise admit culpability to criminal offenses of bribery, kickbacks, collusive bidding, bid-rigging, anti-trust, fraud, undue influence, theft, extortion, or any offense of similar nature, in connection with the Contractor's business;
10. Other just causes for termination as determined by the City.

B. *Written Notice.* The City shall provide the Contractor and Surety with written notice of the City's notice of default. The Contractor and/or Surety shall have 10 (ten) days from receipt of notice to cure any default or to provide to the City a detailed plan, in writing, of how the Contractor will cure the causes for termination listed within the written notice.

C. *City's Remedies.* If a satisfactory effort has not been made by the Contractor or its Surety to correct the default within the prescribed period in the notice, or, if in the judgment of the City, any submitted written plan does not ensure satisfactory performance of the work, the City shall have the right, at its election and without prejudice to any other remedies provided by law or equity, pursue one or more of the following remedies:

   a. The City may require the Contractor, within such reasonable time as may be fixed by the City, to complete or correct all or any part of the Work that is defective, damaged, flawed, unsuitable, nonconforming, or incomplete; to remove from the work site any such work; to accelerate all or any part of the work; and to take any or all other action necessary to bring the Contractor and the work into strict compliance with the Contract Documents and these Standards and Specifications.
   b. The City may perform or have performed all work necessary for the accomplishment of the Default and withhold or recover from the Contractor all the cost and expense, including attorneys' fees and administrative costs, incurred by the City in connection therewith.
   c. The City may accept the defective, damaged, flawed, unsuitable, nonconforming, incomplete, or dilatory work or part thereof and make an equitable reduction in the Contract Price.
   d. The City may terminate this Contract without liability for further payment of amounts due or to become due under the Contract Documents.
      i. Upon any termination of this Contract or of the Contractor's rights under this Contract in accordance with Sections 4.10 or 4.11 of the General Conditions, and at the City's option exercised in writing, any or all subcontracts and supplier contracts of the Contractor shall be deemed to be assigned to the City without any further action being required, but the City shall not thereby assume any obligation for payments due under such subcontracts and supplier contracts for any Work provided or performed prior to such assignment.
   e. The City may withhold from any progress or final payment, whether or not previously approved, or may recover from the Contractor any and all costs including attorneys' fees and administrative expenses, incurred by the City as the result of any Default or as a result of actions taken by the City in response to any Default.
   f. The City may recover any damages suffered by the City.

D. *City's Special Remedy for Delay*. If the work is not completed by the Contractor in full compliance with and as required by or pursuant to the Contract Documents, within the time as such time may be extended by Change Order, then the City may invoke its remedies herein or may, in the exercise of its sole and absolute discretion, permit the Contractor to complete the work but charge to the Contractor and deduct from any progress or final payments, whether or not previously approved, administrative

expenses and costs for each day completion of the work is delayed beyond the completion date, computed as set forth in the applicable liquidated damages provision, as well as any additional damages caused by such delay.

Section 304.00 Measurement and Basis of Payment

This section intentionally left blank.

Section 304.01 Measurement

All work completed under City contracts will be measured in place by the City Inspector, according to United States Customary System of Measurement, using methods generally recognized as conforming to good engineering practices and as specified herein.

Section 304.02 Modifications to Unit Costs

At the written direction of the City, items that are normally paid on a unit basis may be paid on a lump sum basis.

Section 304.03 Substitutions

Whenever a material, article or piece of equipment is identified on the drawings or specifications by reference to brand name or catalog number, it shall be understood that this is referenced for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality and function shall be considered. The Contractor may request, in writing, the substitution of a material, article, or piece of equipment of equal substance and function for those referred to in the Contract Documents by reference to brand name or catalog number within two (2) weeks of execution of the Contract Documents or a subsequent Change Order. If, in the sole opinion of the City, such material, article, or piece of equipment is of equal or superior substance and function to that specified, the City may approve its substitution and use by the Contractor. Any cost differential shall be deductible from the contract price and the Contract Documents shall be appropriately modified by Change Order.

The Contractor warrants that if substitutes are approved, no major changes in the function or general design of the project will result. Incidental changes or extra component parts required to accommodate the substitute will be made by the Contractor without a change in the Contract Price or Contract Time.

Section 304.04 Scope of Payment

Littleton will comply with C.R.S.§§ 24-91-101 through 24-91-110, Construction Contracts with Public Entities, as amended. Littleton shall pay Contractor for the Work requested by Littleton and performed by Contractor under the Contract Documents.

Payment to the Contractor on City projects will be made only for the actual quantities of Contract Items, as may be amended by Change Order, constructed and installed in accordance with the plans and specifications. Payment made at the contract unit price or lump sum amount bid shall be full compensation for furnishing all labor, materials, equipment, appurtenances, taxes, insurance, permits and incidentals necessary to complete the work as shown on the plans and as required by the specifications and acceptable manner and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the prosecution thereof.

Work or materials for which there are pay items, and which are to be paid separately will be included in the approximate quantities listed in the Bid Schedule. Each item, fixture, piece of equipment, etc., shall be complete in place, operational and accepted. Work or materials that are essential to the project but for which there are no pay items, will not be measured and paid for separately but shall be included in the project work. No additional payment, over the amount bid, will be made for related work to any item unless specifically called for in the Contract Documents, subsequent Change Order, or Contract Amendment.

Further, payment will not be made for materials wasted, rejected or placed outside of plan limit lines.

Payment from Littleton of the approved request will be due NET thirty (30) days, unless otherwise stated and agreed to by the parties in the Contract Documents.

Section 304.05 Progress Payments

Partial progress payments shall be made by the City to the Contractor for the percentage of the work completed, subject to inspection and approval by the Project Manager. The City shall determine when work has been completed, and progress payments shall not constitute a waiver of the City's right to require fulfillment of all terms of the Contract Documents and the delivery of all work contemplated within.

Once per month, as the work progresses, the Contractor shall submit an estimate of the value of the work performed and materials completed and in-place or delivered to the work site in accordance with the Contract Documents. Upon the Project Manager's request, the Contractor shall further furnish a detailed estimate of the total Contract Price, showing the amount included for each category of work, to provide a basis for determining the amount of progress payments. The market value of materials and equipment delivered to the work site, but not yet incorporated in the work, may, at the sole discretion of the City, be included in the progress payment. The market value of materials and equipment delivered to the work site(s), but not yet incorporated into the work, may, at the sole discretion of the City, be included with a progress payment. Payment by the City for such materials and equipment shall not relieve the Contractor of the responsibility for the care of such materials and equipment; the City shall not be deemed to have assumed ownership of the materials or equipment until incorporated into the completed and accepted Work. Such increases to progress payments, if authorized, are intended only to reduce the cost of doing business with the City.

The City shall retain from all progress payments an amount equal to all statutory claims filed against the Contractor pursuant to C.R.S. § 38-26-107. The estimates will be approximate only, and all partial or monthly estimates and payments shall be subject to correction in the estimate and payment rendered following discovery of an error in any previous estimates or payments. Should any defective work or material be discovered, or should a reasonable doubt arise as to the integrity of any part of the work completed previous to the final acceptance and payment, the costs shall be deducted from the first payment rendered after the discovery of such work an amount equal in value to the defective or questioned work, and this work will not be included in a subsequent estimate or payment until the defects have been remedied or the causes for doubt removed.

Further, and in accordance with C.R.S. § 24-91-103, where the Contract price exceeds one hundred fifty thousand dollars ($150,000.00), partial payments shall be authorized at the end of each calendar month, or as soon thereafter as practicable, to the Contractor upon satisfactory performance of the Contract. The City shall, from the total of the Contract estimate so ascertained, deduct an amount equivalent to five (5) percent of the whole, to be retained by the City until acceptance of the entire Contract and the balance of the sum equivalent to 95% (ninety-five percent) of the whole, shall be certified to by the Project Manager for payment.

Section 304.06 Deductions from Progress or Final Payment

Without prejudice to any of the City's rights and remedies as found in these standards and specifications, or the Contract Documents, the City have the right, at any time, to deduct and withhold from any progress or final payment, as outlined in Section 304.06 that may be or become due under the Contract Documents for the work, such amount as may reasonably appear to compensate the City for any actual or prospective loss due to one or more of the following:

i. Work that is defective, damaged, flawed, unsuitable, nonconforming, or incomplete;
ii. Claims or liens filed or reasonable evidence indicating probable filing of claims or liens from third-parties, regardless of merit;
iii. Failure of the Contractor to make payments properly and promptly to subcontractors for material or labor;
iv. Failure of the Contractor to complete any portion of the work in compliance with an approved schedule;
v. Reasonable evidence that the work cannot be completed for the unpaid balance of the Contract Price;
vi. Failure of the Contractor to submit on a timely basis, any documentation required by the Contract Documents, including without limitation, monthly reports, schedules, or request for approval of subcontractors;
vii. Unauthorized Work or deviations by the Contractor from the Contract Documents;
viii. Damage to the City or to another contractor;
ix. State or local sales, use, or excise taxes from which the City is exempt;
x. Any other failure of the Contractor to perform any of its obligations under the Contract Documents; or
xi. The cost to the City, including attorneys' fees and administrative costs, of correcting any of the aforesaid matters or exercising any one or more of the City's remedies set forth within the Contract Documents.

The City shall be entitled to retain any and all amounts withheld as outlined herein until the Contractor has either performed the obligations in question or furnished security for such performance satisfactory to the City. The City shall be entitled to apply any money withheld or any other money due to the Contractor under the Contract Documents to reimburse itself for any and all costs, expenses, losses, damages, liabilities, suits, judgments, awards, attorneys' fees and administrative expenses incurred, suffered, or sustained by the City and chargeable to Contractor under the Contract Documents.

Execution of the Contract Documents by the Contractor shall constitute waiver by the Contractor to claim any right of payment of interest upon any such retained funds, or to claim any right of payment of interest upon funds withheld under the provisions of C.R.S. § 38-26-107.

Section 304.07 Liens

A. *Title*. Nothing in the Contract Documents shall be construed as vesting in the Contractor any right of property in any equipment, materials, supplies, and other items provided under the Contract Documents after they have been installed in, incorporated into, attached to, or affixed to, the work or work site(s). All such equipment, materials, supplies, and other items shall, upon being so installed, incorporated, attached or affixed, become the property of the City, but such title shall not release the Contractor from its duty to insure and protect the work in accordance with the requirements of the Contract Documents.

B. *Waivers of Lien*. The Contractor shall, from time to time at the City's request and in any event prior to final payment request, furnish to the City such receipts, releases, affidavits, certificates, and other evidence as may be necessary to establish, to the reasonable satisfaction of the City, that no lien against the work or the public funds held by the City exists in favor of any person whatsoever for or by reason of any equipment, material, supplies, or other item furnished, labor performed, or other thing done in connection with the work or Contract Documents ("Lien"), and that no right to file any Lien exists in favor of any person whatsoever.

C. *Removal of Liens*. If at any time any notice of any Lien is filed, the Contractor shall, promptly and without charge, discharge, remove, or otherwise dispose of such Lien. Until such discharge, removal, or disposition, the City shall have the right to retain from any money payable hereunder an amount that the City, in its sole judgment, deems necessary to satisfy such Lien and to pay the costs and expenses, including attorneys' fees and administrative expenses, of any actions brought in connection therewith or by reason thereof.

D. *Protection of City Only*. This Section shall not operate to relieve a Contractor's surety(ies) from any of their obligations under payment or performance bond(s), nor shall it be deemed to vest any right, interest, or entitlement in any subcontractor or supplier. The City's retention of funds shall be deemed solely for the protection of its own interests pending removal of such Liens by the Contractor, and the City shall have no obligation to apply such funds to such removal but may, nevertheless, do so where the City's interests would thereby be served.

Section 304.08 Initial Warranty

Upon receipt of an approved designated semifinal estimate ("punch list"), as prepared by the City, the Contractor shall, in writing, request the City to make an initial warranty acceptance inspection in preparation for probationary acceptance of the work by the City. The City, upon receipt of written request for the initial warranty acceptance inspection, shall promptly make said inspection of the work and issue to the Contractor a written punch list advising the Contractor of any deficiencies, corrective measures or clean up that must be completed prior to preparation of the final payment request and probationary acceptance of the work.

Section 304.09 Final Payment Request, Acceptance and Release

Upon completion of the work on City projects and final cleanup of the project site, the City, within fourteen (14) calendar days thereafter shall:

A. Review the final payment request prepared by the Contractor that shows the total value of the work completed in accordance with the Contract Documents and as modified by any Change Orders, less the value of:

   1. Partial progress payments previously made by the City to the Contractor.
   2. Retention of any claims, on file with the City against the Contractor.
   3. Estimated costs of completing any incomplete or unsatisfactory items of the Work.
   4. Payments advanced by the City, to subcontractors, material and equipment suppliers or others which are known by the Contractor to have been made but not previously accounted for.
   5. Liquidated damages not previously paid to the City by the Contractor.

B. Advise the Contractor by written notice that:

   1. The work has been inspected and accepted by the City under the conditions of the Contract Documents.
   2. The work, effective the date of the notice, is placed under probationary acceptance, at the Contractor's expense, for a period of two (2) years.
   3. The entire balance shown on the final payment request, as prepared by the City, is due and payable within thirty (30) calendar days from date of approval thereof by the Contractor.

The Contractor shall, at the City's request, furnish satisfactory evidence that all obligations of the nature designated above have been paid, discharged or waived. If the Contractor fails to do so, the City may, after having notified the Contractor, withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged, in accordance with the terms of the contract documents, but in no event shall the provisions of this sentence be construed to impose any obligations upon the Owner to either the Contractor, their surety, or any third party. Such funds shall not be withheld longer than ninety (90) days following the date fixed for final settlement as published unless an action is commenced within that time to enforce such unpaid claim and a notice of lis pendens is filed with the City.

At the expiration of such ninety-day period, the City shall pay to the contractor such moneys and funds as are not the subject of suit and lis pendens notices and shall retain thereafter, subject to the final outcome thereof, only sufficient funds to insure the payment of judgments which may result from such suit. Failure on the part of a claimant to comply with the provisions of C.R.S. § 38-26-101 -38-26-106, as amended, and this section shall relieve the City from any liability for making payment to the contractor.

The acceptance of the Contractor of the final payment shall operate and shall be a release of the City from all claims for liability arising from the performance of the work under the Contract Documents, excepting any claims that may arise during any applicable warranty period(s).

Section 305.00 Project Facilities

Measurement: (Each) - Shall comply with and paid in accordance with CDOT Section 620

Section 306.00 Mobilization

Measurement: (Lump Sum) – Shall be paid in accordance with CDOT Section 626.02

Section 307.00 Equipment Rental

Items: Backhoe, Dragline, Dozer, Front End Loader, Lo-Boy, Patrol Pump, Roller, Truck, etc.

Measurement: (Hour) - The quantity to be measured will be the number of hours or fraction thereof that the Bid Schedule specified piece of equipment is used, as directed.

Payment: The actual number of hours the specified piece of equipment is used will be paid for at the contract hourly rate bid. No measurement or payment will be made for labor, mobilization, time equipment is mechanically inoperative, attachments, piping, discharge lines, channelization, excavation, backfill, grading, etc., but shall be included in the work.

NOTE: Hourly rates shall not exceed the hourly rates recognized by the Colorado Department of Transportation plus one point three five (1.35) times the operator's hourly rate.

Section 308.00 Transplanting Plants, Shrubs, Trees

Measurement: (Each) - The quantity of transplanting to be measured will be the actual number of plants of the various types transplanted and accepted in their final location and in healthy condition at the end of a ninety (90) day maintenance period.

Payment: The accepted quantities of the various plants transplanted, as specified in the Bid Schedule, will be paid for at the contract unit price bid. No separate measurement or payment will be made for digging, balling, spraying, debudding, pruning, transporting, fertilizing, watering and maintaining, but shall be included in the work.

NOTE: As part of payment and not to be considered an additional item for payment, the contractor shall submit a watering plan to extend through the two-year warranty period. The City shall give final acceptance of the trees at the end of this period.

Section 309.00 Stormwater Protection and Erosion Control During Construction

Measurement and Payment: - Shall comply with and paid in accordance with CDOT Section 620, unless otherwise specified in the Contract Specifications or Bid Schedule.

NOTE: If specified that the Measurement is Lump Sum, projects that extend beyond three months, and as allowed by the city, maintenance measures may be paid at periodic intervals for erosion control.

Section 310.00 Trenching, Backfilling, and Compacting

Section 310.01 Asphalt Patching

Items: Base course, asphalt

Payment: Accepted quantities of trench resurfacing will be paid for at the respective contract unit price bid. A separate line item and accepted quantities for cutback and patch will be paid for at the

respective contract unit price bid. The quantity will be limited to the width of cutback approved by the City, and in compliance with OSHA cutback specifications. No separate measurement or payment will be made for wetting and compacting trench backfill, subgrade densification and shaping, vertical trueing of existing surface along each side of the trench, placing materials outside the established prism limits, tacking existing surface edges, traffic control, etc., but shall be included in the work.

Measurement: (Ton) - Measurement of the patching material will be per the recorded value on the material tickets and verified against the calculated quantity established by the engineer.

Section 310.02 Materials for Bedding, Backfill, etc.

Items: Bed course, filter media, select and/or structural backfill, special backfill

Measurement: (Cubic Yard) - Measurement of select materials called for in the Bid Schedule shall be computed between horizontal and vertical neat lines and planes.

A. Circular Conduits: Calculated volume between:

   1. Vertical planes perpendicular to the conduit centerline between stations shown on the drawings or as directed; and between
   2. Vertical planes each side and parallel with the conduit centerline. The spacing between the planes shall not exceed three (3) feet plus the outside diameter of the conduit in feet for trenches over five (5) feet deep and shall not exceed two (2) feet plus the outside diameter of the conduit in feet for trenches less than five (5) feet deep, and between
   3. Two (2) horizontal planes, one being one (1) foot above and parallel with the outside crown of the conduit and one at base course subgrade or at finish grade, whichever is the lower in elevation.

B. Bedding Material: Calculated volume of material lying within the prism shown on the Standard Detail Drawings or construction plans. Except no measurement will be made for trench rock stabilization or conduit bedding material installed below a horizontal plane located one (1) foot above the conduit crown centerline.

C. Bridges and Irregular Shaped Structures: Calculated volume to vertical neat lines one and one-half (1 ½) feet outside and parallel to the outline of the foundation plan and between horizontal planes at elevation limits shown on the drawings or as directed.

Payment: Accepted quantities of select materials will be paid for at the contract unit price bid for the items as they appear in the Bid Schedule. No separate measurement or payment will be made for material royalties, haul, dewatering, compaction, etc., but shall be included in the work.

NOTE: Cost of trench dewatering, disposal of surplus material, trench stabilization, conduit bedding below and to the elevation specified in the Contract Documents shall be in the contract unit price bid for the conduit or pipe in place.

Section 311.00 Water, Sewer, and Storm Facilities

The City of Littleton is not a water service provider. Sanitary Sewer Service shall be in accordance with Section 500 of these Standards and Specifications. Refer to the SDCM, most current edition.

Section 312.00 Reset, Relocate, Reconnect Adjust

Items: Barricade, fence, gate, mailbox, manhole barrel, cover, cone, flat top, ring or steps; pipe, pole, structures; sewer service; traffic devices; water meters, services and valves.

Measurement: (Each) (Lineal Feet) (Square Yards) - The quantity to be measured shall be the actual number, length or area of the various items removed, stored, reconnected, relocated, adjusted and reset to service, when specified on the Bid Schedule.

Payment: The accepted quantities of item reset to service will be paid for at the applicable contract unit price bid. No separate measurement or payment will be made for work related materials necessary to reset the item to service; such as posts, hardware, wire, mailbox, excavation, backfill, concrete, rewiring, bedding, joint material, collars, connecting bands; but shall be included in the work.

Section 313.00 Flow Control, Special Fittings and Measure Devices or Systems

Items: Meters, pumps, special fittings and valves; flumes, drain and head gates; recorders, totalizers, telemetry and electrical systems. NOTE: Fire hydrants are excluded.

Measurement: (Each) - The actual number of the various devices or systems specified in the Bid Schedule installed and accepted.

Payment: The accepted number of flow control, special fittings and measuring devices or systems will be paid for at the contract unit price bid. No separate payment will be made for excavation, dewatering, bedding, in line fittings and connectors, supports, riser guides and extension, valve box with covers, backfill, grading, mounting brackets, electrical conduit, wire etc., but shall be included in the work.

Section 314.00 Fire Hydrants

Measurement: (Each) - Actual number of five and one quarter (5¼) inch three-way fire hydrants installed to grade, including any fire hydrant extensions required.

Payment: The accepted number of fire hydrants will be paid for at the contract unit price bid. No separate measurement or payment will be made for excavation, dewatering, six (6) inch flanged gate valve with box and cover at main, hydrant extensions, bedding, six (6) inch PVC AWWA C900 CL 200 or AWWA C909 CL 150 lateral pipe, gravel underdrain, tie rods, shackle, tape wrapping, concrete anchor block, backfill, grading, etc., but shall be included in the work.

Section 315.00 Piping in Vaults

Measurement: (Lump Sum) - No separate measurement will be made of Piping installed in vaults or within three (3) feet of the vault exterior surface.

NOTE: In line valves, meters, telemetry and electrical systems will be measured and paid for separately as called for in the Bid Schedule.

Payment: - Accepted in vault piping will be paid for at the contract unit price bid. No separate measurement or payment will be made for the various types, sizes or length of pipe and fittings

required, tie-rods, corporation stop, gauges, pipe and device supports, structural steel, steel plates, hardware, gaskets, tubing, insulating and joint bonding material, tape wrapping, gasket and outlet sealants, vents, conduit, etc., but shall be included in the work.

Section 316.00 Casing Pipe – Jacking or Boring

Measurement: (Lineal Feet) – The quantity of casing pipe, according to the type and size called for in the Bid Schedule, will be measured along the pipe centerline between the limits designated on the plans or as directed.

Payment: Accepted quantity of casing pipe will be paid for at the contract unit price bid. No separate measurement or payment will be made for special insurance, excavation, pit sheeting and shoring, dewatering, pressure grouting, skids, chucks, stulls, stringing and anchoring carrier pipe, furnishing and installing sand in voids between the carrier and casing pipe if required, bulkheads, cathodic protection (thirty-two (32) pound anode bags), backfill, disposal of surplus material, etc., but shall be included in the work.

> NOTE: The length of carrier pipe will be paid for separately from the applicable contract unit price bid for pipe, installed through the casing.

Section 317.00 Pipelines and Utility Trenches

Items: Drainage, sanitary sewer and water lines; sanitary and water service lines; irrigation, siphon, underdrain and vent lines.

> NOTE: Fire hydrant laterals and flared end treatments are excluded.

Measurement: (Lineal Feet) – Pipe of the various types, classes and sizes called for in the Bid Schedule will be measured by the lineal foot along the in-place pipe centerline, between points of connection with existing facilities or extremities specified on the plans.

> NOTE: Deduction in measured quantities will be made for piping in vaults and pipe at manholes and structures where the concrete inverts are cast in place and shaped. No deduction in measured length will be made for in line fittings and valves.

Payment: - Accepted quantities of pipe will be paid for at the contract unit price bid. No separate measurement or payment will be made for excavation, dewatering, trench stabilization material, bedding material, in line fittings and connectors, tape wrapping, gasket and joint materials, all thread ties, joint restraints, concrete anchor blocks, clay trench and inversion plugs, backfill, disposal of surplus materials, etc., but shall be included in the work.

Section 317.01 Cathodic Protection Devices and Systems

A. Items: Anode Field, Conductors, Controller, Deepwell Anode System, Rectifier, Submerged Anode System, Test Station.

B. Measurement: (Each) (Lump Sum) – Cathodic protection will be measured by the actual number of the various devices and/or systems, specified on the Bid Schedule, installed.

C. Payment: Accepted quantities of the cathodic protection devices and systems will be paid for at the contract unit price bid. No separate measurement or payment will be made for excavation, drilling, dewatering, Caldwell thermite bonding, insulating, ridged conduit, wire, reference electrodes, ground rod, junction box, backfill, energizing, testing, training owner's personnel in operating the system, retesting, etc., but shall be included in the work.

Section 317.02 Connections to Existing Facilities

A. Items: Inlet, manhole, and pipe connections.

B. Measurement: (Each) - The quantity to be measured shall be the actual number of connections made between a new installation and an existing facility.

C. Payment: Accepted number of connections made to an existing facility will be paid for at the contract unit price bid. No separate measurement or payment will be made for connecting to water taps made by City crews, excavation, dewatering, tapping, cutting, chipping, drilling; furnish and installing; fittings, tie-rods, anchor blocks, tape wrapping, jointing material, gasket sealants, reshaping manhole inverts, backfill, etc., but shall be included in the work.

Section 317.03 Pipeline Inspection and / or Cleaning

A. Items: Root removal, scouring, television inspection.

B. Measurement: (Lineal Foot) - The actual number of lineal feet of pipe requiring root removal, inspected and/or scoured, measured along the pipe centerline between consecutive manholes, to the limits specified in the Contract Documents or as directed.

C. Payment: Accepted quantities of line inspected and/or scoured, as called for in the Bid Schedule, will be paid for at the contract unit price bid. No separate measurement or payment will be made for flow diversion or control; equipment set ups, film, traffic control, collecting data and reporting location of line failures; removal and offsite disposal of purged solids; repair of service lines damaged in performing the work etc., but shall be included in the work.

Section 317.04 Pipe Joint Rehabilitation

A. Items: Joint testing, joint sealing, proof testing.

B. Measurement: (Each) - The actual number of pipe joints tested and/or sealed of the various pipe sizes called for in the Bid Schedule.

C. Payment: Accepted quantities of joints tested and/or sealed will be paid for at the contract unit price bid. No separate measurement or payment will be made for flow diversion or control, equipment set ups, retests of joints sealed, traffic control, etc., but shall be included in the work.

Section 317.05 Pipe Joint Repair

A. Measurement: (Each) - The actual number of point repairs made, in which thirteen and one-half (13 ½) feet or less of new equivalent size pipe is installed.

B. Payment: Accepted quantities of point repairs made, of the various sizes of pipe specified in the Bid Schedule, will be paid for at the contract unit price bid. No separate measurement or payment will be made for mobilization, traffic control, excavation, trench shoring, dewatering, flow diversion or control, service line reconnects, watertight couplings or fittings, locating and protecting other utilities, bedding and backfill placement and compaction, disposal of waste and surplus materials, etc., but shall be included in the work.

Section 317.06 Pipe Slipliner

A. Items: Access pits, service reconnects, sliplining.

B. Measurement: (Lineal Feet) (Each) - In place slipliner, of the various thickness and sizes called for in the Contract Documents, will be measured along the pipe centerline, between points of reconnects. Measurement of the access pits and service line reconnects will be the actual number of access pits for insertion and/or service connections made to the in-place liner pipe.

C. Payment: The accepted number of lineal feet of slipliner pipe installed and/or the number of designated access pits or service reconnects made will be paid for at the respective contract unit price bid, therefore. No separate measurement or payment will be made for mobilization, traffic control, excavation, manhole rehabilitation, flow diversion and/or control, shoring, power, thermal jointing, cement stabilized sand, circle seal clamps, sealing at manholes, saddles, gaskets, backfill, disposal of surplus material, restoration of property, etc., but shall be included in the work.

Section 317.07 Removal and Disposal of Asbestos-Cement (AC) Pipe

A. Measurement: (Lineal Feet) - Measurement shall be based on the proper removal and disposal of the actual number of lineal feet of AC pipe encountered on the project that is required to be removed in order to complete the work. Removal of AC pipe is considered to be a Class II Asbestos removal according to OSHA standards. Contractor shall be responsible for following the regulations and procedures carefully and proceeding accordingly. Contractor may consider having a certified asbestos removal contractor perform this part of the work as a subcontractor.

B. Contractor shall also be responsible for following any of the Colorado Department of Public Health and Environment's (CDPHE) Asbestos Regulations or Jefferson County Health Department standards that apply to AC pipe removal. Should Contractor engage a certified asbestos removal contractor to perform this work, Contractor shall ensure the subcontractor follows all regulations and procedures established by OSH, CDPHE, or the Jefferson County Health Department pertaining to AC pipe removal.

C. Payment: "Removal and disposal of AC pipe will be paid for at the contract unit bid price. No separate payment will be made for complete removal and disposal of the AC pipe in accordance with applicable OSHA standards, CDPHE standards and Jefferson County Health Department standards, or for additional costs involved for removal and disposal of AC pipe, but shall be included in the work.

SECTION 400 SOILS AND EARTHWORK

Section 400.00 Contractor Responsibilities

The Contractor shall be responsible to be fully informed of and shall comply with all sections of these Standards and Specifications, applicable laws, ordinances, rules, regulations and orders of the city, county, state, federal or public bodies having jurisdiction affecting the work. The Contractor shall perform their due diligence to ensure they have applied for and are in compliance with all permits required to perform site work, including a city ROW and grading permit.

Section 401.00 Scope

Site work shall consist of demolition, removal, and abandonment; clearing and grubbing; over lot grading; removal of topsoil; site preparation; installation and maintenance of erosion and sedimentation control measures; embankment subgrade preparation; embankment fill; excavation, trenching, bedding and backfill of pipelines and service lines; excess excavation; structure backfill; roadway excavation, backfill and compaction; borrow; dredging; and restoration and cleanup. All site work and earthwork shall comply with the requirements of these Standards and Specifications and any special criteria established by the City. Site work shall be completed as shown on the approved engineering plans. All workmanship and materials shall be in accordance with the requirements of these Standards and Specifications and shall conform to the lines, grades, quantities, and the typical cross-sections shown on the approved plans, or as directed by the City.

Section 402.00 Inspections, Observations and Testing

Materials testing shall be performed by a qualified geotechnical technician working under the direction of a Colorado Registered Professional Engineer and shall be paid for by the developer on private projects. Quality control testing will be performed and/or paid for by the Contractor on City projects unless otherwise noted in the Special Conditions for the project. The City will provide quality assurance testing as determined by the City Engineer. Reference Section 120.00 Quality Assurance and Quality Control of these Standards and Specifications. All quality control reports must be received and approved by the City prior to Initial Acceptance.

The Contractor shall provide access for all City employees or delegates throughout the earthwork process for observation and testing purposes. The developer shall provide for full-time observation of all embankment fill, over-excavation and re-compaction, and backfill placement by the certified materials testing agency. The Contractor shall not proceed with work until the certified materials Testing Agency is on site for observation and testing, unless approved by the City.

Section 403.00 Qualifications for Testing Agencies

Testing Agencies working in the City of Littleton shall certify annually to the City Engineering Department that they comply, as appropriate, with each of the requirements of:

1. American Society for Testing and Materials (ASTM), Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation, Designation C1077-06
2. American Society for Testing and Materials (ASTM), Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction, Designation D3740-01

3. American Society for Testing and Materials (ASTM), Standard Practice for Certification of Personnel Engaged in the Testing of Soil and Rock, Designation D5255-01
4. American Society for Testing and Materials (ASTM), Standard Specification for Agencies Engaged in Construction Inspection, Testing, and Special Inspection, Designation E329 - 11b

As an alternative to the above qualifications, the Testing Agency may also qualify by providing AASHTO Lab Accreditation, as per Colorado Procedure 10 (CP10), as outlined by CDOT in the Field Materials Manual. Any Testing Agency contracted as part of a Local Agency Grant Project must comply with CP10 and possess current AASHTO Lab Certifications.

The Testing Agencies' submittal shall include, at a minimum, the inspection certificate of the Testing Agency, within the last two (2) years, by a third party such as the American Association for Laboratory Accreditation, the National Voluntary Laboratory Accreditation Program or the Cement and Concrete Reference Laboratory, as appropriate; and a copy of the Testing Agencies Quality Assurance Program.

The person responsible for and is in direct supervision of all the Quality Control testing shall be a Registered Professional Engineer in the State of Colorado and practicing in the field. Technician conducting inspections, taking samples and performing tests must possess one or more of the following qualifications:

- Technicians conducting soil and material testing inspection, compaction testing, or collecting samples for laboratory testing must have a WAQTC or CDOT/LabCAT Certificate and Level II or higher NICET certificate in each area.
- Technicians conducting pavement inspections, taking asphalt samples, conducting asphalt content tests, conducting gradation tests or asphalt compaction tests and
- determining asphalt volumetric and strength characteristics must have the following certifications from LabCAT or equivalent.
- Certification A - Laydown
- Certification B - Plant Materials Control
- Certification C - Volumetrics & Stability
- Certification E - Aggregates
- Certification I - Asphalt Inspector
- Technicians taking concrete samples and conducting field tests must have a Field certification from ACI or equivalent.
- Technicians conducting test of Portland Cement Concrete for compressive strength shall be an ACI Level I or equivalent certified technician
- Technicians conducting tests of Portland Cement Concrete for flexural strength and determine mixture design characteristics shall be an ACI Level I or equivalent.

Section 404.00 Minimum Testing Requirements

All materials and operations shall be tested in accordance with these Specifications and as directed by the City. Agencies testing soil and rock shall meet the requirements of ASTM D 3740. All testing agencies shall meet the requirements of ASTM E 329.

A trained and properly qualified representative of the testing agency shall observe, sample and test the materials and work on all projects. If any materials furnished or the work performed by the Contractor fails to meet the Specifications, such deficiencies shall be reported to the Engineering Inspector immediately. Preliminary written field reports and/or test results shall be given to the Engineering Inspector immediately after they are performed. Final reports shall be forwarded to the Engineering Inspector no later than one week following the testing.

Results of all tests, including failing tests, shall be reported. When the work fails to pass tests or meet Specifications, additional tests shall be taken as directed by the City. All testing and retesting services shall be at the expense of the Contractor or Developer except for City projects where the cost of testing will be covered by the City unless otherwise noted in the Special Conditions for a City project. Testing agency personnel are not authorized to stop work or to alter, relax or release any requirements of these Specifications, or to approve, accept or reject any portion of the work.

Reports shall bear the signature of a Professional Engineer registered in the State of Colorado and competent in the required testing practice. All test reports must show the location of the test and include all information specified in the AASHTO or ASTM test procedure used. All test reports shall be attached to a written declaration letter signed by a Professional Engineer on behalf of the private engineering or geotechnical firm stating that the test results and frequency were in general compliance with the plans and specifications.

The use of a testing agency's services does not relieve the Contractor of the responsibility to furnish the required materials and to perform the required construction in full compliance with the Specifications. Passing test results do not constitute acceptance of the work or materials represented by the test. The Contractor is solely responsible for quality control of the work.

All subgrade test results including trench compaction, subgrade preparation and stabilization etc. on private developer projects and on City projects must be submitted to the City for approval prior to placement of any asphalt or surface concrete.

Section 405.00 Minimum Materials Testing Frequencies

Table 405.01 – Minimum Material Testing Requirements

Fill/Backfill			
Materials	**AASHTO**	**ASTM**	**Minimum Frequency of Tests**
Gradation	T27 & T11	C136	One Test per Soil Type
Atterberg Limits	T89 & T 90	D4318	One Test per Soil Type
Liquid Limits, Plastic Limit & Plasticity Index of Soil (Atterberg Limits)	T89 & T 90	D4318	One per Source
Moisture-Density Curve	T99 / T180	D698 / D1557	One Test per Soil Type
Moisture-Density Relations of Soils (Proctor)	T99 / T180	CP23	One Test per Soil Type

In Place Density - Nuclear	T238 / T239	D2922 / D3017	Utility Trenches – One (1) Test per two-hundred fifty (250') feet per six (6") inch Vertical Lift - Test Points Staggered so as not to Align on Top of the Test Below Minium of three (3) Tests per Day Minimum one (1) Test per 6 inches of Vertical Lift per Service Line. Vertical Structures – maintenance holes, Inlets, Fire Hydrants, & Valve Boxes – One (1) Test per six (6") inch Vertical Life -
Proof Rolling			All Subgrade and Base Courses
Aggregate Base Course			
Gradation	T27 & T11	C136	One Test per Every 500 Tons or Fraction Thereof
Atterberg Limits	T89 & T 90	D4318	One Test per Every 500 Tons or Fraction Thereof
Moisture-Density Curve	T180	D1557	One Test per Class
In Place Density	T238 & T239	N/A	One (1) Test per Every two hundred (200') feet per six (6") inch Vertical Lift
Thickness	N/A	N/A	One (1) Test per Every two hundred (200') feet per six (6") inch Vertical Lift
Proof Rolling	N/A	N/A	Final Lift – Within 24 hours of Paving

Section 406.00 Demolition, Removal and Abandonment

The Contractor will be held responsible to ensure the protection of all existing public and private improvements, including but not limited to fire hydrants, streetlights, traffic lights, parking meters, traffic signs, catch basins, manholes, valves, survey monuments, overhead utility lines and poles, and any existing underground sprinkler or utility lines which may be damaged during the execution of the City contract or developer project. It will be the Contractor's responsibility to replace all public improvements so damaged at their own expense. Existing manhole rings and covers, valve boxes and sprinkler heads found defective shall be replaced, as directed by the City Inspector.

The Contractor shall take proper precautions for the protection of and replacement or restoration of driveway culverts, street intersection culverts or aprons, storm drains or inlets, fences, irrigation ditches crossings and diversion boxes, mailboxes, shrubbery, flowers, ornamental trees, driveway approaches and all other public or private installations that may be encountered during the

performance of work. The Contractor shall provide each property with access at all times during construction. Existing driveways shall be cut, filled and graded as required or as directed by the City Inspector to provide permanent access. Existing driveways shall be resurfaced with the then existing type of surfacing whenever surfaces are destroyed.

Adequate erosion and sediment control measures will be installed prior to any demolition or site work commencement. A Grading Permit (erosion control permit) as per the Littleton SDCM may be required by the Littleton SDCM. A State Construction Stormwater Discharge Permit will be required for disturbance of an acre or more. Site shall achieve final stabilization prior to permit closure.

Before starting demolition of any structure, the Contractor shall obtain a Residential or Commercial demolition permit and appropriate Right-of-Way, floodplain and Grading permits, as applicable, for the disconnection of all utility service connections, such as water, sewer, cable TV, telephone, gas and electrical power connected thereto. Disconnects shall be made in accordance with the regulations of the utility that controls the supply of service involved.

Underground services are to be cut, capped and marked at the main to facilitate future location of the line. Caps of underground storm and sanitary sewer shall consist of a plug being placed in the line and the opening then sealed with concrete. Markings at the end of the line shall consist of a 4 x 4 wooden stake or metal fence post driven into the ground and then tagged to note the type of facility.

The City Inspector will coordinate with City staff to ensure a representative will be on site to observe and approve the Contractor's disconnect of the water and sewer services at the main line. It shall also be the responsibility of the Contractor to backfill all holes to finished grade and install concrete or asphalt surfacing when the holes excavated are in streets or paved areas. The Contractor shall correct any unsatisfactory disconnects.

Prior to the start of demolition or construction, any public survey monument or range box that may be disturbed during construction shall be referenced to a minimum of two (2) points outside the limits of construction by a Colorado Professional Land Surveyor. Any public survey monument or range box disturbed as a result of construction shall be replaced by a Colorado Professional Land Surveyor in accordance with the current Colorado Revised Statutes.

The Contractor shall remove—wholly or in part—and satisfactorily dispose of all foundations, signs, structures, fences, old pavements, abandoned pipelines, traffic control device materials and any other obstructions which are not designated on the approved plans or allowed to remain.

Utilities and other items for which other provisions have been made for removal shall follow demolition, removal and abandonment procedures in compliance with Section 8-1-3 of the City Code. Removal of sign panels shall include all work necessary to remove the panel and attachment hardware from the existing installation. Concrete sign post bases shall be removed. Pedestals and bases shall be removed to a minimum of three (3) feet below the surrounding ground or subgrade and backfilled with suitable material.

Dust suppression is required for all demolition that may create nuisance conditions. Control measures should be implemented to limit discharge into any inlet, ditch, swale, or waterway.

Where portions of structures shall be removed, the remaining parts shall be prepared to accommodate new construction. The work shall be performed in such a manner that materials left in place shall be protected from damage. All damage to portions of structures to remain shall be

repaired at the Contractor's expense. Reinforcing steel that projects from a structure to remain shall be cleaned and aligned to provide an adequate bond with new construction. Dowels shall be securely grouted with an approved grout. Depressions which result from removal of structures, footings, and other obstructions, shall be filled and compacted with clean structural fill materials or an approved Controlled Low-Strength Material (CLSM) or "flowable fill" or "flash fill") mixture so as to eliminate hazards such as cave-in or accumulation and ponding of water.

Materials used for traffic detour structures supplied by the Contractor shall be the property of the Contractor. After the detour is abandoned, the Contractor shall completely remove the traffic detour structure materials and disposal of materials shall comply with Section 431.00 Restoration and Cleanup of these Standards and Specifications.

After all demolition, removal and abandonment work is complete, the Contractor shall grade the entire contract area by properly filling, compacting, and leveling the site to existing adjacent grades or to lines and grades shown on the approved plans.

Measurement: (Each) (Lump Sum) - Demolition will be measured as the number of locations where structures have been razed or removed and area properly graded and accepted.

Payment: Accepted areas on which demolition has been performed will be paid for at the contract amount bid for the specified location. No separate measurement or payment will be made for: clearing and grubbing, removal of buildings, foundation, basement slabs, cesspool, privies, buried fuel and septic tanks, wells, well casing, slabs on grade; disconnect and protection of public utilities or improvements; hauling and disposal of rubble, furnishing, hauling, placing, compacting fill and grading the area to drain; protection of facilities designated to remain, but shall be included in the work.

Section 407.00 Bridges, Culverts and Other Drainage Structures

Bridges, culverts, and other drainage structures in use by traffic shall not be removed until a Traffic Control Plan has been approved by the Traffic Engineer. Refer to Section 131.00 Traffic Control, Barricades, and Warning Signs of these Standards and Specifications. If a structure is proposed to be removed with the use of a crane or by other aerial methods, the contractor shall provide a pick plan, illustrating the means, methods and protections the contractor will employ to perform the work in a safe method.

Unless otherwise directed, the foundations or substructures of existing structures shall be removed down to three (3) feet below natural ground surface or bottom of drainageway. Where such portions of existing structures lie wholly or in part within the limits of a new structure, they shall be removed as necessary to accommodate construction of the proposed structure. Steel, concrete, and wood bridges shall be dismantled. Steel members to be salvaged shall be match-marked by the City or the Contractor with waterproof paint.

Any work within Jurisdictional Waters of the US must have an applicable Army Corps of Engineers Permit (see Section 126.02) and/or a Floodplain Permit (see Section 151.00) of these Standards and Specifications.

Section 408.00 Pipe and Appurtenances

All pipe and appurtenances to be taken out of service shall be completely removed as specified below:

1. Water Lines – The City of Littleton is not a water service provider; abandonment shall be in accordance with governing jurisdiction standards.
2. Fire Service (mainline tee or swivel tee) – The City of Littleton is not a water service provider; abandonment shall be in accordance with governing jurisdiction standards.
3. Main Lines - In accordance with Section 600 for sanitary sewer main and 700 for storm sewer main.
4. Sanitary Sewer Service – In accordance with Section 600.
5. Gas Services – The City of Littleton is not a gas service provider; abandonment shall be in accordance with governing jurisdiction standards.
6. Electric Services – The City of Littleton is not an electric service provider; abandonment shall be in accordance with governing jurisdiction standards.

For all pipe and appurtenances located within the Rights-of-Way or easement that the City is a party to that are to be taken out of service are to be completely removed with services line abandoned at the main.

Existing pipe cannot be removed and reused.

Excavation required to remove pipe or appurtenances shall be backfilled and compacted in accordance with Section 424.00 Trenching, Backfilling and Compacting of these Standards and Specifications

When removing appurtenances such as manholes, catch basins, inlets etc., any live lines connected to these appurtenances shall be properly bypassed and shall remain in operation until abandonment is complete.

When appurtenances are to be abandoned in place, the remaining structure shall be lowered to a minimum of three (3) feet below finished grade and shall be filled with concrete with a minimum compressive strength of three thousand (3000) psi (at 28 days) to the top of the remaining structure and then backfilled and compacted to the required grades.

Section 409.00 Pavement and Concrete Flatwork

All concrete or asphalt to remain shall have a straight, true break line and a vertical face. Concrete or asphalt may be cut with a cutting wheel or saw. The City may require that saw-cutting be performed. All concrete removal shall be to the nearest joint. Any damage to adjacent concrete or asphalt to remain in place shall be repaired at the Contractor's expense. The minimum depth of saw cuts for repair in concrete shall be equal to one-third (⅓) the slab depth.

If areas cut for future placement of concrete or asphalt adjacent to existing asphalt or concrete are left exposed for longer than thirty (30) days or are subjected to inclement weather, the areas shall be evaluated by a Geotechnical Engineer and a recommendation shall be provided to the City. An additional cut of at least six (6) inches behind and/or below the existing structure—or until competent subgrade is encountered—may be required by the City.

The Contractor shall be responsible for the cost of removal and replacement of all overbreak as determined by the City. Concrete washout must be controlled and contained within the site and properly disposed of at the end of the project.

The Contractor shall follow CDOT Section 201.02 Construction Requirements.

Section 410.00 Cesspools, Privies, Buried Fuel and Septic Tanks

Potentially contaminated sites or project areas must conform to regulations of the Littleton City Code and their respective County Health Department. Tanks that may exist on project sites shall be completely removed and contaminated soils remediated in accordance with all local and state standards. The void created shall be filled by the Contractor to finished grade.

Underground motor fuel storage tanks shall be excavated and removed under the direction and in the presence of a representative from the location's respective Fire District. The Contractor shall notify the fire district twenty-four (24) hours in advance of the time he proposes to start excavation in the vicinity of the tanks.

Section 411.00 Wells

On-site wells and well casings shall be sealed to prevent contamination of groundwater aquifers in accordance with all applicable local and State regulations. All abandonment activities shall be approved by the utility that services the location, and the State Engineer. This includes obtaining all necessary state permits required for this work. The City of Littleton does not permit the removal or abandonment of on-site wells.

Section 412.00 Buildings

A permit is required prior to any building demolition. All sewer lines served by the municipal sewer system associated with buildings being demolished shall be capped at the main and inspected by City Inspector prior to building demolition.

Section 413.00 Walls

Retaining walls and their footing shall be removed in their entirety from the site.

Section 414.00 Disposal

No material or debris shall be disposed of or buried within the project limits without the written permission of the City. The Contractor shall make all necessary arrangements for obtaining suitable disposal locations. If disposal shall be at other than established dumpsites, the City may require the Contractor to furnish written permission from the property owner on whose property the materials and debris are proposed to be placed. Burning shall not be allowed.

Section 415.00 Salvage

All salvageable material shown on the approved plans and any additional salvageable material marked by the City shall be removed without unnecessary damage in sections or pieces which may be readily transported and shall be stored by the Contractor in locations approved by the City. The Contractor shall be required to replace any materials lost from improper storage methods or damaged by negligence. These materials include, but shall not be limited to, manhole frames and covers; inlet grates; valves and fire hydrants; landscape plant materials; fence materials; handrails; culverts; guardrail; walkway; roadway and traffic appurtenances (traffic signals and attached hardware, including mast arms and span wire) and irrigation systems and appurtenances.

Section 416.00 Site Preparation

The Contractor shall complete all work necessary to properly prepare the site as shown on the approved plans and as specified herein. The site shall be prepared in such a manner that facilitates subsequent soils or earthwork operations. Site preparation includes clearing and grubbing, which

includes but is not limited to, grading, tree and shrub removal, native grass stripping and removing and disposing of all debris within the limits of the project and other such areas as may be indicated on the plans or required by the work, grading and over-excavation.

Site preparation procedures shall be performed to comply with the approved Geotechnical Report and/or plans or as designated by the City. All areas to receive fill should be inspected and tested before placement of fill. Prior to placing fill materials, the contractor is responsible to perform scarification to a depth of six (6) inches and complete soil preparation including moisture and compactive measures. Adjacent vegetation and other items to remain shall be adequately preserved from injury.

Erosion and sedimentation control measures shall be installed and maintained as necessary through final stabilization in accordance with the erosion and sediment control plans.

Section 417.00 Clearing and Grubbing

All sites to receive fill shall be cleared of organic materials, including root structures, at the Contractor’s expense. Vegetation shall be pulled or grubbed in such a manner as to assure complete and permanent removal. Branches of trees extending over the roadbed shall be trimmed to give a clear height of thirteen (13) feet and six (6) inches above the roadbed surface and tree branches extending over the sidewalk shall be cleared to an elevation of ten (10) feet following the City of Littleton .

All surface objects and trees, stumps, roots and other protruding obstructions not designated to remain shall be cleared and/or grubbed as required by the City. Non-biodegradable, solid objects located at least two (2) feet below the final subgrade surface may remain at the discretion of the City.

The City may establish clearing lines and designate items and materials to remain. The Contractor shall preserve all materials and items to remain. Trees scheduled to remain shall be carefully protected from damage during performance of the work. Any damage due to the Contractor's operations shall be repaired by suitable tree surgery methods. Damaged trees shall be replaced, as approved by the City Forester at the Contractor's expense. Paint used for cut or scarred surfaces of trees or shrubs to remain shall be an approved asphalt base paint formulated especially for tree surgery.

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.

The Contractor shall scalp areas where excavation or embankment shall be made. Scalping shall include the removal of organic material such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and vegetable matter from the surface of the ground.

Clearing shall be performed with due consideration and protection of the general public and public and private property. Any damage to streets, parking lots, utilities, plants, trees, buildings or structures on public or private property, or to benchmarks and construction staking due to the negligence of the Contractor, shall be repaired and restored to its original condition at the Contractor’s expense. Areas proposed to be preserved shall be clearly staked or fenced off by the Contractor. It shall be the Contractor's responsibility to ensure that these areas are not damaged during the construction process. Any damaged areas shall be repaired or replaced at the Contractor's expense.

Section 418.00 Staking and Grade Control

Control and construction stakes shall be set by field parties under the supervision of a Colorado Registered Professional Engineer or a Colorado Registered Land Surveyor who shall be paid by the Contractor. These field parties shall be available to check field control and to provide assistance to the Contractor. A set of approved plans shall be kept on the job site at all times by the Contractor.

It shall be the responsibility of the Contractor to maintain the alignment and grade shown on the approved plans. The alignment and grade elevation of forms shall be checked, and any necessary corrections shall be made before placing the concrete. When any form has been disturbed or any subgrade thereunder has become unstable, the subgrade shall be reconditioned or replaced in accordance with these Standards and Specifications.

Section 419.00 Erosion Control

No person shall clear, grub or grade land without implementing erosion and sediment control measures. Grading, erosion and sediment control practices shall comply with FEMA, CDPHE, MHFD and Littleton regulations. Any proposed construction or other development work may require a Littleton Grading Permit and CDPHE Construction Stormwater Discharge Permit.

Refer to City of Littleton SDCM, most current edition for erosion and sediment control requirements.

Section 420.00 Earthwork

Earthwork shall consist of grading, excavation, embankment, disposal, shaping and compaction of all material encountered within the limits of the project, including but not limited to excavation of ditches and channels, surface boulders, muck, rock, concrete foundations, slabs, stripping, etc. Excavation shall be performed to the line and grade and typical cross-sections shown on the approved plans.

Excavation, dewatering, sheeting, and bracing shall be performed so as to eliminate any possibility of undermining or disturbing the foundation of any existing structures, utilities, pavement, and concrete flatwork.

Free-running water shall be drained from all earthwork materials prior to construction of structures, utilities, or concrete flatwork construction. Drained water shall be free from pollutants, including sediment, to the maximum extent possible. Under no circumstances shall groundwater be discharged into the storm sewer system, irrigation ditch or waterway without a Groundwater Dewatering Permit issued by the Colorado Department of Public Health and Environment.

The City may require the Contractor to submit a proposed earth-moving diagram and map of proposed haul routes for approval.

Section 420.01 Definitions

1. Unclassified Excavation - Any and all earthen materials encountered, including rocks and boulders, during construction. Rock formations that can be removed by ripping with a D-9 tractor in good repair with a single hydraulic ripper are considered as unclassified excavations.
2. Embankment Construction - Earthwork including preparation of the subgrade upon which embankment material shall be placed; dikes within or outside right-of-way; placement and compaction of approved material within areas where unsuitable

materials have been removed; and placement and compaction of embankment materials in holes, pits and other depressions to lines and grades shown on the approved plans. Only suitable materials approved by the project Geotechnical engineer shall be used in construction of embankments and backfills.

3. Suitable Material/Backfill - earthen material that consists of non-organic sands, gravels, clays, silts, and mixtures thereof. Rock with a maximum size of six (6) inches is allowable for embankment. Rock with a maximum size of three (3) inches is allowable for trench backfill. Claystone fragments exceeding three (3) inches in particle size are not to be incorporated in embankment material unless specifically approved by the project Geotechnical engineer and the Project Manager. Bedrock that breaks down to specific soil types and sizes during excavation, hauling and placement may be considered as suitable material if they are excavated and moisture conditioned and aged for a period of time to achieve a uniform, homogeneous material.
4. Unsuitable Material - Any earthen material that contains vegetable or organic silt, topsoil, any soils with organic contents exceeding two (2) percent by weight, wet and oversaturated soils, frozen materials, trees, stumps, certain man-made deposits, or industrial waste, sludge or landfill, lignite, or other undesirable materials.
5. Structure Excavation - Excavation of any and all materials over an area extending three (3) feet out from the outermost bottom edge of a proposed structure, up to existing grade or top of proposed grade (whichever comes first) at a 1:1 slope.
6. Structure Backfill - Earthen material that is installed around and over any structure shown on the approved plans. Imported structure backfill (Class I) shall meet the general gradation of “Class 1 Structure Backfill Material” as specified in Section 703.08 of the CDOT Standard Specifications for Road and Bridge Construction, Controlled Low-Strength Material (CLSM) “flowable fill”, --OR-- “flash fill” shall confirm with MGPEC Section 19.
7. Rock Excavation - Rock excavation shall consist of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or with the use of rippers and all boulders or other detached stones each having a volume of one cubic yard or more, as determined by physical or visual measurements. Unless specified in the Contract, rock excavation is material that meets one of the following field test criteria to be conducted by the Contractor:
    a. Ripping Test: Material that cannot be broken down by one pass with a single tooth ripper mounted on a crawler type tractor in low gear with a minimum net flywheel power rating of two-hundred thirty-five (235) horsepower; or material that cannot be broken down with a 48,000-pound tracked excavator using a bucket with rock teeth.
    b. Seismic Test: Material that has a seismic velocity of six thousand (6,000) feet per second or greater. The Contractor shall submit the qualifications of the individual performing or interpreting the seismic testing to the Engineer a minimum of fourteen (14) days prior to testing. The ripping test will be used to resolve differences if seismic velocities fall below six thousand (6,000) feet per second.
    c. Handling Test: Any boulder or detached stone having a volume of one (1) cubic yard or more that cannot be readily broken down with the excavation equipment described above in one (1) Unclassified Excavation.

8. Controlled Low - Strength Material (CLSM) or Flowable Backfill - A self-leveling low strength concrete material composed of cement, fly ash, aggregates, water, chemical admixtures and/or cellular foam for air-entrainment as described in MGPEC Section 19.
9. Borrow - Backfill or embankment material which shall be acquired from designated borrow areas to make up the deficient areas which cannot be completed from excavation within work limits. All sources of borrowed material shall be approved prior to use by the project Geotechnical engineer and the Project Manager.
10. Proof-Rolling - The application of test loads over a subgrade surface by means of a heavy pneumatic-tired vehicle to locate weak areas in subgrade. Refer to Section 430.00 Proof-Roll Observation and Testing of these Standards and Specifications.
11. Bedding Material - Material that is installed under and around pipelines, riprap, low flow channels, and any other locations required by the City. The thickness and gradation of bedding materials shall comply with Section 426.02 Bedding for Pipelines and Service Lines of these Standards and Specifications.
12. Stabilization Material - Material which shall be placed in over-excavation areas, areas with unsuitable in situ material, or areas with a high-water table in order to stabilize the existing material. Thickness of stabilization material shall be determined and installed in the field, on a case-by-case basis. Gradation of stabilization material shall be determined on a case-by-case basis and shall be approved by the project Geotechnical engineer.

Section 420.02 Grading Tolerances

All earthwork shall be performed in such a manner that final grades after excavation, compaction of backfill, placement of riprap, installation of landscaping, construction of channel lining, etc. shall conform to the cross-sections shown on the approved plans. The final earthwork shall comply with the design elevations, with the following allowable tolerances:

1. 0.25 feet in cross section and 0.25 feet in sixteen (16) feet measured longitudinally on cut or fill slopes.
2. 0.5 feet in all portions of the site, not included in items (1) or (2) in this list.
3. In addition to the above tolerances, positive surface drainage shall be provided on the entire site so that no depressions or ponds are formed, regardless of depth.
4. Any changes to grade within the floodway will require hydraulic analysis, and potentially no-rise certification, CLOMR and LOMR documentation.
5. Any changes to grade within a local or FEMA floodplain will require hydraulic analysis, and potentially no-rise certification, CLOMR and LOMR documentation.

It shall be the Contractor's responsibility to ensure that all portions of the site drain as shown on the approved plans.

Section 420.03 Borrow

It shall be the Contractor's responsibility to stockpile suitable materials for use in the project. Only after the Contractor estimates that sufficient suitable backfill material is stockpiled to complete all earthwork operations of the project, shall excavated material be removed from the project site. If the Contractor fails to preserve onsite, sufficient suitable material, and removes or disposes of suitable material, suitable material shall be recovered at the Contractor’s expense. If there is an

insufficient quantity of suitable material available onsite, the Contractor shall provide additional suitable material, as defined in Section 420.01 Definitions of these Standards and Specifications.

Section 421.00 Embankment Construction

Embankment construction shall include placement, processing, and compaction of all embankment material, and all related work required to ensure proper bond of materials with previously placed embankment material. All embankment construction should be conducted in accordance with specifications and procedures provided and under the direct supervision of the project Geotechnical engineer.

Section 421.01 Preparation of Embankment Subgrade

No excavation shall be performed in any area until the proposed work has been staked by the Contractor, cross-sections of existing ground are determined and plotted, and all survey elevations and cross-sections shown on the approved plans are reviewed and approved by the City. Excavation shall be performed to the lines and grades shown on the approved plans. Prior to placement of subgrade, utilities shall be installed, utility service lines shall be stubbed to the edge of the ROW, and all trenches shall be backfilled and properly compacted.

Fill shall be placed on competent subgrade as determined by the project Geotechnical engineer. The Contractor shall excavate soft, yielding, over-saturated, or otherwise unsuitable soils prior to the placement of fill.

The grade shall be maintained so that the surface is well drained at all times. When necessary, temporary drain systems shall be installed to intercept or divert surface water that may affect the work.

Where an embankment shall be constructed, unsuitable material shall be removed from the surface. The cleared surface shall be plowed or scarified to a minimum depth of six (6) inches. The embankment area shall adhere to the following density and moisture content requirements. AASHTO classified soils A-1, A-2-4, A-2-5 and A-3 are compacted at positive to negative two (+/-2) percent of optimum moisture content and to at least ninety-five (95) percent of maximum dry density determined in accordance with AASHTO T180, modified by CP23. All other soils are compacted to ninety-five (95) percent of maximum dry density determined in accordance with AASHTO T99, modified by CP23. Soils with equal to or less than thirty-five (35) percent fines are compacted at positive to negative two (+/-2) percent of optimum moisture content. Soils with more than thirty-five (35) percent fines are compacted at a moisture content of one to four (1 to 4) percent above optimum moisture content. If the soils prove to be unstable, when compacted at or above optimum moisture content, the moisture required for compacted may be reduced below optimum as approved by the Engineer. Contractor may reference section 4.4 of the CDOT Soils, Excavation and Embankment Inspection Manual.

Where embankments shall be placed on slopes steeper than 4:1 (horizontal to vertical), benches shall be excavated into the slope by a method approved by the project Geotechnical Engineer and the Project Manager. Such slopes include existing and previously constructed embankments.

The benches shall be cut ten (10) feet horizontally into the existing slope to create a stepped bench condition, and the vertical step shall not exceed four (4) feet unless otherwise approved by the project Geotechnical Engineer and the Project Manager. All surfaces to receive embankment material shall be inspected and approved by the project Geotechnical Engineer immediately prior to embankment material placement.

Section 421.02 Embankment Material Placement

No embankment material shall be placed until approved in writing by the Geotechnical Engineer. Earthmoving equipment, watering equipment, processing equipment, and compaction equipment are the responsibility of the Contractor. Equipment shall be suitable for performing excavation and embankment work in accordance with these Standards and Specifications and the Contract schedule.

After subgrade is properly prepared, the embankment filling operation shall begin in the deepest section of the area to be filled. Embankment material shall be placed and compacted in parallel layers until the finished rough grade is reached. Temporary gaps through the embankment shall not be allowed without approval of the City. All temporary and permanent slopes shall not be steeper than 4:l (horizontal: vertical).

The thickness of each layer shall not exceed (before compacting) eight (8) inches or less in loose thickness when heavy, self-propelled compaction equipment is used and six (6) inches or less in loose thickness when and-guided equipment (i.e., jumping jack, plate compactor) is used.

Embankment material shall be a homogenous mixture of Suitable Material as defined in Section 420.01 Definitions of these Standards and Specifications. The full depth of each layer shall be processed to ensure a satisfactory bonding surface for the next layer of embankment material. If more than twenty-four (24) hours have lapsed between the time of compaction testing and placement of the next layer of roadway embankment, the area shall be retested.

In order to achieve uniform moisture content throughout the materials in the layer, wetting or drying of the material and manipulation shall be performed. Placement of material shall not proceed until excessively wet material has been dried and overly dry material has been wetted with methods approved by the project Geotechnical Engineer. Each layer of embankment shall be properly processed by disking or by other approved methods so that the water is distributed uniformly throughout the layer prior to rolling and after compaction. In no case shall additional embankment material be placed until the underlying layer has been properly processed in accordance with these Standards and Specifications. Materials placed that do not comply with moisture and/or density specifications are subject to removal and replacement and/or reprocessing at the Contractor's expense. Each layer shall be conditioned in a manner compliant with the table shown below.

Table 421.01 – Soil Compaction and Moisture

Soil Type	Compaction	Moisture Percent
A-1,A-2-4,A-2-5,A-2-6,A-2-7	95% Min. of ASTM D1557 or ASSHTO T180	-2 to +2

A-3, A-4, & A-5	95% Min. of ASTM D698 or ASSHTO T99	-2 to +2
A-6, A-7-6, & A-7-6	95% Min. of ASTM D698 or ASSHTO T99	0 to +4

The surfaces of previously placed embankment material that have not had material placed on them for a period of time and judged to be unsuitable by the Project Manager or Geotechnical Engineer shall be re-processed to comply with the moisture and density requirements, prior to placement of additional material.

Proof rolling shall be performed after specified compaction has been obtained for the final lift of roadway embankment/subgrade. Areas found to be weak, areas with vertical deflection of more than one-half (½) inch, areas exhibiting "pumping conditions", and those areas which fail a proof roll as indicated by the Inspector shall be ripped, scarified, wetted or dried if necessary, and re-compacted to the requirements for density and moisture.

Rock and Bedrock Material In Common Embankment:

Excavated material that contains solid rock consisting of cobbles, boulders or rock fragments ("rock material") less than one cubic yard in volume; a maximum thickness of one and one-half (1½) feet; and a maximum dimension of six (6) feet that cannot be processed by crushing, breaking or pulverizing, may be placed in embankments below ten (10) feet from the rough subgrade elevation with approval from the project Geotechnical Engineer and the Project Manager. In no case shall claystone fragments larger than three (3) inches in any dimension be incorporated into the embankment layers. Rock material does not include the claystone bedrock formations common throughout Littleton. If placed, rock material shall be incorporated in layers no thicker than the thickness of the largest pieces. The rock material shall be carefully dispersed throughout the layers and throughout the embankment to avoid nesting. Rock fragments shall be spaced far enough apart to allow the Contractor's equipment to operate between the rock pieces. All voids shall be filled with fines material to obtain the required uniform density around the rock fragments.

Embankment areas that contain rock material shall be compacted with adequate equipment and sufficient passes to ensure that the embankments meet all specified moisture and density requirements for common embankment before the next lift is placed.

Section 422.00 Excavation

All excavated areas shall be graded in a manner that allows adequate drainage and does not disturb material outside the limits of construction. Excavated areas shall be within the tolerances noted in Section 420.02 Grading Tolerances of these Standards and Specifications. When practical, all suitable material removed from the excavation shall be used in the formation of embankments, for backfilling, and for other purposes. Materials that are considered unsuitable material (including rock) or surplus by the City will be disposed of at the Contractor's expense, in accordance with Section 414.00 Disposal.

All groundwater pumped or drained from the work shall be disposed of according to provisions of the CDPHE low risk discharge guidance policy and CDPHE Construction Dewatering Discharge permit in a manner satisfactory to the City, without undue interference with other work or damage to pavements, other surfaces, or property.

Section 422.01 Excavated Material

Excavated material shall be placed so as to minimize the inconvenience to occupants traveling on streets and driveways or adjoining properties. Excavated material shall not be deposited on private property unless written consent of the property owner(s) has been filed with the City. Erosion control measures shall be placed to protect the storm sewer system and adjacent waterways. Suitable excavated material shall be used as backfill, fill for embankments, or other parts of the work in accordance with the appropriate sections of these Standards and Specifications. Disposal of surplus material shall be in accordance with 414.00 Disposal of these Standards and Specifications.

Section 422.02 Excess Excavation

If in the opinion of the project Geotechnical Engineer, Project Manager, or Superintendent, the material at or below the depth to which excavation for structures would normally be carried is unsuitable for the required installation, it shall be removed to such widths and depths as directed by the project Geotechnical Engineer or the Project Manager and shall be replaced to provide a stable, non-yielding surface that is approved by the project Geotechnical Engineer and the Project Manager.

It is the sole responsibility of the Contractor to become familiar with the existing conditions and potential excess excavation at each project site. Geotechnical reports or other data provided by the City may be used to assist in determining general site and soil characteristics.

If, through failure or neglect of the Contractor to conduct the excavation work in a proper manner, the surface of the subgrade is in an unsuitable condition for proceeding with construction, the unstable material shall be removed and replaced with recycled concrete, structure backfill, or other approved material at the Contractor's expense. The condition of the subgrade shall be approved by the project Geotechnical Engineer and the Project Manager before any additional materials are placed.

Section 423.00 Over Excavation and Re-compaction for Buildings

All over-excavation and re-compaction operations for buildings shall be done in accordance with the construction and testing procedures provided in the Final Geotechnical Report. Excavation shall extend at least twenty (20) feet outside the proposed building on all sides or as indicated in the Final Geotechnical Report to protect structure and concrete flatwork.

Section 424.00 Trenching, Backfilling, and Compacting

This work shall consist of furnishing all labor, materials, tools and equipment for trenching, bedding, backfill, and compaction for all underground utilities located under roadways, within rights-of-way, and City owned property, as specified herein and shown on the approved plans.

The excavation shall be made to lines and grades shown on the approved plans, and as established by the City. Except where shown otherwise on the approved plans and except where the City gives written permission to do otherwise, all trench excavation shall be made by open cut to the depth required to construct the pipelines as shown on the approved plans. All excavation shall be

'unclassified', as defined in Section 420.01 Definitions. All trenching shall be performed in accordance with all Occupational Safety and Health Administration (OSHA) requirements. These regulations are described in Subpart P, Part 1926 of the Code of Federal Regulations.

Excavated material can be reused as backfill provided all organic material is removed unless more stringent requirements are provided in the geotechnical report, if provided. For trenches beneath pavements and flatwork, backfill from a minimum of 1 foot below grade to grade shall consist of material meeting the requirements for AASHTO class A-1 or A-2 material. All excavated material which meets the requirements for backfill materials shall be stockpiled in a manner which shall not contaminate the excavated material and shall be located a sufficient distance from the trench to avoid overloading, to avoid obstructing sidewalks, driveways, or streets, and to provide the least possible interference with traffic.

Section 424.01 Special Conditions

A. Subsurface Investigation - Prior to the connection of any planned utility line to an existing line, the Contractor shall expose the existing utility at the points of connection in order to verify the elevations and materials of construction. The City will be notified a minimum of two (2) working days before such an investigation is performed. The Contractor shall also expose utilities as they cross each other to allow for verification of elevation and materials of construction.

B. Underground Wire, Cable, Fiber Optic, or Similar Lines - Where underground wire, cable, fiber optic or similar lines are encountered, they shall be relocated as directed by the utility owner and in accordance with their specifications. The Contractor shall coordinate this work with all other phases of construction to avoid further conflicts.

C. Gas and Electric Lines - Where underground gas and electric lines are encountered, they shall be relocated as directed by the gas and electric service provider and in accordance with their specifications. The Contractor shall coordinate this work with all other phases of construction to avoid further conflicts.

Section 424.02 Removal of Water

The Contractor shall provide and maintain adequate equipment to properly remove and dispose of all surface or groundwater that enters the trench. Water shall be disposed of without damage to adjacent property and without being a nuisance to public health and convenience. The trench shall be dry at all times during pipe installation. The use of any sanitary sewer to dispose of trench water shall not be allowed. A Colorado Discharge Permit System (CDPS) Construction Dewatering Permit shall be required prior to construction dewatering activities should groundwater be discharged to the City storm or to waters of the State. Dewatering shall be accomplished by well points, sumping, or any other method approved by the City.

Section 425.00 Trench Excavation for Roadways

When excavating in concrete or asphalt areas, the limits of the trench shall be string lined and the surface cut in a vertical plane. If the vertical edges of a trench in a roadway ravel during construction, they shall be trued to a vertical plane to a point twelve (12) inches outside the limits of excavation prior to milling and placing the resurfacing material, in accordance with the Detail Drawings of these Standards and Specifications

Surface materials such as concrete and asphalt shall be disposed of independently of the underlying soil. Unsuitable materials shall be disposed of by the Contractor in accordance with Section 414.00 Disposal of these Standards and Specifications.

Section 426.00 Trench Excavation for Pipelines and Service Lines

The width of the trench shall comply with the requirements set forth in these Standards and Specifications and shall be sufficient to allow pipe to be installed and backfill placed and compacted as shown in the Detail Drawings found in these Standards and Specifications. For RCP pipe that is bedded to springline, the space between the pipe and trench wall must be wider than the compaction equipment used in the pipe zone. Minimum trench widths for RCP installations shall be the pipe outside diameter plus sixteen (16) inches as shown in the Detail Drawings found in these Standards and Specifications.

Section 426.01 Preparation of Foundation for Pipe Laying

When the excavation is in firm earth, care shall be taken to avoid excavation below the established grade plus the required specified over depth to accommodate the pipe bedding material. In case soft or otherwise unsuitable foundation material is encountered in the bottom of the trench, the project Geotechnical Engineer, Project Inspector, and/or the Project Manager may require removal and replacement with stabilization material to provide a suitable foundation for the pipe. If the trench bottom is wet, the project Geotechnical Engineer shall determine whether it is stable. The bottom of sumps utilized for dewatering shall be two (2) inches minimum below the bottom of the trench excavation to prevent the upward flow of water into the excavation, which may result in unstable bottom conditions.

Section 426.02 Bedding for Pipelines and Service Lines

All pipes shall be installed with sufficient bedding material to provide a minimum of six (6) inches of separation between the subsoil and the barrel of the pipe. The bedding material shall be tamped under the haunches for the full length of the pipe barrel to ensure support for the entire length of pipe. The pipe barrel shall be uniformly supported along the entire length of the pipe.

Bedding material for all RCP shall consist of materials that meet the gradation of “No. 67 Coarse Aggregate” as specified in Section 703.00 of the CDOT Standard Specifications for Road and Bridge Construction unless otherwise recommended by the Geotechnical Engineer and approved by the City Engineer.

Bedding material for all PVC, HDPE, CPP, PP and DIP (“flexible pipe”) shall be material that complies with the gradation of “Fine Aggregate” as specified in Section 703.01 of the CDOT Standard Specifications for Road and Bridge Construction, well-graded sand or squeegee sand which complies with the following:

Bedding material shall be placed to a depth of twelve (12) inches above the barrel section of all flexible pipes. RCP shall be bedded to springline, at a minimum. Bedding material shall be worked under pipe to provide uniform haunch support. Pipe shall be installed in accordance with these Standards and Specifications. Bedding for underdrain pipe or gravel for underdrain without pipe shall be well-graded washed rock ranging in size from one-half (½) inch minimum to one (1) inch maximum.

Bedding material for metallic pipe and fittings shall be high-resistance (>10,000 W-cm)

Table 426.01 – Aggregate Gradation

Sieve Size	*No. 3	*No. 357	*No. 4	*No. 467	*No. 57	*No. 6	*No. 67	*No. 7	*No. 8	Fine Aggregate
	50 mm to 25 mm (2” to 1”)	50 mm to 4.75 mm (2” to No. 4)	37.5 mm to 19 mm (1½” to ¾”)	37.5 mm to 4.75 mm (1½” to No. 4)	25 mm to 4.75 mm (1” to No. 4)	19 mm to 9.5 mm (3/4” to 3/8”)	19 mm to 4.75 mm (3/4” to No. 4)	50 mm to 25 mm (1/2” to No. 4)	9.5 mm to 2.36 mm (3/8” to No. 8)	4.75 mm to 150 µm (No. 4 to No. 100)
63 mm (2-1/2”)	100	100								
50 mm (2”)	90-100	95-100	100	100						
37.5 mm (1-1/2”)	35-70		90-100	95-100	100					
25 mm (1”)	0-15	35-70	20-55		95-100	100	100			
19 mm (3/4”)			0-15	35-70		90-100	90-100	100		
12.5 mm (1/2”)	0-5	10-30			25-60	20-55		90-100	100	
9.5 mm (3/8”)			0-5	0-10		0-15	20-55	40-70	85-100	100
4.75 mm (#4)		0-5		0-5	0-10	0-5	0-10	0-15	10-30	95-100
2.36 mm (#8)					0-5		0-5	0-5	0-10	80-100
1.18 mm (#16)									0-5	50-85
600 µm (#30)										25-60

300 µm (#50)										10-30
150 µm (#100)										2-10

*Coarse Aggregates from ASSHTO M43

Table 426.02 - Bed Course Material Gradation

Sieve Size	Mass Percent Passing
75 mm (3 inch)	100
4.75 mm (No. 4)	20-65
75 µm (No. 200)	0-10

Section 426.03 Backfill for Pipelines and Service Lines

Suitable backfill shall be as defined in Section 420.01 Definitions of these Standards and Specifications. The following special trench backfill requirements shall apply for utilities located in existing or planned road rights-of-way:

1. Isolated Street Cuts – Service line cuts and other isolated utility repairs or modifications in a paved street area shall be backfilled with Controlled Low Strength Material (CLSM) "flowable fill" or "flash fill" per MGPEC Section 19.
2. Constrained Areas - Areas in which proper backfill compaction cannot be achieved such as utility crossing, under curb and gutter, or any area identified by the Certified Materials Tester or Construction Inspector, shall be backfilled with Controlled Low Strength Material (CLSM) "flowable fill."

Materials used above the subgrade level shall comply with the requirements for sub-base and base course materials as defined in Section 1000 Asphalt Mix Design and Construction of these Standards and Specifications.

Bracing installed to prevent cave-ins shall be withdrawn in a manner that shall maintain the desired support during the backfill operations. Driven sheet pilings shall be cut off at or above the top of pipe, and the portion below the cutoff line shall be left in the ground.

Section 426.04 Backfill Compaction

Trench backfill shall be placed in lifts of eight (8) inches or less in loose thickness when heavy, self-propelled compaction equipment is used, six (6) inches or less in loose thickness when hand-guided equipment (i.e. jumping jack, plate compactor) is used, processed and moisture-conditioned, and each lift thoroughly consolidated by tamping, vibrating, or a combination thereof, until the moisture content and the relative compaction complies with the values shown in the Moisture and Density Requirements for Embankment Materials table in Section 421.00 Embankment Construction for the various soil classifications and relative compaction.

For new landscape areas, compaction shall be between ninety (90) percent or greater of the maximum Standard Proctor dry density in the top two (2) feet of soils below finished grade.

Where sidewalk or concrete trail will be constructed, soils shall be scarified for a minimum depth of twelve (12) inches, moisture treated and recompacted two (2) feet wider than the footprint of the sidewalk or trail until the moisture content and the relative compaction complies with the values shown in the Moisture and Density Requirements for Embankment Materials requirements in Section 421.00 Embankment Construction of these Standards and Specifications.

Section 427.00 Backfill of Structures in the Right-of-Way

Areas adjacent to structures located within the right-of-way such as bridge abutments, box culverts, vaults, manholes, and storm inlets, and other areas inaccessible to mobile compaction equipment shall be compacted with suitable power-driven hand tampers or other approved devices. Backfilling shall consist of placing materials in horizontal, uniform layers brought up uniformly on all sides of the structure. The thickness of each layer of backfill shall not exceed six (6) inches before compacting to the required density. The Contractor shall uniformly process, maintain proper moisture in, and properly compact each lift throughout the backfilling process.

Backfill material shall not be deposited against the back of concrete abutments, concrete retaining walls, or the outside of cast-in-place concrete structures until the concrete has developed a strength of not less than eighty (80) percent of the required design strength, as determined by non-destructive testing procedures. Backfill placed within two (2) feet of any structure shall be placed evenly on all sides to avoid unequal lateral pressures.

Compaction equipment or methods that produce horizontal or vertical earth pressures which may cause excessive displacement or loss of compaction in the backfill zone, or may damage structures, shall not be used.

Unless otherwise shown on the approved plans or directed by the City, all sheeting and bracing used for structure excavation shall be removed by the Contractor prior to backfilling.

In the event that suitable backfill material is not available on the site; the Contractor shall import suitable backfill as defined in Section 420.01 Definitions of these Standards and Specifications.

Where pipe is connected to a structure to be backfilled, bedding and backfilling procedures shall comply with Section 426.01 - Bedding for Pipelines and Service Lines and Section 426.02 - Backfill for Pipelines and Service Lines of these Standards and Specifications.

In constrained areas where proper compaction of backfill cannot be achieved around structures, CLSM “flowable fill” shall be used as defined in Section 420.01 Definitions of these Standards and Specifications.

Section 428.00 Roadway Excavation, Backfill and Compaction

Prior to placement of street subgrade, base, paving and concrete materials, utilities shall be installed, utility service lines shall be stubbed to the edge of the ROW, and all trenches shall be backfilled and properly compacted. Roadway embankments shall be constructed in accordance with Section 420.00 Earthwork of these Standards and Specifications.

Section 428.01 Base Course (For Composite Sections)

A. Materials

Base course subgrade shall consist of a foundation course composed of crushed gravel, approved recycled concrete, recycled asphalt or crushed stone and filler, constructed on the prepared subgrade. Materials and construction shall be in accordance with the requirements of Section 304 of the CDOT Standard Specifications for Road and Bridge Construction. Base course material gradation shall meet the requirements of Class 5 (one and one-half (1½) inch maximum) or Class 6 (one (1) inch maximum), in accordance with Table 703.03 of CDOT Standard Specifications for Road and Bridge Construction. Base course shall be moisture treated and compacted as described in the Standards and Specifications. Onsite waste disposal is prohibited, but asphalt millings may be used as final stabilization, provided they are compacted to a degree that effectively minimizes erosion and track-out. Asphalt millings and crushed concrete can be recycled and used as the base material for new asphalt pavement.

B. Construction

All work shall be observed and tested by the Project Manager or Geotechnical Engineer. The base course material shall be placed on the previously prepared subgrade at the locations and in the proper quantities to conform to the cross-sections shown on the approved plans and as directed by the City. Geotextile fabric shall be installed if required on the approved plans or final pavement design report. Placing and spreading shall be done by means of a spreader machine, moving vehicle, motor grader, or by other approved equipment methods. The material shall be placed without segregation. Any segregated areas shall be removed and replaced with uniformly graded material at the Contractor's expense.

The thickness of each base course layer shall not exceed six (6) inches before compaction. If uniform density cannot be obtained by six (6) inch lifts, the maximum lift thickness shall not exceed four (4) inches. Each lift must be compacted with vibratory equipment.

Base course material shall not be placed on a dry or dusty soil foundation which could cause rapid dissipation of moisture from the base course material and hinder or preclude proper compaction.

Excessively dry soil foundations shall have water applied to them and shall be reprocessed and recompacted. If at any time, the subgrade construction is subjected to rain, snow or other significant events, the Project Manager or Geotechnical Engineer shall evaluate the affected areas prior to continuing with subgrade preparation and shall make a recommendation to the Contractor and to the City.

Rolling shall be continuous until the base course material has been compacted thoroughly in accordance with Section 304 of the CDOT Standard Specifications for Road and Bridge Construction. Water shall be uniformly applied during compaction to obtain the specified moisture content and to aid in consolidation. The surface of each layer shall be uniformly maintained during compaction operations.

The prepared base course surface shall be smooth and free of ruts and irregularities and shall be true to line and grade shown on the approved plans and as directed by the City. The base course shall be maintained in this condition by watering, drying, rolling, and/or blading until the asphalt or concrete flatwork is placed. The surface tolerance of the base course shall be in accordance with Section 304.06 of the CDOT Standard Specifications for Road and Bridge Construction.

Section 429.00 Lime-Treated Subgrade

When required, lime treated subgrade shall comply with Section 307 of the CDOT Standard Specifications for Road and Bridge Construction and as determined by a stamped Geotechnical Report. Lime-treated subgrade shall extend to the back of the sidewalk as shown in the Detail Drawings of these Standards and Specifications Lime treatment of subgrade is disallowed during the winter months when ambient temperatures are below forty (40) degrees Fahrenheit. Alternative methods of soil stabilization may be allowed with approval of the City. Soil mix design procedures shall comply with the CDOT Standard Specifications for Road and Bridge Construction.

Section 430.00 Proof-Roll Observation and Testing

Within the twenty-four (24) hour time period prior to paving and after a moisture related weather event, subgrade compaction testing and proof-roll observation and testing (proof-rolling) with a loaded tandem wheeled vehicle or other equipment bearing eighteen (18) KIPS per axel or approved by the Inspector or Geotechnical Engineer.

After passing compaction tests, the Contractor and/or Owner's representative shall proof-roll the areas. No proof-roll inspections shall be performed until all underground utility testing is complete. Subgrade areas failing compaction testing or proof-rolling shall be delineated and reprocessed and/or removed and replaced in a manner approved by the project Geotechnical Engineer and the Project Manager. Such procedures may include over-excavation, scarification, moisture-conditioning, recompaction, and/or replacement with suitable materials that comply with the moisture and density requirements. In addition to complying with moisture and density requirements, all subgrade materials shall exhibit stability during proof-rolling. Additional compaction testing and proof-rolling may be required at the discretion of the City. All proof-rolling operations shall be at the Contractor's expense. Changes in weather such as freezing, or precipitation will require reapproval of the subgrade prior to asphalt placement.

Section 431.00 Restoration and Clean Up

At all times during construction, the Contractor shall maintain the site, including partially finished structures, material stockpiles, erosion and sedimentation control measures, and other like areas, in a reasonable state of order and cleanliness.

The grade and condition of all unsurfaced areas shall be restored to a condition equal to or better than the grade and condition immediately prior to construction unless otherwise shown in the approved plans and approved by the City. The Contractor shall restore or replace all seeded areas, sod, trees, landscaping materials, landscape irrigation systems, fences, and any other items, to a condition equal to or better than before the work began and to the satisfaction of the City. All grassed areas shall be reseeded or resodded in accordance with Section 1100 Grounds Open Space and Natural Resources of these Standards and Specifications. The Contractor shall be responsible for maintaining these areas until substantial growth, defined as seventy (70) percent density of vegetation as compared to pre-existing conditions, occurs and Construction Acceptance into

Warranty. Refer to Section 200 Development Acceptance Procedures of these Standards and Specifications.

All pavement and concrete flatwork shall be restored or replaced to a condition equal to or better than before the work began and to the satisfaction of the City. In the event of failure of the Developer or Contractor to complete work, correct deficiencies, or clean up a project site in a reasonable time period, the City has the right to draw upon the performance guarantee and complete the work as needed.

SECTION 500 WATER SUPPLY FACILITIES

The City of Littleton is not a water service provider. Standards and Specifications for potable water systems shall be in accordance with their respective governing entity.

SECTION 600 SANITARY SEWER FACILITIES

The City of Littleton Sanitary Sewer Standards and Specifications shall be in accordance with the most current edition of Platte Canyon Water and Sanitation District's Sanitary Sewer Standards and Specifications.

In the event of conflicting design standards or specifications, the most restrictive standard shall apply or from written approval by the City Engineer.

The following special provisions supplement or modify the Platte Canyon Water and Sanitation District Sanitary Sewer Standards and Specifications:

Section T.1 Sanitary Sewer System Design and Layout

T.1.1 Size and Slope of Sewer Mains and Appurtenances shall be amended as to the following requirement only:

The sewer's hydraulic capacity shall be such that the sewer is flowing at less than seventy-five (75) percent of the full depth at the calculated future peak flow rate: $d/D < 0.75$

All other requirements in T.1.1 remain in effect.

SECTION 700 STORM DRAINAGE FACILITIES

Refer to the City of Littleton SDCM, most current edition.
https://www.littletonco.gov/Government/Departments/Public-Works-Engineering/Storm-Drainage

In the event of conflicting design standards or specifications, the most restrictive standard shall apply.

SECTION 800 ROADWAY AND PARKING LOT DESIGN, TRAFFIC SIGNALS, AND STREET LIGHTING

Section 801.00 Contractor Responsibilities

The Contractor shall be responsible to be fully informed of and shall comply with all sections of these Standards and Specifications, applicable laws, ordinances, rules, regulations and orders of the city, county, state, federal or public bodies having jurisdiction affecting the work.

Section 802.00 Scope

New and redevelopments shall provide a Transportation Impact Study or Letter that complies with the City of Littleton Transportation Impact Study Guidelines. All requirements of the City's Unified Land Use Code, Zoning Ordinances and other applicable Titles of the Littleton Charter and City Code, the City's Comprehensive Plan and the City's Transportation Master Plan shall be met. Roadway design and ROW modifications shall conform to the latest edition of PROWAG: Accessibility Guidelines, AASHTO: A Policy on Geometric Design of Highways and Streets, AASHTO: Roadside Design Guide, these Standards and Specifications, AASHTO Guide for the Development of Bicycle Facilities, NACTO Urban Bikeway Design Guide, and any other requirements determined by the City.

If these standards are inconsistent with one another, or with other listed guidelines, the more restrictive provision will control.

The design and installation of traffic control devices and street lighting shall comply with these Standards and Specifications, all applicable portions of the latest edition of the CDOT Standard Specifications for Road and Bridge Construction and the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD), and any other requirements determined by the Traffic Engineer. If these standards are inconsistent with one another, or with other listed guidelines the more restrictive provision will control.

Prior to the installation of any traffic control devices, the Traffic Control Plan and associated submittals shall be approved by the Traffic Engineer, and all underground utilities shall be located. All traffic control devices shall be installed and maintained by the Developer or Contractor through the warranty period, unless otherwise stated in the Development Agreement.

Section 803.00 Roadway Design

A. Minimum Sight Distance

1. Intersection and stopping sight distances shall conform to the latest edition of AASHTO: A Policy on Geometric Design of Highways and Streets.

B. Intersection and Access Spacing

1. If adherence to the criteria would leave a parcel with no access and shared access cannot be obtained, then the City Engineer may vary, in writing, the requirements to provide a single point of access on a case-by-case basis.
2. Arterials
   a. Access points shall be no closer than 300 feet to arterial intersections, measured centerline to centerline. Depending on site characteristics access control may be required.

b. Signalized intersections shall be spaced a minimum of 660 feet from the nearest signalized intersection, measured centerline to centerline. Signal progression analysis may be required at the discretion of the Traffic Engineer to determine if increased signal spacing is needed.
c. Full movement access shall be evaluated by a minimum of 300 feet criteria and shall only be allowed if queuing does not impede, as determined from a detailed transportation impact study. Instances where queuing does impede, restricted movements may apply.
d. State owned facilities within the City of Littleton shall follow access spacing criteria defined in the State Highway Access Code.
e. These recommended spacing minimums may only be modified with the approval of the Traffic Engineer.

3. Collectors
   a. Access points shall be no closer than 150 feet to collector intersections, measured centerline to centerline. Depending on site characteristics access control may be required.
4. Locals
   a. A minimum of 150 feet spacing is required between all intersections and driveways (for commercial and private driveways), measured flowline to flowline.
5. Alleys and Residential Driveways
   a. A minimum of 75 feet spacing is required between all intersections and alleys, measured flowline to flowline
   b. Residential driveways shall be located as far from street intersections as possible.
      i. 50 feet from a local-to-local intersection (measured from the intersecting street's flowline)
      ii. 75 feet from a local to collector, or local to arterial intersection (measured from the intersecting street's flowline)
   c. Opposing access points should be aligned or have a minimum of 75 feet spacing measured flowline to flowline.
6. Roundabouts & Alternative Intersection Control & Geometries
   a. For collector-to-collector classifications and below, roundabouts and alternative intersections shall be considered as a substitute for other types of intersection traffic control, i.e., two-way or four-way stops or for traffic signal locations, if deemed potentially warranted in the future.
   b. Arterials may consider alternative intersection control and geometries as needed for optimal operational performance, and coordination with Traffic Engineering is required prior to site plan.
7. Parcel/Parking Access
   a. Only the minimum number of curb cuts necessary to serve the subject parcel/parking lot shall be permitted.
   b. Access drives shall be oriented substantially at right angles (90 degrees) to the street.
   c. Multi-family residential access driveway widths shall not be less than 18 feet nor more than 30 feet. Driveways that are proposed to be less than 20 feet in width will need to meet Fire District standards and will require a turning analysis. Driveways with medians will be reviewed on a case by case basis in accordance with the

approved Transportation impact study. If crosswalks are present where medians are proposed, a pedestrian refuge island will be created within the median.

d. Access to parking lots along arterials shall be from the local side street wherever possible, except between commercial parking areas bordered by residential property.

8. Miscellaneous Access
   a. Edge of access point (curb or pavement edge) shall be no closer than ten feet to any adjacent property line unless they are shared accesses with appropriate existing or proposed easements.
   b. Access points shall align with other access points/streets across from the cross street.
   c. Shared access across sites or for future development opportunities may be required along arterial roadways. Evidence of correspondence indicating an effort to obtain shared access may be required for approval.
9. Throat Depth
   a. The entrance throat shall be designed to safely accommodate ingress without the potential for queuing to back onto the feeding street. Entrance throats shall meet the following criteria.
   b. For entrance throats off arterial roadways, the throat depth shall be the greater of either 150 feet, or the 85th percentile egress queue.
   c. For entrance throats off collector roadways, the throat depth shall be the greater of either 75 feet, or the 85th percentile egress queue.
   d. There are typically no throat depth requirements for local roadways. The Traffic Engineer may require a minimum throat depth based on the context of the project.
10. Gating Systems
   a. Gate(s) within a public ROW are not allowed.
   b. If a gating system is proposed to be installed at a site access point, the gate access shall be set back from the flow line of the street at least 35 feet or one design vehicle length, whichever is larger, and be approved by South Metro Fire Rescue.
   c. Gating systems located within close proximity to public right-of-way (ROW) shall be assessed by the City of Littleton Traffic Engineer, or Authorized Agent, and may require a traffic analysis to determine the appropriate distance of the gating system to the street flow line.

11. Access Alignment

When lots are not large enough to allow access points on opposite sides of the street to be aligned, the center of driveways not in alignment shall be offset by a minimum of one hundred fifty (150) feet (as measured from centerline to centerline of access points on all Collector Streets, and three hundred (300) feet on Arterial Streets. Access points must intersect a public street at a ninety (90) degree angle; if physical constraints make this impractical, up to a ten (10) degree variance may be permitted with review and approval of the City Engineer.

12. Roadway Cross Sections

Refer to Section 1300 Appendix for the City of Littleton roadway cross sections i.e. typical sections for each roadway classification in the City's Transportation Master Plan.

13. Street Design Criteria

Roadway classification is based on the role a street fulfills within the street and highway system while accommodating twenty (20) year forecasts of the future traffic average daily trips (ADT). For further information on functional classification and ADT see the City's Transportation Master Plan and the Street Design Criteria Table below. Typical street sections shall conform to the City's Unified Land Use Code, Comprehensive Plan, and Cross Sections i.e. Typical Sections by Roadway Classification as shown in the Detail Drawings found in these Standards and Specifications. Collector and arterial streets shall be constructed along the general alignment shown in the City of Littleton Transportation Master Plan, and whenever a traffic engineering analysis of the future traffic volumes indicates the need for a collector or arterial typical section.

Additional ROW may be required to satisfy other criteria contained in these Standards and Specifications. Areas outside the typical section shall be contour graded, compacted, and sloped, as required for proper drainage, soil stability, and maintenance accessibility. Cut and fill slopes steeper than four horizontal to vertical (4:1) shall require supporting calculations provided by the Project Geotechnical Engineer based on a soils analysis.

All raised roadway medians shall be at least four (4) feet wide from back of curb to back of curb.

The City may require or allow modifications to the typical street sections on a case-by-case basis due to factors such as surrounding land use, access, or right-of-way constraints. Street design criteria for various street classifications are listed in the table below:

Table 803.01 - Street Design Criteria

Design Element	Major Arterial	Minor Arterial	Major Collector	Minor Collector	Local
Curb & Gutter	6” Vertical with 2’ Gutter				
Flow Line Curb Radius	25’ min	20’ min	20’ min	15’ min	15’ min
Cross Slope without Super Elevation	2.0%				
Super Elevation Max.	4%	4%	4%	Not Allowed	Not Allowed
Min. Horizontal Curve[1] (4% Superelevation)	711'R	711'R	533'R	---	---
Min. Horizontal Curve[1] (Normal Crown)	1039’R	1039’R	762’R	510’R	333’R
Max. Street Grade	6%	7%	7%	7%	7%
Min. Street Grade	2.0%				
Max. Grade at Intersection	2% for 300’	3% for 300’	4% for 150’	4% for 100’	4% for 100’
Tangents Between Horizontal and Vertical Curves	150' min	100' min	100' min	N/A	N/A

Notes:[1] Centerline

1. Horizontal Alignment

   a. Streets shall generally be aligned to bear a reasonable relationship to topography. Horizontal curves shall conform to the Street Design Criteria table. Minimum spacing between intersection centerlines shall be as follows:

   Streets shall intersect or connect to other streets at a right angle with a minimum tangent section of 100’ approaching the intersection. Any deviation from right angle intersection connections requires City approval. Horizontal and vertical alignment and ROW limits shall be coordinated to not obstruct sight distance at intersections, in accordance with the Detail Drawings found in these Standards and Specifications. Curb return radii shall be as shown on the Street Design Criteria table. Where two different street types connect, the larger curb return radius shall apply. In cases of existing skewed intersections, the curb return radius shall be large enough to accommodate an appropriate design vehicle of the City’s choosing.

2. Vertical Alignment

   Street centerline profile grades shall be as shown in the Street Design Criteria table. Where a street is curved and minimum profile grade is desired, the centerline grade

shall be adjusted so that the curb line grade on the outside of the radius shall be no less than the minimum street grade specified on the Street Design Criteria table.

Centerline profile grades shall not exceed four (4) percent for a distance of at least one hundred (100) feet to either side of an intersecting centerline. Gutter flowline grades shall be no less than one (1) percent along curb returns, in cul-de-sacs and bulb areas, and other areas where gutter flowline grades do not directly parallel centerline profile grades.

The minimum K values for crest and sag vertical curves shall be in accordance with the following table:

Table 803.02 – Minimum "K" Value for Crest and Sag Vertical Curves

Design Speed (MPH)	Minimum K Value Crest	Minimum K Value Sag
15	3	10
20	7	17
25	12	26
30	19	37
35	29	49
40	44	64
45	61	79
50	84	96
55	114	115

3. Major Structures

   Major structures, such as retaining walls, box culverts and bridges, that are appurtenant to proposed street and/or parking lot construction, shall conform to all structural design and loading requirements found in, but not limited to the CDOT Bridge Design Manual, Structural Worksheets, Standard Specifications for Road and Bridge Construction and the geometric and drainage requirements of these Standards and Specifications. Plans and supporting calculations for major structures shall be prepared by a Colorado Registered Professional Engineer. Major structures outside of the public right-of-way shall also comply with City Code.

4. Traffic Barriers and Guardrail

   Traffic barriers including guardrail shall conform to the guidelines of the CDOT Standard Specifications for Road and Bridge Construction.

5. Design Element Coordination

   Horizontal and vertical alignment continuity shall be provided between new and existing streets to achieve safe and aesthetically pleasing transitions. Construction shall be staged to eliminate grade and alignment conflicts and unnecessary damage to existing or newly constructed facilities. Street design and proposed construction shall be coordinated with drainage and utility facilities.

6. Fire Apparatus Access Roads and Emergency Access

   Emergency access roads shall be designed to minimum widths and radii as required by South Metro Fire Rescue.

7. Public Street Improvements
   Public street improvements shall be required for all new developments that front an existing public roadway. Where public street improvements are required, sufficient ROW shall be dedicated to accommodate the ultimate typical section for the associated future street type of the adjacent roadway as identified in the Transportation Master Plan. Additional ROW may be required if the development site is adjacent to a future project identified by the Transportation Plan or any project that is currently in development by the City of Littleton. Additional ROW may also be required if the existing roadway width exceeds the ultimate section roadway width. If the ultimate street section includes sidewalks, shared use paths, bike lanes, or other multimodal amenities the development shall construct these multimodal facilities in the ultimate location in relation to the existing back of curb, unless otherwise approved by the City Engineer. Where future protected bike lanes are identified along a development's frontage, protected intersection(s) per the latest edition of the AASHTO Guide for the Development of Bicycle Facilities shall be constructed by the development.

8. Cul-de-sacs
   Cul-de-sacs shall be in accordance with the Detail Drawings found in these Standards and Specifications and will only be allowed on Local Streets. Lengths of cul-de-sacs are recommended to be between one hundred forty (140) feet and five hundred (500) feet. Proposed cul-de-sac lengths that are not in this range shall be fully justified and based on the following considerations:
   a. Intersection vehicular traffic capacity
   b. Emergency vehicle response time
   c. Pedestrian trip time to bus routes
   d. Reduction of double travel distances for service and patrol vehicles
   e. Utility systems, drainage, and open space access
   f. Other requirements by the City
   g. Emergency Access Locations
   h. Presence of approved fire sprinkler systems in all structures

   For cul-de-sacs between five hundred one to seven hundred fifty (501-750) feet in length, the clear roadway width shall be a minimum of twenty-six (26) feet wide and where cul-de-sacs exceed seven hundred fifty (750) feet in length special approval is required from the South Metro Fire Rescue.

   Surface drainage shall be directed toward the intersecting street, or if this is not reasonably practical, a drainage structure and easement shall be provided at the end of the cul-de-sac. Specially designed temporary cul-de-sacs may be allowed when approved by South Metro Fire Rescue.

9. Parking Lots and Private Street Systems
   Private street systems and parking lots shall conform to City Code, ADA/PROWAG, Fire Code, and all other applicable criteria that apply to public streets.

All private parking, driveways, turnarounds and access drives of parking areas shall be surfaced with hot-mix asphalt, concrete, or other surface material approved by the City Engineer.

When an impervious surface is used, all driveways, parking areas, aisles and turnarounds shall have on-site stormwater facilities in conformance with the City of Littleton SDCM.

Private street systems and parking lots will not be maintained by the City and shall be maintained in accordance with the SIA or the record drawings. If the responsible party wishes to dedicate the private streets to the City in the future, the dedication must meet the following requirements:

a. The offer must include the entire street; and

b. The City will estimate the cost to bring roadway up to City standards and specifications, including the need for any additional right-of-way, and the Owner or any successor in interest will be responsible for all costs associated, as the City determines is necessary; and

c. The City in its sole discretion shall determine whether to accept any such dedication.

10. Intersections
Intersections shall be designed to provide for the safety of motorists, pedestrians, and bicyclists. At street intersections, property lines shall provide adequate ROW for curb ramps and utilities. Refer to the AASHTO Green Book and the Detail Drawings found in these Standards and Specifications.

11. Acceleration and Deceleration Lanes
On Colorado Department of Transportation owned facilities, refer to the most recent Colorado State Highway Access Code for when auxiliary acceleration/deceleration may be required based on criteria for Non-Rural Arterials. Exact Classification to be determined in coordination with the Traffic Engineer.

When auxiliary acceleration/deceleration lanes are necessary, the most recent Colorado State Highway Access Code shall be used for design specifications.

Deceleration or acceleration lanes may be required for unique factors such as high speeds, traffic density, access volume, truck usage, sight distance, and other features that create operational or safety reasons as determined by the Traffic Engineer.

12. Storage Length
The auxiliary lane should be sufficiently long in order to store the number of vehicles that accumulate during a peak time. Sufficient storage length should be provided such that the queue length does not compromise the deceleration length provided. Additionally, the storage length shall be sufficiently long so that the entrance to the auxiliary lane is not blocked by vehicles queued in the through lanes at a signal.

Storage lengths for signalized and unsignalized intersections shall be determined via methods outlined in the City of Littleton Transportation Impact Study Guidelines. The minimum storage length for left-turn lanes at signalized intersections shall be 100 feet.

13. Pavement Design

The design methodology provided in this section is based upon the 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures, the Metropolitan Government Pavement Engineers Council (MGPEC) Pavement Design Standards (latest edition), and the Colorado Department of Transportation (CDOT) Roadway Design Manual (latest edition). The design methodology in this section is prescriptive in nature and represents the minimum requirements of a pavement design for the City.

a. General

A geotechnical investigation and pavement design report is required for all new paved roadways and fire lanes as well as for reconstruction or modification of existing paved roadways, dedicated bus lanes and fire lanes. All subgrade investigations and pavement designs shall be completed by or under the supervision of and signed by a Professional Geotechnical Engineer registered in the State of Colorado.

As outlined in the MGPEC Standards Sections 1.4 through 1.6, these Standards are intended to provide a pavement design based on actual subgrade soil conditions prior to paving. As a result, these Standards should be used in a prescriptive manner to prepare a Pavement Design to be submitted to the City for approval. This Pavement Design would be considered a final document, and upon approval would be used for the construction of subject roadways. Preliminary designs are typically used only for division budgeting and planning purposes and are typically not submitted for approval beyond the initial development or subdivision process. Such a design should be clearly labeled as “Preliminary”. A preliminary design should be performed based on the subgrade soil types most likely to be encountered at rough grade following grading and installation of underground utilities. Preliminary designs should always include the stipulation that a final Pavement Design or Design Confirmation Report shall be conducted in accordance with these Standards once the subject roadways are at rough grade.

A Design Confirmation Report should be prepared and submitted by the Design Engineer where a final Pavement Design Report cannot be prepared. The Design Confirmation Report should include sufficient soil sampling, field and laboratory testing, compaction reports for embankment materials placed, etc. to confirm the preliminary design is appropriate for the actual subgrade materials.

b. Field Exploration

The field investigation shall consist of borings or other suitable methods of sampling subgrade soils to a depth of at least five (5) feet below proposed subgrade elevation (ten (10) feet below proposed subgrade on arterial roadways), at spacings of not more than two-hundred fifty (250) feet unless otherwise accepted by the City. Additional borings should be made to investigate anomalous conditions such as drainages, soft spots, areas of existing pavement distress, etc. Every fourth hole shall be at least ten (10) feet deep. Where the length of the proposed new street is less than two-hundred fifty (250) feet, two borings shall be made. Soil samples shall be sampled using a "California" type sampler (or “split-spoon” or equal) for

disturbed samples. The boring logs generated during geotechnical explorations should record the blows/foot, boring number, and sample description. The sampler device used shall be noted in the boring logs. A representative bulk sample of the upper five (5) feet of the subgrade shall be taken from each boring. Boring logs shall include a description of soil types encountered, samples taken, blow counts, moisture conditions, free water and anomalous conditions.

If a preliminary report was previously prepared for the project, a Design Confirmation Report should be prepared and submitted for review. The exploration for the Design Confirmation Report should include:

i. Sampling to provide one subgrade sample for each two-hundred fifty (250) linear feet along the alignment.
ii. Samples of the subgrade soils, using a “California" type sampler, with liners (either drive samples obtained by drill rig or utilizing a hand sampler) that are representative of any embankment material or moisture treated subgrade zone.
iii. A description of soil types encountered, samples obtained, blow counts (if obtained), moisture conditions, free water and anomalous conditions.
iv. Compaction Test Reports for any embankment materials placed.

c. Laboratory Testing

The purpose of the laboratory testing program is to classify subgrade material and determine support properties and movement potential. Testing for soil classification, soil swell/collapse, and subgrade support shall conform to the MGPEC Standards Section 3.1 except were noted below.

Soil Classification - All samples of the subgrade soils shall be tested to determine classification in accordance with AASHTO specifications and procedures. The minimum requirements are as follows:

d. Soil Classification Requirements

Table 803.03 – Soil Classification Testing Requirements

Soil Test, AASHTO Test Procedure	Test Frequency
Soil Classification, AASHTO M145	Each soil type in each boring
Natural Moisture, AASHTO T265	Two tests per boring
Density, AASHTO T204	Two tests per boring
Liquid Limit, AASHTO T89	One test per boring
Plastic Limit, AASHTO T90	One test per boring
Percent Passing No. 200, AASHTO T11 (fine grained soils only) or Gradation Analysis, AASHTO T27 (fine or coarse grained soils)	One test per boring
Sulfate Tests, AASHTO T290	1 test each 1,000 feet of roadway with a minimum of 2 per project

i. Swell Tests - All soil groups, excluding A-1 through A-4, shall be tested to determine swell or settlement potential. Tests shall be run on the "California" samples in general accordance with ASTM D4546, Method B under a surcharge load of two hundred (200) psf. A minimum of one (1) test per two (2) borings shall be conducted on borings with soil groups other than A-1 through A-4.

ii. Subgrade Support Testing - For the soil groups which govern the design (as determined in MGPEC Standards Section 3.1A) of the pavement system, subgrade support testing shall be performed in accordance with the following table for both Pavement Design or Design Confirmation Reports.

Table 803.04 – Subgrade Support Testing

Type	Standard	Description
Laboratory R-Value	CP-L 3101	Resistance R-Value and Expansion Pressure of Compacted Soils or Aggregates by Means of Hveem Stabilometer
Laboratory CBR	ASTM D1883 – Samples should be run using soaked CBR as the default condition	

e. Pavement Thickness Design

The design methodology is based upon the 1993 AASHTO Guide for Design of Pavement Structures equations and considers Traffic and Subgrade Resilient Modulus as the primary variables. Traffic loading requirements are presented in

Section 803.13 of these Standards and Specifications. The Subgrade Resilient Modulus and swell/consolidation analysis shall be determined in accordance with Section 803.13. The design equations for flexible and rigid pavements are presented in Section 803.13 and 803.13, respectively. Alternatives will be considered with advances in pavement design methods and paving material changes. Any deviation from guidelines presented in this document must be technically justified and approved by the City.

f. Equivalent Single Axle Load (ESAL)

A primary factor in pavement design is the loading of traffic on the roadway. This is a combination of the volume of traffic and the weight of the vehicles on the street. This factor is described in terms of eighteen thousand (18,000) pound Equivalent Single Axle Loads (ESAL)'s. The calculation of ESAL's is based on the following information:

i. ADT
ii. Lane distribution
iii. Truck volumes
iv. Truck weights and axle configurations

Since this information is not always readily available for all streets, this manual provides minimum ESAL values for City street classifications. Calculated ESALs must be equal to or greater than the Minimum ESALs listed in table below. The intersections of Collector and Arterial streets shall increase the ESALs by a factor of one point five (1.5). The City may increase the minimum ESAL at any location, if, in their opinion, traffic conditions warrant.

Table 803.05 – Equivalent Single Axle Load (ESAL)

Minimum ESAL Values Location	Minimum Equivalent Single Axle Load (ESAL)
Arterial	2,200,000
Collector	1,500,000
Local or Private Street	73,000
Fire lane	73,000
Parking, Cars Only	36,500
Parking, All Others	73,000

Alternatively, pavement design can be completed using a roadway specific ESAL value. ESAL can be calculated using the technique described in the most recent CDOT M-E Pavement Design manual. The calculations, input data, and any assumptions must be reviewed and accepted by the City.

The pavement design procedure in this Section provides for a twenty (20) year service life of all pavements, given that normal maintenance is provided to keep roadway surface in an acceptable condition.

g. Subgrade Support Characterization

Subgrade support shall be determined as described in the MGPEC Pavement Design Standards (current edition) Section 4.2.

Swelling soils should be mitigated in accordance with MGPEC Section 4.2.B.

The depth of moisture treatment is described in MGPEC Section 4.2.B. Alternatively, the depth of moisture treatment may be determined using the "Effective Depth of Moisture Treatment" figure in the Colorado Department of Transportation Pavement Design Manual may be used in place of the Depth of Moisture Treatment table in this Section.

Subgrade soils can be stabilized in accordance with MGPEC Section 4.2.D.

h. Flexible Pavement Structural Section

i. Flexible Pavement Strength Coefficients – The table below contains the standard design coefficients for various pavement materials. Nonstandard design coefficients may be used only if approved in advance by the City. In addition, design values must be verified by predesign mix test data and supported by daily construction tests; or redesign values will be required.

Table 803.06 – Flexible Pavement Structural Section

Pavement Structure Component*	Strength Coefficients	(Limiting Test Criteria)
Plant Mix Seal Coat	.25	
Hot Bituminous Pavement	.44	
Existing Bituminous Pavement	.30	(9-15 years)
	.24	(>15 years)
Unbound Granular Base	0.09	Soft Subgrade [M_r<5,000 psi]
(Aggregate Base Course)	0.12	Firm Subgrade [M_r>=5,000 psi]
Chemical Treated Subgrade (Including lime treated subgrade)	0.11 Higher strength coefficients may be justified per 2014 CDOT Pavement Manual, Section 3.5.	Assumes 160 psi - 7 day compressive strength
Cement Treated Aggregate Base	.23	(7 day, 640-1000 psi)
Mechanically Stabilized Base (MSB)	0.15	Assumes 6 inches to 12 inches of aggregate

Notes:

*The combination of one or more of the following courses placed on a subgrade to support the traffic load and distribute it to the roadbed.

ii. Flexible Pavement Design Equations and Inputs - Flexible pavements shall be designed using the 1993 AASHTO Design Equation presented below, or Pavement Design Software using this equation:

$$\log_{10}(W_{18}) = Z_R \times S_o + 9.36 \times \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{\Delta PSI}{4.2-1.5}\right)}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \times \log_{10}(M_R) - 8.07$$

Where:

W18 = 18-kip equivalent single axle loads (ESALs) over design life
ZR = Standard normal deviate (function of the design reliability level)
So = Overall standard deviation (function of overall design uncertainty)
SN = Structural Number
ΔPSI = Serviceability loss at end of design life (Po=initial-Pt=terminal)
Po = Initial serviceability; Pt = Terminal serviceability
MR = Subgrade resilient modulus (psi)

Values in the following table shall be inputted into the Design Equation or Pavement Design Software that uses that equation. Any variation shall be justified in the Pavement Design Report.

i. Flexible Pavement Design Inputs

Tables 803.07 – Flexible Pavement Design

Parameter	Input Values
Design Life	20 years
18k ESAL	See Section 729.04.02
Reliability Level (%), Refer to 1993 AASHTO for Z_r value	95% - Arterial 90% - Collector Streets 85% - Local Streets and Parking Lots
Overall Standard Deviation, S_0	0.44
Initial Serviceability, P_0	4.5
Terminal Serviceability, P_t	2.5 – Arterial and all Collector Streets 2.0 – Local Streets and Parking Lots
Subgrade Resilient Modulus	Refer to MGPEC Pavement Design Standards Section 4.2
Layer Strength Coefficients, a_i	See Strength Coefficients Table
Drainage Coefficient, m	1.0

Flexible Pavement Section Thickness Calculation - Flexible pavement section thickness shall be calculated based on the structural number determined using the 1993 AASHTO Design Equation, and the equation below:

$$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

Where:

SN = Structural number
a_1 = Strength coefficient of asphalt
a_2 = Strength coefficient aggregate base or chemically treated subgrade
a_3 = Strength coefficient subbase layers
D_1 = Depth of asphalt (inches)
D_2 = Depth of aggregate base or chemically treated subgrade (inches) D_3 = Depth of subbase layers (inches)
m_2, m_3 = Drainage coefficient

Section 803.01 Rigid Pavement Structural Section

Use of Rigid Pavements will only be allowed with written permission of the City Engineer. Use of rigid pavements is prohibited where underlying soils have a PI greater than ten (10). Design of rigid pavements shall conform to MGPEC Pavement Design Standards (current edition) Section 5.2

The design of rigid (Portland Cement Concrete – PCC) pavements is a function of structural quality of the subgrade soil (R-value or CBR), traffic (ESALs), 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 subbases under concrete pavement to achieve greater structural capacity is considered to be uneconomical and will not be considered.

Section 803.02 Minimum Pavement Sections

The following table provides the minimum acceptable pavement sections for public roadways in the City of Littleton. These pavement thicknesses may be used for preliminary planning purposes. Final pavement designs must be based on actual subgrade support test results. If the calculated pavement sections indicate sections thinner than the Minimum Pavement Sections shown in the table below, the Minimum Pavement Sections, outlined in the table below, shall govern. The following table lists these minimum thicknesses for each roadway classification.

Table 803.08 - Minimum Pavement Sections

Classification	Minimum ESAL	Composite Section		Full Depth Hot MixAsphalt (inches)	Portland Cement Concrete (inches)*
		Hot Mix Asphalt (inches)	Aggregate Base Course or Treated Subgrade (inches)		
Arterial	2,200,000	10	12.0	12	10.0
Collectors**	1,500,000	8	10.0	10	9.0
Local Street and Private Street	73,000	6.0	6.0	8.0	5.5
Fire Lane	73,000	6.0	6.0	8.0	5.5
Parking, Cars Only	36,500	6.0	6.0	8	5.0
Parking, All Others	73,000	6.0	6.0	8	5.5

Notes:
*Rigid Pavement (Portland Cement Concrete) only permitted with permission of City Engineer.
**Includes Major Collectors, Collectors, and Minor Collectors

Section 803.03 Alternate Pavement Designs

The City understands the need to consider emerging technologies in pavement design. In light of this, any alternate pavement design will be reviewed and considered with respect to the following criteria:

A. Initial construction cost
B. Life cycle cost
C. Construction delay and impact
D. Facility maintenance and ease of repair
E. Pavement noise, smoothness
F. Industry capacity and local contractor capability
G. Special design provisions such as edge drains behind the curbs to intercept moisture from adjoining development and prevent it from adversely affecting the road subgrade and paving section.

The City reserves the right to make the pavement type selection using these and/or other criteria on City funded projects.

Warm mix asphalt (WMA) may be allowed as an alternate asphalt mixture provided that all material requirements and specification standards are met and as approved by the City.

Section 803.04 Pavement Design Report Deliverables

Deliverables for Final Pavement Design Reports and Design Confirmation Reports shall be as described in the MGPEC Pavement Design Standards (current edition) 6.1 and 6.2 respectively.

Section 804.00 Signs

Section 804.01 Types of Signs

A. Street Name Signs

Street name signs shall be furnished and installed by the Contractor or Developer and may be inspected by the City before and after installation. Street name signs shall have black letters on a white background, consist of the standard Littleton logo, and shall comply with the following:

1. All signs shall be constructed with 0.080-inch aluminum blanks. They shall have three-eighths (⅜) inch holes punched in the center two (2) inches from the bottom and top edges, white diamond grade, retro-reflective sheeting, with black Electro Cut film, retro-reflective letters or numbers.
2. The street name blank shall be nine (9) inches in height, with six (6) inch Series C upper case letters or numbers and three (3) inch MUTCD upper case prefix or suffix.
3. There shall be an adequate space to the left of the street name to provide for the placement of the City of Littleton logo. The logo shall be placed in the left face side of the sign and centered accordingly. Refer to details for specific spacing.
4. The length of the sign shall vary due to the length of the street name. MUTCD letters may be permitted to maintain the length of the street name sign
5. Signs shall have a one-half (½) inch black diamond grade, retro-reflective border for non-signalized intersection signs, signs mounted to signal equipment shall have a one (1) inch diamond grade, retro-reflective white border.
6. Silk-screened signs are acceptable if they are manufactured with diamond grade, retro-reflective sheeting and 3M “Scotchlite” Brand Process Colors transparent inks or equivalent. Signs fabricated with diamond grade sheeting with translucent 3M “EC” film or equivalent are also allowed.
7. At every cross intersection, two (2) street name signs shall be provided for each named street. At every tee intersection, one (1) street name sign shall be provided for each named street.
8. Signs manufactured with sheeting and letters placed back-to-back on the same sign blank are not permitted.
9. For sign installation, sign posts and support posts see Section 804.03 Sign Installation and Section 804.04 Sign Posts and Support Posts of these Standards and Specifications.

B. Stop Signs and Yield Signs

Stop signs shall be mounted on the same support posts as street name signs where possible. All signs shall have white diamond grade, retro-reflective sheeting with red Electro Cut film and meet the MUTCD Conventional Road Dimension charts and the MUTCD Standard Highway Signs.

For sign installation, sign posts and support posts see Section 804.03 Sign Installation and Section 804.04 Sign Posts and Support Posts of these Standards and Specifications.

C. Other Signs

Regulatory, warning, guide, informational, and custom signs shall be installed at locations reviewed and approved by the Traffic Engineer. All signs shall have high intensity, retro-reflective sheeting and shall meet the MUTCD Conventional Road Dimension charts and the MUTCD Standard Highway Signs. School and pedestrian warning signs shall be fluorescent yellow/green with diamond grade, retro-reflective sheeting.

For sign installation, sign posts and support posts see Section 804.03 Sign Installation and Section 804.04 Sign Posts and Support Posts of these Standards and Specifications.

D. "No Parking" Signs

"No Parking" signs shall be installed at locations designated and/or approved by the Traffic Engineer. All signs shall have high intensity, retro-reflective sheeting and shall meet the MUTCD Conventional Road Dimension charts and the MUTCD Standard Highway Signs.

Fire lane signs shall be provided in locations dictated by the adopted fire code for emergency access roads or as specified by the fire district, whichever is more restrictive.

For sign installation, sign posts and support posts see Section 804.03 Sign Installation and Section 804.04 Sign Posts and Support Posts of these Standards and Specifications.

Section 804.02 Sign Dimensions

Signs shall be fabricated in accordance with the dimensions described on the MUTCD Conventional Road Dimension charts and the MUTCD Standard Highway Signs.

Section 804.03 Sign Installation

Install per MUTCD Section 2A.20 and the CDOT Standard Specifications for Road and Bridge Construction.

All special mounting hardware shall be galvanized. All mounting nuts and bolts shall be steel and shall be five sixteenths (5/16) inch diameter x two- and one-half (2 ½) inch respectively. Mounting washers shall be steel and shall be three eighths (3/8) inch. No rivets or other alternatives allowed for mounting of signs to posts.

Section 804.04 Sign Posts and Support Posts

All sign supports and sign posts shall conform to specifications for perforated square steel tubing and to the latest ASTM A-569-72, Standard Specifications for Cold Rolled Carbon Steel, Commercial Quality. Tubing with plain finish, shall be roll-formed from twelve (12) gauge (105 U.S.S Gauge) hot rolled steel, ASTM A1011 Grade 50 pickled and oiled. Tubing with galvanized finish shall be roll-formed from twelve (12) gauge (.105 U.S.S. Gauge) hot rolled steel, galvanized material ASTM A653 Grade Fifty (50). The average minimum yield strength after cold forming shall be sixty thousand (60,000) PSI. Posts shall conform to the following sign dimensions:

Table 804.04 - Sign Post Dimensions

Number of Signs	Sign Post Dimensions	Anchor Post Dimensions
1	1-¾" x 1-¾" x 8'	2" x 3'
2	1-¾" x 1-¾" x 10'	2" x 3'
3+	1-¾" x 1-¾" x 12'	2" x 3'

The finished members shall be straight and shall have a smooth, uniform finish. Consecutive sizes of tubes shall freely telescope with a minimum amount of play. All holes and cut-off ends shall be free of burrs. Seven-sixteenth (7/16) inch diameter holes shall be punched on one (1) inch centers on the entire length of all sides of the tube. All posts shall be galvanized.

Section 805.00 Pavement Markings

The Contractor shall submit a Striping and Pavement Marking Plan to the Traffic Engineer for approval. The Striping and Pavement Marking Plan shall meet the requirements outlined in the MUTCD. All pavement marking symbols, crosswalk markings, and stop bars shall consist of preformed thermoplastic material conforming to Sections 713.12, 713.13, and 713.14 of the CDOT Standard Specifications for Road and Bridge Construction. All longitudinal striping shall be modified epoxy per CDOT standards unless approved by the Traffic Engineer. All transverse markings and symbols must comply with CDOT's Pavement Marking Practice Guide. The Contractor is solely responsible for placement and maintenance of all necessary temporary and permanent pavement markings until Construction Acceptance into Warranty is issued.

All temporary pavement markings shall comply with Section 627 of the CDOT Standard Specifications for Road and Bridge Construction.

Section 805.01 General

Pavement marking materials and construction shall comply with Sections 627, 713.12, 713.13, and 713.14 of the CDOT Standard Specifications for Road and Bridge Construction, and the approved plans. Placement shall comply with the MUTCD, the CDOT M&S Standards and the manufacturer's recommendations. All pavement markings shall be 0.125 mil thick.

Section 805.02 Typical Pavement Marking

Table 805.01 - Typical Pavement Markings

Double Yellow Line	4" with a 4" separation gap (4-4-4)
Median Yellow Line	4"
Yellow Passing Line	4" X 10' gap spaced 30' (ft)
White Turn Pockets	8"
Decel. or Accel. Lane	8"
White Skip Lines	4" X 10' gap spaced 30'
White Lane Extension Lines	8" X 2' gap spaced 6'
White Edge Line	4", 8" for bike lanes
White 45º Diagonal Hatch Line	8" at spacing equal to 1' per 1 MPH posted speed

Section 805.03 Typical Crosswalks

A. When no center road lines are present, center a crosswalk bar on the road and space every next bar four (4) feet apart towards the gutter edge.

B. When centerlines are present, center crosswalk bars on designated travel lane markings of the road and place bars parallel and next to the gutter. Then, space bars a minimum of four (4) feet apart as necessary

C. Align crosswalks to center of pedestrian ramps.

D. Keep crosswalk bars parallel to the traveling lane lines even if the crosswalk is skewed.

E. All crosswalk and stop bars must comply with CDOT's Pavement Marking Practice Guide.
F. Crosswalk bars shall not be placed in the wheel paths of travel lanes.

Table 805.02 - Typical Crosswalks

Crosswalk Bars	2' x 9'

Section 805.04 Typical Stop Bars

Table 805.03 - Typical Stop Bars

Stop Bars	24" wide from travel center yellow to edge of gutter

Section 805.05 Surface Preparation

A general cleaning of the pavement surface is required prior to placing beaded preformed thermoplastic materials. The cleaning shall remove oil, dirt, dust, grease, and other foreign materials. It is recommended that new thermoplastic pavement markings be applied immediately after new asphalt has been placed, thereby reducing the necessary surface preparation and allowing the asphalt rollers to inlay preformed pavement marking material. If the roadway striping cannot be placed immediately following paving operations, then it is the sole responsibility of the Contractor to apply and maintain temporary pavement markings to sufficiently delineate travel lanes until permanent pavement markings can be placed. Permanent pavement markings shall be placed within two (2) weeks of completion of paving operations, exceptions to be reviewed and approved by Traffic Engineer.

A. Removal of Pavement Markings

Existing pavement markings shall be removed by water blasting (if approved) or grinding unless a new surface will be immediately applied (seal coat, chip seal, etc). In such instances, the existing pavement markings may be ground so that a flush surface is achieved for the seal coating.

Section 805.06 Prior to Placement of Pavement Marking Materials

A. Control Points: Set control points to ensure compliance with the approved Striping Plan.

B. Conflicts: Verify that there are no conflicts between the approved Pavement Marking Plan and existing pavement markings.

C. Material: Verify the pavement marking materials to be installed.

D. Surface Preparation: Ensure the surface is cleaned and free of moisture, oil, dirt, dust, grease, and other foreign materials. Verify whether sandblasting or primer is required.

E. Temperature: Check that air temperature complies with the manufacturer's recommendations.

F. Signing Conflicts: Check for conflicts with signage.

G. Pre-placement inspection: inspection of control points and pre-markings shall be conducted by the City Traffic Operations Manager, or designee, prior to placement of permanent pavement markings.

Section 805.07 Placement of Pavement Markings

During the placement of pavement markings, regular checks shall be performed to ensure that the surface is clean and dry. The Contractor shall regularly check pavement markings for good workmanship and straightness. When placing pavement markings, the following requirements apply:

A. Application Procedures: Application procedures shall comply with the manufacturer's recommendations and these Standards and Specifications.

B. Application Rate: Application rate of pavement marking materials shall comply with these Standards and Specifications.

C. Reflective Beads: Check that the application rate of reflective beads complies with specified manufacturer requirements.

D. Protection: Traffic cones shall be used to prevent damage to new pavement markings.

E. Permanent Markings: Verify proper application of all permanent markings.

F. Conflicting Pavement Markings: Pavement markings shall not be conflicting or confusing.

G. Preformed Thermoplastic Pavement Markings: For the application of preformed pavement markings, consider the following:

1. Heating: Ensure that equipment provides proper heating and placement of material.
2. Existing Pavement: When placed on existing cold pavement, check for a clean, dry, and properly prepared surface. Verify if sandblasting is required. Ensure that primer, if required, has been properly applied. Check for appropriate splicing sequence.

Section 806.00 Traffic Signals

Section 806.01 Control of Work

The design criteria for all traffic signals shall be per the 2015 AASHTO "LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, First Edition", including interim revisions. An ultimately wind velocity of 130 MPH and a mean recurrence interval of one thousand seven hundred (1,700) years and an effective performance tested mitigation device approved by the City allowing for a fatigue importance Category II shall be used for all designs. The fatigue loads shall be calculated on the requirements of Section 11 of the 2015 AASHTO "LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, First Edition", including interim revisions and the following conditions:

A. Natural wind gusts based on the yearly wind velocity of eleven point two (11.2) MPH.

B. Truck-induced gust loads, as required by the owner of the structures.

An alternative traffic signal design without a mitigation device may be used if it meets the above-mentioned criteria in addition to a Category III galloping-induced cyclic loads and a fatigue importance of Category III. All alternative traffic signal poles and mast arms shall be hot dipped galvanized according to ASTM standard A123.

Section 806.02 Regulations and Code

Traffic signal materials and installation shall comply with these Standards and Specifications. Items not referenced in these Standards and Specifications shall conform to the latest edition of the Colorado Department of Transportation "Standards and Specifications for Road and Bridge Construction" and the Manual on Uniform Traffic Control Devices. All electrical equipment shall comply with these Standards and Specifications. In addition to the requirements of the approved plans, standard special provisions, and project special provisions, all material and work shall comply with the National Electrical Code (NEC), the National Electrical Manufacturers Association (NEMA), the Rules for Overhead Electrical Line Construction of the Public Utilities Commission, the Standards of the American Society for Testing Materials (ASTM), the American Standards Association (ASA) and all local ordinances and regulations that may apply.

Section 806.03 Inspection

All material delivered to the site shall be subject to inspection—prior to or during installation—as deemed necessary by the City Inspector. The City Inspector may request samples of certain materials from the factory or warehouse for testing purposes prior to delivery on the site. Material which has been rejected by the City shall not be delivered to the work site, and any material rejected at the work site shall be immediately removed from the site. Failure by the City to note faulty

material or workmanship during progress of the work shall not relieve the Contractor of the responsibility of removing and/or replacing faulty materials at the Contractor's expense during the warranty period.

Any work within the public ROW shall require two (2) working days (forty-eight (48) hours) prior notice to the City by the Contractor or Developer.

Any new traffic signal, or modification of the existing traffic shall comply with the approved construction plans.

Section 806.04 Traffic Control

Refer to Section 131.00 Traffic Control, Barricades and Warning Signs of these Standards and Specifications.

Section 806.05 Equipment List and Drawings

The Contractor shall submit a list of all materials and equipment proposed to be used in the work to the Traffic Engineer a minimum of five (5) working days prior to installation for approval. The submittal shall include all equipment and material as identified on the plans or in the specifications by the manufacturer's name which is necessary or customary in the trade to identify such equipment and material. The list shall include the name of manufacturer, size, material composition and catalog number of unit. Supplemental data, including detailed scaled drawings and wiring diagrams of any non-standard or special equipment, and any proposed deviation from the approved plans shall be submitted to the Traffic Engineer for approval.

The Contractor shall furnish all materials, equipment and labor needed to install and maintain temporary traffic signals during progress of the work. All intersections presently signalized shall be kept in operation until the new signal equipment is properly installed and ready for operation. If in the opinion of the Traffic Engineer, this is not possible because the installation of new equipment is in the same location as existing equipment, the Contractor shall not proceed with any work, which may cause the present equipment to become inoperative until all necessary replacement equipment is onsite.

Existing traffic signals shall remain operational until changing over and connecting new equipment. Signals shall be operational at the close of each day's work, over weekends, and during times when the Contractor is not working. When removal of a signal from operation is proposed, the City shall be notified in writing two (2) working days (forty-eight (48)) hours in advance.

Section 806.06 Coordination with Other Agencies and Contractors

Refer to Section 126.02 Permissions and Permits Required by Other Agencies of these Standards and Specifications.

Section 806.07 Traffic Signal Start-Up Procedures

The Contractor shall deliver all new traffic signal cabinets and controllers to the City for inspections, testing and programming a minimum of fifteen (15) working days prior to installation. The Contractor is responsible to schedule delivery and pick-up of all equipment with the Traffic Engineer. The City shall install all signal timings prior to the first turn on. The Contractor shall have a representative present at the first turn on.

Section 807.00 Traffic Control Materials

Section 807.01 Signal Heads

A. All signal units shall be modular section type and shall be adjustable with respect to positioning and lens replacement. Heads shall be polycarbonate or approved equivalent, black in color and shall meet the requirements of the latest version of the ITE standards "Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement" and "Vehicle Traffic Control Signal Heads: Light Emitting Diode Arrow Traffic Signal Supplement". Unless otherwise indicated on the plans, all signal and pedestrian displays shall be Traffic Engineer approved LED type and shall conform to the appropriate sections below.

B. Visors shall be detachable tunnel type, open at the bottom; be black in color on the outside and flat black on the inside.

C. Lenses shall be in accordance with ITE Specifications.

D. Sockets shall be fixed focus.

E. Doors on the signal heads, for the installation of lamps or other maintenance, shall not require use of any tool whatsoever to be opened. Doors and lenses shall be equipped with neoprene weatherproof gaskets to insure against infiltration of moisture, road film, and dust. Each three-color signal unit shall have the socket leads from all signal sections connected to a terminal board stamped with identifiable terminals. There shall be a terminal for color indication plus a common terminal where one lead from each socket shall terminate. The terminal board shall be mounted in the middle section and be properly insulated. All openings, top and bottom, shall be for one-half (½) inch pipe or pipe mounting brackets. Gaskets shall be supplied for top and bottom openings.

F. Traffic signal heads shall be attached using standard ASTRO-BRAC assembly or approved equivalent. Side of pole signal heads shall be installed with banding blocks and ninety (90) degree elbows with nipple length determined by the size of the head so as not to interfere with closing doors.

G. All pedestrian indications shall be countdown indication and LED. All heads shall be polycarbonate and black in color.

Section 807.02 Back Plates

A. Where shown on the plans, back plates shall be furnished and installed on signal faces. No background light shall show between the back plates and the signal face or between sections. All back plates are to be of aluminum construction, black in color, and shall be the louvered type. Back plates shall provide a five (5) inch border for all twelve (12) inch signal heads.

B. Traffic signal heads requiring back plates shall be drilled for three-sixteenths (3/16) inch diameter by one-half (1/2) inch pan head bolt with nut and lock washer. If the manufacturer fails to supply as described, it shall be the contractor's responsibility to do so. When installing back plates on the traffic signal head, the contractor shall furnish three-sixteenths (3/16) inch fender washers between bolt head and back plate.

C. The manufacturer shall fabricate all back plates with a three-sixteenths (3/16) inch washer on both sides of each rivet which is used to hold each section of the back plate together.

D. Back plates shall have two (2) inch yellow retro reflective border tape that outlines the outside edge of each back plate.

Section 807.03 Traffic Signal Lamps

A. LED indications shall be furnished for all signal indications unless defined otherwise in the standard drawings and shall include all circular (ball) and all arrow indications. Traffic LED indications shall meet the requirements of the latest version of the ITE Standards.

B. Verification of LED adherence to ITE standards shall be through a 3rd party "Nationally Recognized Testing Laboratory (NRTL)" to demonstrate compliance to Section 6.3 (Production Tests & Inspections) of the latest ITE VTCSH Full Ball specification dated June 27th, 2005 (for LED ball modules), and ITE VTCSH Arrow specifications dated July 1st, 2007 (for LED arrow modules), and ITE PTCSI Pedestrian specification dated March 19th, 2004 (for LED pedestrian combo or countdown modules). Third Party lab must have NRTL status. Proof of certification must be documented. Proof of certification must be presented when requested by the Traffic Engineer.

Section 807.04 Electrical Cable

Electrical signal cables shall be fourteen (14) AWG multi conductor, stranded, copper wire manufactured to meet International Municipal Signal Association (IMSA) 19-1 specifications or approved equivalent. Each conductor in the cable shall be individually insulated and rated at six-hundred (600) volts. There shall be a minimum of four (4) and a maximum of nine (9) strands per conductor. There shall be a separate twenty-one (21) conductor cable installed from the controller cabinet to the bottom hand hole of each signal pole. From that point, a separate five (5) or seven (7) conductor cable for each overhead signal shall be spliced to the twenty-one (21) conductor cable. Outboard signal heads shall use seven (7) conductor cable to accommodate for present or future left turns.

Section 807.05 Service Cable

Two (2) No. TRW 8, seven (7) strands, tinned, soft drawn copper wire, one sixteenth (1/16) inch neoprene insulation, black and white in color.

Section 807.06 Detectors

A. Inductive Loop Detection: This specification defines the minimum design operational and performance requirements for multiple channel, digital self-tuning inductive loop detectors. Detector units shall be card rack mounted plug in type and operate from an external twenty-four (24) VDC power supply. Detector units shall be in full compliance with the environmental and size requirements of NEMA standard TS1 Section 15 and meet the design, operation, electrical and functional performance requirements of both TS1 and TS2 specifications.

1. The front panel shall include an erasable, write-on channel identification area and clearly indicated switch operating position. I.D. area one (1) centimeter square per channel minimum.

2. All component parts and test points shall be clearly identified by permanent markings of circuit referenced on the P.C. Board. Integrated circuit devices having sixteen (16) or more leads shall be socket mounted to facilitate repair and maintenance of units. Detectors supplied to this specification shall be warranted by the supplier to be free of defects in materials and workmanship for a period of five (5) years from date of shipment from manufacturer.

3. Each detector unit shall include two (2) or four (4) complete detector channels. Each channel shall sequentially energize its loop inputs to eliminate crosstalk (mutual coupling) between large, very closely spaced adjacent loops connected to the same unit. The sequential time sharing, and digital processing of loop inductance data shall be accomplished on a single LSI microcircuit per unit for maximum reliability. The method of measuring shall be crystal reference digital period counting and multi-channel scanning. Only one channel input per unit shall be active at any point in time.

    i. Sequential scanning shall fully prevent crosstalk between channels of a detector connected to closely spaced or overlapped loops for directional detection.
    ii. Sequential scanning shall allow two (2) detection channels to operate with full performance using a common home run cable.
    iii. Sequential scanning shall allow two (2) or more detection channels to be connected to a single detection amplifier with full operating performance, including separate mode and sensitivity selection capability on each channel.

4. Each channel of the sensor unit shall automatically self-tune to any loop and lead-in inductance from twenty (20) to twenty-five hundred (2500) microhenries within two (2) seconds with full sensitivity after application or interruption of supply voltage. Units shall also track changes in loop/lead-in electrical characteristics, as might reasonably be expected to occur in undamaged loops, properly installed in sound pavements, without producing false indications or changes in sensitivity.

5. Each detector unit shall be provided with a loop test switch position to verify loop system integrity and reduce maintenance costs. The "open loop test" position shall indicate a previous fault via the front panel indicator. The memory shall remain intact and can be queried repeatedly. Existing detections shall not be reset, and the memory shall only be reset by power interruption as by removing and reinserting the plug-in detector units.
6. Each channel shall include a sixteen (16) position push type wheel switch to allow selection of eight (8) pulse sensitivities, seven (7) presence levels and a "Reset" and an "Off" position. Each detector unit shall include eight (8) sensitivity selections in 2:1 steps that can be correlated to the relationship of the number of turns of wire in a loop versus the sensitivity required to detect a specified vehicle. The selections shall be designed to allow detection of licensable vehicles in loops of two (2) or more turns electrically in series, parallel or series/parallel configuration in non-reinforced or reinforced pavements with lead-in/home run combinations from fifty (50) feet to one thousand (1,000) feet. The number of turns in a loop, electrical configuration of multiple loops and pavement type shall dictate the sensitivity required for proper predictable detection.
7. If specified, channel presence time shall be modified if delay or extension time is selected. The timing switch shall select delay or extension or "Off", if no timing is desired. Internal DIP switches shall provide for selection of "Delay" time of zero to thirty-one (0 to 31) seconds in one (1) second increments and "Extension" time of zero to seven point seven-five (0 to 7.75) seconds in point two five (0.25) second increments.
8. Presence indicators shall be wide angle, high brightness type LED suitable for sunlight visibility. When timing is selected, and a channel is active that channel's indicator shall flash at four (4) Hz during Delay and at sixteen (16) Hz during Extension to indicate timing is in progress. Further, the timing shall be aborted when the vehicle is no longer present and/or the channel control input shall become inactive. The Delay timer shall be reset when a vehicle leaves the loop prior to time out and shall abort when the control input becomes inactive. The Extension timer shall operate and reset when a vehicle leaves the loop and be aborted when the control input becomes inactive. Each timer (Delay and Extension) shall be provided with buffer circuitry to enable or disable the timer, based on an external input (green gate) signal. The circuit shall be designed for AC or DC input control on AC powered units and for DC control on DC powered units.
9. Each detector unit shall utilize a ΔL = (Delta L) thresholding technique to provide a more constant, predictable vehicle detection sensitivity with series added inductance, i.e., many loops connected in series and/or long lead-in/home runs will generally require the same sensitivity setting as would be required for a single loop with short lead in, to simplify setup.

10. Each channel shall automatically recover from intermittent opens or multiple shorts to ground. Each channel shall tolerate and continue to operate with no change with a single point short to ground on the loop or lead in system. Each channel shall provide a continuous, non-resettable (fail safe) output and indication in response to an open loop/open lead in system. The open loop indication and output shall not be resettable as long as the open exists, except that they shall be defeated when the channel "Off" position is selected.
11. Extended features shall include: Two (2) serial ports (front panel RS232 and Edge connector Xmit/Recve), TS1 and TS2 compatible from manual or software switch, microloop occupancy detection, traffic counting capable to include long-loop presence count from fifteen (15) minute to infinite intervals all accessible from either serial interface, Dual Detect and Fault LED indicators per channel, External inputs to control Timing functions and enable Remote Reset, Extended diagnostics, programming and Live status available via serial interface utilizing windows compatible software.
12. Loop Wire - Refer to Approved Products List. Loop wire shall consist of single conductor No. 14 stranded THHN with an outer protective sleeve.
13. Loop Lead-In Cable - Detector loop lead-in cable shall be a four (4) conductor point two five (0.25) inch diameter, shielded and jacketed cable suitable for installation in a pavement saw slot, conduit or direct burial. Conductors shall be AWG No. 18 stranded copper with polypropylene insulation. The conductors shall be twisted at least six (6) turns per foot. Color rotation shall be black, red, white, green. The interior of the cable shall be filled with an amorphous material which prevents water penetration. Aluminized polyester shielding shall be applied around the conductors to prevent electromagnetic interference. The Cable jacket shall consist of black high-density polyethylene. The jacket shall not be degraded by prolonged exposure to typical pavement runoff components. The cable shall be suitable for operation at temperatures of 60oC to +80oC. (Canoga 30003 43#18 AWG shielded loop detector lead in cable or approved equivalent.).

Section 807.07 Emergency Vehicle Preemption

Emergency vehicle detectors for emergency vehicle preemption to be used shall be as listed on the Approved Products Lists. Placement of the Detectors shall be determined by the Traffic Engineer, and South Metro Fire Rescue. Optical phase selector modules for emergency vehicle preemption to be used shall be as listed on the Approved Products Lists. The lead-in cable for the Emergency Vehicle Optical Detectors to be used shall be as listed on the Approved Products Lists.

Section 807.08 Pedestrian Push-Button Station

A. General:

1. Pedestrian push button stations to be used shall be as listed on the Approved Products Lists. Pedestrian push buttons shall be ADA compliant accessible detectors and integral with the push button/push button sign station.
2. The button housing shall be black in color and shall include a nine-inch width by twelve-inch height (9” W x 12” H) sign, MUTCD Reference # R10-3, or approved equivalent, and shall be installed as shown on the Standard Details.
3. Pedestrian push buttons shall be of tamper proof design.
4. The assembly shall be weatherproof.
5. The housing shall be shaped to fit the curvature of the pole to which it is attached to provide a rigid installation. Saddles shall be provided to make a neat fit when required.
6. Push-buttons shall be located in accordance with ADA specifications and the MUTCD.
7. Push button locators shall only be used where specified in the plans and project specials and may be considered by the Traffic Engineer on a per project basis. When push button locators are requested, this function shall be integrated as part of the pedestrian push button, the pedestrian push button shall be of the manufacturer and model number specified and shall conform to the MUTCD.
8. Audible tactile pedestrian indications shall only be used where specified in the plans and project specials and may be considered by the Traffic Engineer on a per project basis. When audible tactile pedestrian indications are requested, they shall be per the Approved Products List and shall conform to the MUTCD. The system shall consist of a Central Control Unit and Pedestrian Push Button Stations, as described below, and handheld infrared devices, PC with USB A-B cable, or Ethernet connections to CCU2EN for programming the system settings. The System shall be manufactured by an ISO 9001:2008 registered company.

B. Pedestrian Push-Button Cable: Two (2) conductor No. 14, seven (7) strands, tinned, soft drawn copper wire, one sixteenth (1/16) inch neoprene insulation. Conductors to be twisted. Color coded one (1) white and one (1) black.

Section 807.09 Traffic Signal Poles, Pedestals and Mast Arms

Traffic signal poles, pedestals, and mast arms shall be of the general configuration shown on the standard drawings.

A. New Structures:

1. All new signal poles shall conform to the City of Littleton standards signal pole design.
2. All new signal poles and mast arms shall be hot dipped galvanized according to ASTM standard A123.
3. Any galvanized surface areas damaged during handling or installation shall be repaired immediately..

B. Existing Structures:

1. All designated previously installed signal poles and mast arms with existing painted finish shall be field painted. All exterior surfaces shall be cleaned and examined for damaged paint, and any such damage shall be given a spot coat of primer and the entire exterior surface repainted. Previously painted surfaces whether finish or prime coats, shall be scuff sanded to yield 500 PSI of adhesion with particular attention paid to the lower eight (8) feet of the pole. Inspection of the poles prior to application of the finish coat is required.
2. A finish coat of a product listed on the Approved Products Lists shall be applied over the primer or previously painted surfaces. Two (2) coatings shall be applied leaving approximately six (6) mils of dry film. The color shall be a dark bronze formula which is available from the Traffic Engineer.
3. The painting shall be done in a neat and workmanlike manner and shall be applied either by hand brushing or spraying. The Traffic Engineer reserves the right to require the use of brushes for the application of paint if the work done by the paint spraying machine prove unsatisfactory or objectionable.

Section 807.10 Controller Cabinet

A. General:

1. All controllers and auxiliary equipment shall be housed in a factory wired, weatherproof, metal cabinet following NEMA specification TS2 Type P. The cabinet shall have minimum interior dimensions, exclusive of stiffeners, shelf brackets, etc., of height forty-six (46) inches, width twenty-nine (29) inches, and depth fifteen (15) inches.
2. The cabinet shall be constructed of point one two five (0.125) minimum thickness bare aluminum. Cabinets shall be braced internally or by folded seams in order to provide sufficient rigidity to withstand normal handling and transport to the field location without deforming.
3. The main door shall have a self-locking, keyed, tumbler lock with two (2) keys. Hinges shall be mounted on the cabinet in such a way that interchangeability of doors is possible between cabinets of like size and manufacturer. Hinge pins shall be stainless steel. Doors shall have neoprene gaskets of sufficient thickness to provide a rain tight and dust tight seal.

4. A police or auxiliary door shall be provided. It shall be constructed so that no sharp edges protrude from the main door and shall provide access to panel with labeled switches for automatic to flashing operation and signal power on/off.
5. The cabinet shall be equipped with a thermostatically controlled ball bearing fan with a capability of at least one hundred (100) cubic feet per minute. The fan shall be mounted in a weatherproof housing attached to the top of the cabinet. The thermostat shall be adjustable to turn on between ninety (90) degrees Fahrenheit and one-hundred fifty (150) degrees Fahrenheit and be so mounted as to be easily accessible for adjustment from the front of the cabinet. Cabinet shall have internally mounted fluorescent tube light and one gooseneck incandescent light.
6. The cabinet shall have two shelves each capable of supporting seventy-five (75) pounds. Shelves shall be supported on brackets which provide for height adjustments. Each cabinet shall contain a ten (10) mil thick plastic envelope with side opening. It shall be a minimum size of ten by twelve (10 x 12) feet and be attached to the door by screws.
7. Assembly Wiring All cabinet wiring shall be neatly arranged and laced or enclosed in plastic tubing. No harness or wire shall be attached to any shelf rack or other point where it may be damaged by movement of shelves or doors.
8. Terminal Facilities Terminal facilities (load bays) shall be firmly attached in a position not less than six (6) inches from the bottom of the cabinet so as to provide easy access and maximum convenience to the user.
9. Side mounted auxiliary panels shall be firmly installed with the forward edge not more than four (4) inches from the door sill and not less than six (6) inches from the bottom of the cabinet in all cabinets.
10. The load bay and its associated equipment, harness, switches, etc., shall be grouped on removable panels. Each panel or group of receptacles and connecting cables shall be arranged to permit so that work can be performed on panel backs or cables.
11. A load switch bay and flash transfer capability is required for each phase. Load switches shall be provided for only the phases shown on the plans.
12. The load bay shall be protected by a main circuit breaker. A gas tube surge arrester with MOV and a suitable radio interference filter shall be supplied. The arrester shall be a three (3) electrode type with the following ratings:
    a. Impulse Breakdown: less than 1,000 volts in less than 0.1 microseconds at 10 KV per microsecond
    b. Standby Current: less than one (1) milliampere
    c. Striking Voltage: greater than two-hundred twelve (212) VDC
    d. Energy Capability: capable of withstanding pulses of peak current each of which will rise in eight (8) microseconds and fall in twenty (20) microseconds to one half (½) the peak voltage at three (3) minute intervals.

e. Peak Current Ratings shall be 20,000 amps. The MOV shall have ratings equal to or better than a General Electric type VI50LA20A. The RFI filter shall have a current rating equal to or greater than the main circuit breaker capacity.

13. Field terminals shall be screw type, capable of accommodating at least three (3) #12AWG wires. All terminals in the load bay shall be permanently identified by engraving, silk screening or contrasting plastic labels. Terminal blocks shall be the barrier type and no live parts shall extend above the barrier.
14. 8 convenience outlets with a ground fault interrupter fused at fifteen (15) amps shall be provided. They shall be located in a position which is convenient and safe for service personnel.
15. All AC power busses, switch or relay lugs and/or similar activity connection points which extend more than one and one-half (1½) inches from the panel are to be protected by insulation for safety. The locations of these items shall provide reasonable protection for service personnel.
16. Signal power relays shall be mercury wetted, equal to or greater than circuit breaker capacity. Flash transfer relays shall be as manufactured by Midtex Model 136 62 T 3A1, 120 VAC, DPDT, 30 amp with Jones Plug base and dust cover or approved equivalent.
17. Flasher. The cabinet shall be equipped for flashing operation of signal lights with a two (2) circuit solid state flasher in accordance with the latest NEMA specifications (15 amps per circuit). Flashing operation shall be set for flashing red on all approaches. Pedestrian and turn signals shall be extinguished during flashing operation. The flashing mechanism shall remain in operation during shutdown or removal of controller.
18. Load Switches. The cabinet shall be equipped with solid state load switching assemblies in accordance with the latest NEMA specification. Each load switch to be equipped with a three (3) input LED indicator. Load switches shall contain three (3) separate cube type solid state relays, which use a solid state switch which is capable of operations at 240 VAC and 25 amps when properly heat synced but derated to ten (10) amps when used in load pack assembly.
19. Conflict Monitor/Malfunction Management Unit (MMU). The cabinet shall have provision for conflict prevention in accordance with the latest NEMA TS2 specification. Conflict prevention shall be provided by a conflicting display monitor unit that monitors all green, yellow and walk displays and detects absence of reds to cause flashing operation and stop timing if conflicting indications are detected. Removal of the monitor from the cabinet shall cause flashing operation.

20. Emergency Vehicle Preemption. The cabinet shall be equipped and wired with an Opticom Card rack mount for GTT Model or as otherwise specified by South Metro Fire Rescue. All equipment shall be capable of accommodating a minimum of two modules with capability of four channel operation.
21. Ground Wire - Single conductor, AWG No. 8, soft-drawn bare copper wire.

Section 807.11 Controllers

A. General:

1. Compatibility: The local controller and cabinet shall be one hundred (100) percent compatible with the City of Littleton's existing computerized signal system which utilizes Econolite equipment. The local controller to be used shall be as listed on the Approved Products List.
2. An actuated controller shall be completely solid state, electronic device capable of selecting and timing traffic movements. It shall provide timing and load switch control for each major vehicular phase, including concurrent associated pedestrian movements. The controller shall conform to the latest NEMA and ATC specifications and shall provide for complete and full operation of eight (8) phases from within either a TS1 or TS2 Type P cabinet.
3. The controller shall have all electronic components easily accessible and arranged in functional groupings on the printed circuit boards. Printed circuit boards shall be designed to facilitate identification of components for maintenance purposes. Printed circuit design shall be of NEMA specification quality and designed so that components can be removed and replaced without permanent damage to the board or track.
4. Front-panel inputs shall be via touch screen or by clearly labeled elastomeric keypad. These shall use a ten (10) digit numerical keypad, Main and Sub keys, toggle keys, special function and enter keys, six function keys, status and help keys and a large, four (4) direction cursory control key.
5. The display shall be a seven (7) inch, color, TFT (Thin Film Transistor) LCD (Liquid Crystal Display) with high brightness. It shall be readable in direct sunlight. The display shall perform over the NEMA temperature range and shall have a resolution of eight hundred by four hundred eighty (800 X 480) with an eighteen (18) bit color depth. The luminous intensity shall be a minimum of eight hundred (800) nits. The display shall include an industrial, resistive touch screen that can be operated with gloved hands. The touch screen and display shall not be affected by condensation or water drops.
6. All circuitry components shall be available on the open market and the original manufacturer's part number shall be shown on the part's list.
7. Overlap programming shall be provided through the keyboard. Protected-Permissive Left Turn, Flashing Yellow Arrow shall be an overlap programming choice.

8. An entry mode to any single-phase parameter of a keyboard controller shall not affect any other parameter or the same parameter on another phase, unless programmed by specific keyboard instructions, such as, "copy" sequences or other prescribed methods of rapid program entry.
9. Every controller supplied shall be the manufacturer's latest, first line production model tested and delivered by a domestic manufacturer who is regularly engaged in the construction of such equipment.
10. Each controller shall be supplied with a complete set of operational and service manuals, wiring schematics and parts layout up to a maximum of ten (10) sets per order. Any controller for which these documents are not available is not a production model within the meaning of these specifications.
11. Each controller shall have a SD card slot.
12. Preemption. All actuated controllers shall be equipped to accommodate four (4)
13. E.V.P. inputs and one (1) railroad preemption input. Controller software shall be capable of being updated, database copied, or logs from a USB memory stick or a SD card.
14. A Logic Processor shall be capable of testing inputs, outputs and timers. If true, it shall set inputs, outputs or other functions. The logic processor shall be programmed by the end user to accomplish unusual operations.
15. The controller shall offer Peer to Peer operation using the logic processor to test for conditions at neighboring intersections over Ethernet.
16. The controller shall offer sequence choices following preemption to service the longest queue, pedestrian movements interrupted, phases interrupted or free for one (1) cycle with special timing before returning to coordination.

B. Coordination Unit:

1. The coordination unit shall be an internal function within each local controller and shall meet, as a minimum, the following functional requirements.
2. The coordinator shall provide one-hundred twenty (120) patterns each consisting of a cycle length, splits in seconds or percentages and an offset in seconds or percentage.
3. Standard NEMA functions shall be used to control the intersection timing.
4. The coordinator shall be capable of changing the controller's phase sequence upon command.
5. The coordinator shall be capable of setting the intersection free by loss of system sync, cycle/offset false commands, free command and telemetry failure.
6. The coordination unit shall be capable of setting the intersection into a flashing operation in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways, latest edition.

7. The controller shall be capable to operate using an internal Ethernet or serial port.
8. Time base coordination mode shall be provided as a backup with all standard coordination features available. At least two (2) seven (7) day programs shall be available with fifty (50) additional holiday programs in the event of a master controller or communications failure. Time base standby mode shall be programmable for an entire year with automatic daylight savings and leap year changes.

Section 807.12 Uninterrupted Power Supply (UPS)

A. General:

1. A UPS shall be incorporated in all new traffic signals and where otherwise specified in the plans and/or project specials. The UPS to be used shall be as listed on the Approved Products List.
2. The UPS shall be installed per manufacturer's specifications.
3. Programming software and manuals shall be supplied with each UPS and shall become the property of the City at the completion of the project.
4. A UPS shall include all labor, equipment, and materials necessary to install the UPS complete-in-place.

B. Operational Specifications:

1. Power Input/Output:

a. Use 120VAC, 60Hz, single phase source input.
b. Provide for input surge suppression.
c. Output a single-phase pure AC sine-wave regulated at 120VAC positive three (+ 3) percent, 60 Hz.
d. Be capable of operating in the voltage range of 85VAC to 135VAC without using the batteries.
e. Be of double-conversion/true on-line design.

Double-Conversion/True On-Line: As a double-conversion/true on-line design, the UPS shall be in an "always on" condition such that it continuously monitors the input and provides continuous frequency and voltage regulation of the output. Upon loss of power, the UPS shall transfer to battery mode in 0ms. No transfer time shall be experienced when transitioning to/from full UPS operation.

f. Be installed in series with the utility power such that the UPS powers the entire traffic signal cabinet and all associated equipment.

2. Temperature:

a. Negative thirty-four point six (-34.6) degrees Fahrenheit to one hundred sixty-five point two (165.2) degrees Fahrenheit (negative thirty-seven (-37) degrees Celcius to positive seventy-four (+74) degrees Celcius).
b. Humidity – ten (10) to ninety (90) percent non-condensing.

3. Run Time:
    a. Provide for full signal operation at an average of seven hundred (700) Watts for a minimum of two (2) hours, with additional minimum flash time of two (2) hours.
    b. Provide for user definable full run time settings to define full run time prior to the UPS transitioning to flash operation.
    c. Provide for user definable battery level flash settings by which the user can change battery level flash settings.
    d. Remain in, or automatically transition to flash operation, when utility power fails and the UPS battery levels are below, or fall below, the user defined battery level settings.
    e. Restore the signal to full operation any time utility power is restored, or power is supplied via the generator receptacle.
    f. Include a low battery cutout to prevent critical discharge of, and damage to, the UPS batteries.
    g. Provide a battery recharge of ninety-five (95) percent within eight (8) hours.
4. Indications, Alarms, Faults:
    a. Provide a means by which the user can accurately check the battery charge level, and UPS load level.
    b. Provide indications which display the current condition of the UPS including the presence or absence of a critical UPS fault, and the presence or absence of utility power.
    c. Provide an automatic bypass switch by which the UPS unit is bypassed and runs off utility power if a critical internal UPS fault occurs.
    d. Provide a single dry contact relay output and alarm trigger with user definable trigger options to notify the owner of critical events and/or failures to include:
        i. UPS critical fault
        ii. Loss of utility power input
        iii. Low battery condition
5. Switches, Ports, Receptacles, Controls:
    a. Provide Ethernet SNMP port for remote configuration and monitoring of the UPS via the traffic/transportation network.
    b. Provide a bypass switch by which the user can manually bypass the UPS and power the signal via utility power. This feature is to be used in the case of UPS failure and/or the need for UPS maintenance or repair services.
    c. Include a generator receptacle accessible via the exterior of the traffic and UPS cabinets.
    d. Provide automatic sensing of generator power. The UPS shall be configured such that the UPS provides regulated 120VAC, 60Hz, single phase output power to run the signal in full operation and recharge the UPS batteries while under generator power. The UPS shall be configured to run the signal in full operation regardless of the UPS' battery charge

level. The UPS unit shall automatically sense when generator power is applied, and when generator power fails. The UPS shall be configured such that it automatically reverts to generator power when generator power is applied. When generator power fails (generator power falls outside of acceptable signal tolerances), the UPS shall automatically revert to either utility power or UPS battery power respectively based upon the availability at the time.

e. Provide all required software and cabling for both networked remote and local UPS monitoring and management.

6. Hardware, Software, Cabling: All UPS units shall include all components, hardware, cabling, installation manuals, and software required for complete installation, operation, programming, monitoring, and maintenance of the UPS system.

7. Warranty: All proposed UPS equipment shall be warranted for a period of two (2) years by the manufacturer.

Section 807.13 Aluminum Pedestal Mounts

Aluminum pedestal mounts (Type III) shall be either of two (2) types, as called for in the plans and specifications. Center mount with two (2) side ports, plain or offset mount serrated with one (1) side port.

Section 807.14 Mast Arm Brackets

Mast arm brackets to be used shall be as listed on the Approved Products List and shall be installed ninety (90) degrees to the roadway.

Section 807.15 Instructions and Wiring Diagrams

All equipment shall be provided with three (3) sets of complete installation instructions, including a complete chart of field connections as well as a manual for the controller, containing service instructions, wiring diagrams, trouble-shooting procedures, etc. Each and every component used shall be clearly referenced in the service manual and its value, ratings and manufacturer part number shall be given.

Section 807.16 Guarantee

The contractor shall include in their proposal all warranties and/or guarantees with respect to materials, parts, workmanship and performance to be supplied. The minimum guarantee period for the product shall be two (2) year from the date of final acceptance of the contract. The contractor shall attach to the bid a statement that all material to be supplied is either in exact accordance with the specifications or shall list in detail any and all deviations therefrom. The supplying of equipment that is not in accordance with the specification and on which the contractor has indicated no exception shall be cause for rejection of the equipment and correction of the non-specification items entirely at the contractor's expense.

Section 808.00 System Communications

Section 808.01 Ethernet Managed Switch

A. An Ethernet Managed Switch shall be provided with all traffic signals. The Ethernet switch to be used shall be as listed on the Approved Products List.

B. An Ethernet Managed Switch shall include all equipment, and materials necessary to install the item complete-in-place, including, but not limited to, switch operating system, SFPs, hardened power supplies, power cords, CAT5e Ethernet cables, console serial cables, and single-mode fiber patch cords.

C. Unless otherwise specified, the contractor shall be responsible for proper programming, setup, and testing of the Ethernet Managed Switch. The City shall provide IP addresses to the contractor. At the City's discretion, the City may opt to have their maintenance contractor or other third-party complete Ethernet Managed Switch, setup and/or testing. When the City's maintenance contractor or other third party is enlisted for programming, setup, and/or testing of the Ethernet Managed Switch, associated costs for the maintenance contractor or third-party labor shall be the responsibility of the City.

Section 808.02 Radio/Wireless Communications

When radios are specified in the project plans and/or specifications, and unless otherwise specified, radios to be used shall be as listed on the Approved Products List and shall include the radio, power supply, antenna, antenna surge/lightning suppressor, equipment mounts, and all associated cabling, connectors and strain relief hardware as required to support Ethernet communications to the local traffic signal controller. All materials shall be as approved by the radio manufacturer. A site survey with the local vendor representative shall be required during the design process and prior to installation to assure radio communication is functioning appropriately.

Unless otherwise specified, Yagi antennas shall be used. The antenna gain for each Yagi antenna shall be determined as a result of the wireless site survey. When specified in the project plans and/or specifications, a wireless site survey shall be required and shall include both a site analysis and spectrum analysis to verify line-of-sight and define existing wireless link interference prior to installation. A wireless site survey report shall be issued to the Traffic Engineer following a wireless site survey and shall define installation requirements, including use of an antenna riser(s), and anticipated link signal loss.

Where use of antenna pole risers are specified or requested, antenna riser lengths shall be limited such that the riser extends no more than ten (10) feet beyond the top of the traffic signal pole or structure. Where additional height is required, written authorization shall first be required from the Traffic Engineer.

While installation includes radio programming, the City may opt to have the radio turned over to them for programming prior to installation, returning the radio to the Contractor after programming for completion of field installation. Where the Contractor is to complete radio programming, the Traffic Engineer shall provide programming parameters as required.

When being directed by the Traffic Engineer, and prior to antenna installation, the Traffic Engineer shall define the structure on which to mount the antenna, the antenna orientation, and the direction in which to point the antenna.

Section 808.03 Traffic Signal Interconnect Cable - Fiber Optic

A. General Fiber Specifications:

1. Unless otherwise noted, all traffic signal interconnect communications shall be accomplished through a fiber optic cable system.
2. Fiber optic cable shall be of the count and configuration specified in the Plans or supplemental documentation as provided by the City.
3. Fiber optic cable shall comply with the latest version of all industry standards designated herein, including all addendums and revisions. Applicable standards development organizations are expected to include, but are not limited to, Telcordia Technologies (formerly Bellcore), Electronic Industries Alliance (EIA), Telecommunications Industry Association (TIA), International Telecommunications Union (ITU), International Electrotechnical Commission (IEC), American Society for Testing and Materials (ASTM), Insulated Cable Engineers Association (ICEA), National Fire Protection Association (NFPA).
4. Fiber optic cable used for projects in the City of Littleton shall be new and unused, unless otherwise specified in the Plans or directed by the Traffic Engineer.
5. Fiber optic cable construction shall conform to the requirements of ICEA S-87-640 Optical Fiber Outside Plant Communications Cable and Telcordia GR-20 Generic Requirements for Optical Fiber and Optical Fiber Cable. The cable shall employ a non-armored, all-dielectric, loose tube design for outside plant installation with a single outer jacket and dry water blocking materials in the cable interstices and buffer tubes.
6. Fiber optic cable installation into a building shall conform to the requirements of Article 770 of NFPA 70 National Electrical Code (NEC).
7. All fibers in the fiber optic cable must be usable single mode optical fibers conforming to the requirements of ITU-T G.652D for zero water peak and low polarization mode dispersion. It shall also conform to the requirements of Telcordia GR-20.
8. All optical fibers shall be free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
9. Unless otherwise specified in the Plans or directed by the Traffic Engineer, no less than twenty-five (25) feet of fiber cable slack shall be neatly coiled within each pull box (non-splice location) included as part of the fiber optic cable run. Fifty (50) feet of fiber slack shall be coiled in all pull boxes designated as a splice location.

B. Fiber Specification Parameters:

1. Color Code: The individual colors for optical fibers and cable buffer tubes shall comply with the TIA-598 Optical Fiber Cable Color Coding standard.

2. Central Strength Member: The central strength member functions as an anti-buckling element and shall be a glass/epoxy composite dielectric rod. A polyethylene overcoat shall be applied to the central member to provide the proper spacing between buffer tubes during stranding.
3. Cable Buffer Tubes:
    a. Optical fibers are enclosed within buffer tubes that have a diameter several times larger than the diameter of the fibers. The optical fibers are loose within the buffer tubes allowing the fibers to move freely. The loose buffer tubes shall have a minimum 2.3 mm diameter depending on the number of fibers contained within each buffer tube.
    b. Buffer tubes shall be constructed out of industry standard polybutylene terephthalate or similar thermoplastic polymer.
    c. Each buffer tube shall contain twelve (12) fibers.
    d. Filler rods may be included in the cable core to lend symmetry to the cable cross-section where needed.
    e. The buffer tubes (and filler rods, if necessary) shall be stranded in a Reverse Oscillation Lay (ROL) technique around the central strength member to allow for easy mid-span access. The core of buffer tubes shall be wrapped with two counter helically applied threads to bind together the cable core.
    f. Binders shall be applied with sufficient tension to secure the buffer tubes to the central strength member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.
    g. Tensile strength shall be provided by high tensile strength aramid yarns, fiberglass yarns, or both.
    h. Water blocking of the cable core interstices and inside the buffer tubes shall be accomplished via dry water blocking elements.
    i. Each buffer tube shall be color coded with distinct and recognizable colors in accordance with EIA-359 Colors for Color Identification and Coding and TIA-598. Buffer tube coloring shall be stable during temperature cycling and shall not be subjected to fading or smearing onto each other or into the dry water blocking material in each buffer tube. Colorings shall not cause fibers to stick together.
4. Cable Outer Jacket Characteristics:
    a. All-Dielectric cables shall be sheathed with medium or heavy density polyethylene. The minimal nominal jacket thickness shall be one point four (1.4) mm. Jacketing material shall be applied directly over the tensile strength members and dry water blocking material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.
    b. The cable sheath shall be free of holes, splits, and blisters.
    c. For ease of outer jacket removal, a minimum of one clearly identifiable polyester ripcord shall be provided directly under the cable sheath.

5. Cable Outer Jacket Markings:
    a. For standard outer jackets, printed characters shall be indent printed with white characters for black jackets, and black characters for non-black jackets.
    b. The characters shall be of proper height and space to produce good legibility. A minimum character height of two (2) mm shall be required.
    c. The cable length shall be sequentially marked in “feet” at a minimum spacing of 1 meter intervals. The length intervals shall not be reset to zero on any length of the cable. The actual cable length must be within positive to negative three (± 3) percent of the marked length.
    d. Each length of the cable shall be marked with manufacturer’s name, manufacturer’s part number, month and year cable was manufactured, fiber counts, fiber type, telephone handset symbol (as required by Section 350G of the National Electrical Safety Code) and manufacturer’s serial number.
6. Cable Packaging:
    a. The manufacturer shall supply the product using their standard reel sizes, methods, apparatus, and lagging. The Contractor shall order standard reel sizes specific to the project in an effort to minimize the introduction of passive attenuation due to unnecessary reel-to-reel cable splices. The minimum barrel diameter of the reel shall not be less than thirty (30) times the cable diameter.
    b. Reels are assumed to be in good working condition, firm, and able to support the product through shipping and final installation. Reels shall be clean, dry, and free of excessive dirt. All reels shall be checked for high nails, stave fit, and proper stenciling.
    c. Each wood reel shall be permanently marked with the manufacturer’s name, “OPTICAL CABLE”, an arrow with the words “CABLE END” to indicate the position of the outer cable end, an arrow with the words “ROLL THIS WAY” to indicate the direction that the reel shall be rolled to prevent loosening, and reel number.
    d. Outer layers of the reel shall be covered with a protective wrap to limit the solar heating of the cable.
    e. Each end of the cable shall have end seals in order to prevent moisture ingress into the cable during shipping, storage, or installation.
    f. The top end of the cable shall be securely fastened to the inside of the reel flange to prevent the cable from becoming loose in transit or during handling. The bottom end, “Test Tail”, shall be approximately three meters in length and easily accessible. The end shall be protected within a cable slot and be securely fastened to the outside of the reel flange with wire ties or walkout straps.
    g. Each cable shall have certified test data securely fastened to the reel in a waterproof wrapping. The certified test data shall include the following information:
        i. Cable Number
        ii. Date
        iii. Customer Name
        iv. Ordered Length

v. Customer Order Number
vi. Ship Length
vii. Customer Cable Code
viii. Customer Reel Number
ix. Customer Attenuation Specifications
x. Final Attenuation Inspection Test Report for Each Fiber:
- Number of Fibers
- Type of Fibers
- Cable Construction
- Authorized Signature

j. Each cable shall have a reel tag securely fastened to the reel in a waterproof wrapping. The reel tag (Cut Length Data Sheet) shall include the following information:
i. Cable Number
ii. Date
iii. Customer Name
iv. Ordered Length
v. Customer Order Number
vi. Ship Length
vii. Customer Cable Code
viii. Customer Reel Number
ix. Customer Attenuation Specifications
x. Number of Fibers
xi. Beginning and Ending Sequential Length Markings
xii. Gross Weight
xiii. Net Weight
xiv. Inspected by Signature

Section 808.04 Fiber Optic Splicing and Terminations

Description:

A. This work consists of furnishing and installing hardware used to splice and terminate single mode fiber optic cable. All fiber optic industry standards referenced herein shall be the current, adopted version that is active, including all amendments, changes and revisions noted by its respective standards development organization.

B. Materials:

1. Fiber optic splice closures shall utilize a dome closure design with an end plate system that allows independent access to each cable port without disruption to the surrounding cables. For backbone-to-lateral splices and backbone-to-backbone splices, the fiber optic splice closure shall not exceed nine (9) inches in diameter by eighteen (18) inches in length. The closure shall be able to accommodate a maximum of one-hundred forty-four (144) single fusion splices and support the corresponding management of buffer tubes and trays required. The closure shall accommodate both loose tube butt and mid-span access splicing. A minimum of four (4) cable ports shall be provided on the end plate system and the closure shall be rated for below grade installation within a splice vault or manhole. The closure shall have the capability to be assembled and disassembled without the need for any special tools. The closure shall be tested and approved in accordance with Telcordia GR-771 Generic Requirements for Fiber Optic Splice Closures by an independent outside laboratory. Closures shall be re-enterable, re-usable, hermetically sealed and utilize flexible grommet cable seals at each cable port appropriate for the fiber optic cables being fusion spliced. At a minimum, each closure shall include an end plate with buffer tube organizer, one (1) dome, one (1) dome gasket, one (1) dome collar, silicone lubricant, hose clamps (appropriate for number of cable ports), flexible grommet cable seals appropriate for the number of cables, strength member brackets (as needed), port seals (for sealing unused cable ports), mounting bracket kit (for installation within splice vaults and manholes), cable support hooks (for orderly coiling of fiber optic cable in splice vaults and manholes) and other required accessories not specifically mentioned herein.

2. Fusion splicing of backbone-to-backbone and backbone-to-lateral fiber optic cables shall be stored and protected within the fiber optic splice enclosure. The Contractor shall utilize a fusion splicer that automatically positions, aligns and fuses together two (2) stripped, cleaned and cleaved optical fibers with an electric arc. The Contractor shall provide strain relief and protection of each stripped fiber splice by utilizing heat-shrink sleeves and housing the splices in splice trays within the closure. The maximum individual splice loss of single-mode fiber shall not exceed 0.10 dB.

3. Fiber optic termination assemblies shall include termination patch panel, connector bulkheads, single mode lateral fiber optic cable (lateral fiber optic cable) and associated hardware. Termination panel shall be configured with the required number of connector ports as shown in the Plans. If no connector port information is provided in the Plans, a minimum of six (6) ports shall be required for a six (6) fiber lateral cable and a minimum of twelve (12) ports shall be required for a twelve (12) fiber lateral cable, unless otherwise specified by the Traffic Engineer. The fiber optic termination assemble connector bulkheads shall be single mode, Straight Tip (ST), Ultra Physical Contact (UPC) type. The lateral fiber cable shall be factory terminated on one (1) end with ST connectors, the other end shall be pigtailed. The lateral fiber optic cable shall be of an appropriate length as noted on the Plans for splicing to the backbone fiber optic cable at the splice vault or manhole adjacent to the traffic signal controller cabinet. If no length is provided on the Plans, the minimum cable length shall be one hundred (100) feet. The lateral fiber optic cable shall be designed and tested in accordance with Telcordia GR-3152 Generic Requirements for Hardened Multi-Fiber Optical Connectors.
4. Each fiber optic termination assembly utilized for projects in the City shall be outdoor-rated for operation in temperatures ranging from negative forty to positive one hundred fifty-eight degrees Fahrenheit (-40ºF to +158ºF). Its lateral fiber optic cable shall be rated for outside plant installation and use all-dielectric cable construction.
5. The factory terminated ST connectors on the lateral fiber optic cable shall have an UPC finish for single-mode fiber with an insertion loss not exceeding 0.5 dB and a reflectance of ≤ -50 dB as specified by TIA-568-C.3 Optical Fiber Cabling Components.

Each connector shall utilize a ceramic ferrule and the durability of the connector shall change ≤ 0.2 dB by 500 re-matings in accordance with TIA-455-21 Mating Durability of Fiber Optic Interconnecting Devices.

C. Construction Requirements:

The Contractor shall provide the City with one (1) copy of the manufacturer's installation instructions for each type of fiber optic splice closure and fiber optic termination assembly. All installations shall be in accordance with the manufacturer's recommendations, except as otherwise directed by the Traffic Engineer. All additional costs including damage to fiber optic cables, splice closures, fiber optic termination assemblies and optical end equipment caused by the Contractor's neglect of recommended procedures shall be the Contractor's sole responsibility.

If not provided by the City, the Contractor shall submit a Method Statement to the Traffic Engineer indicating cable routing, splice points and cable end splicing locations. Installation of splice closures and terminating hardware shall not be permitted until the schematic diagram has been approved by the Traffic Engineer.

The fiber optic termination assembly's lateral fiber optic cable shall be back fed, pigtailed end, in a continuous run from the traffic signal controller cabinet to the backbone fiber optic cable splice location. The length of the lateral fiber optic cable

shall be sized adequately when ordering the product to accommodate both the run distance and coiling requirements in splice vaults and manholes as designated on the Plans or described in the City's fiber optic specifications. Strain relief for the lateral fiber optic cable shall be provided at a minimum of two (2) locations within the traffic signal controller cabinet.

The Contractor shall splice fiber cables at locations shown on the Plans and as approved by the Traffic Engineer in the Contractor's Method Statement. All splices shall be enclosed within a splice closure as approved by the City. Following successful splicing, the splice closure shall be placed inside the splice vault or manhole. The Contractor shall use tools and hardware recommended by the splice closure manufacturer.

Only proposed active (lit) fibers shall be spliced in the closure and terminated in the traffic signal controller cabinet, unless otherwise specified by the Plans. All unused (dark) fibers of both the backbone and lateral fiber optic cables shall remain uncut and be neatly coiled in the splice tray within the closure. All unused buffer tubes shall remain uncut and neatly coiled along with the buffer tubes used for splicing in appropriate locations in the splice closure.

Backbone and lateral fiber optic cable buffer tubes and fiber strands shall be labeled on the splice tray prior to sealing of the closure.

Unless otherwise specified on the Plans, the Contractor shall coil a minimum of one hundred (100) feet of backbone and lateral fiber optic cables in splice vaults and manholes.

The Contractor shall ensure that all cable coils are attached to the cable management hardware in all splice vaults and manholes as stipulated by the Traffic Engineer.

The Contractor shall utilize a fiber optic termination assembly at each traffic signal controller cabinet, unless otherwise shown on the Plans or directed by the Traffic Engineer.

Unless otherwise specified by the Plans or directed by the Traffic Engineer , all fiber jumpers connected to the fiber optic termination patch panel in traffic signal controller cabinets shall utilize single-mode fiber that conforms to the requirements stated in the City's fiber optic specifications and have a, UPC finished, ST connector on the fiber optic termination patch panel end and an appropriate connector type for connection to the optical end equipment. The reflectance value of the connectors on both ends of each jumper shall conform to the connector requirements previously stated.

D. Measurement and Payment:

1. Measurement:(Each) Fiber optic splice closure shall be measured by each and shall include all fusion splicing, splice trays, heat-shrink sleeves, labor, materials, tools, equipment and incidentals required to fusion splice the cable.

2. Fiber optic termination assembly shall be measured by each and shall include all labor, materials, tools, equipment and incidentals required to splice its integrated fiber optic cable pigtail to the backbone cable. It shall also include:

a. All required optical attenuators, fiber optic jumper cables, CAT5e cables and serial cables (as applicable) within each traffic signal controller cabinet where a fiber optic termination assembly is installed and at corresponding fiber optic termination panels at City Hall. Payment:

b. Payments shall be made according to the pay items below:

Fiber Optic Splice Closure	Each
Fiber Optic Termination Assembly	Each

3. Testing fiber optic cable shall be measured and paid for separately in accordance with the City's "Testing, Identification and Administration of Fiber Optic Infrastructure" standard specification

Section 808.05 Testing, Identification and Administration of Fiber Optic Infrastructure

A. General

1. Work Included. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the fiber optic work called for in the Contract.

2. Scope. This section includes the minimum requirements for acceptance testing, identification and administration of backbone and lateral fiber optic cabling. This section includes the minimum requirements for the following:

   a. Fiber optic test instruments
   b. Fiber optic testing
   c. Identification
      i. Tags and associated labeling
      ii. Labels and associated labeling
   d. Administration
      i. Test results documentation
      ii. As built drawings

3. Testing shall be carried out in accordance with this document. This includes testing the attenuation of the installed fiber optic cable plant with an Optical Loss Test Set (OLTS) and the installed condition of the cabling system (and its components) with an Optical Time Domain Reflectometer (OTDR)

4. OLTS testing shall be performed on each terminated strand of fiber in the cable (patch panel to patch panel)

5. OTDR testing shall be performed on each strand of fiber in the cable (terminated with a connector or bare end)

6. All tests shall be documented including the following:

   a. OLTS dual-wavelength attenuation measurements for single mode fiber optic links
   b. OTDR traces and event tables for single mode fiber optic links

B. Quality Assurance

1. All testing procedures and field-test instruments shall comply with applicable requirements of the following recognized standards:
    a. TIA-455-78 – (FOTP 78) Optical Fibers – Part 1-40: Measurement Methods and Test Procedures – Attenuation
        i. TIA-455-133 – (FOTP 133) Optical Fibers – Part 1-22: Measurement Methods and Test Procedures – Length Measurement
        ii. TIA-455-160 – (FOTP 160) Optical Fibers – Part 1-50: Measurement Methods and Test Procedures – Damp Heat (Steady State)
        iii. TIA-526-7 – (OFSTP 7) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
        iv. TIA-568-C.3 – Optical Fiber Cabling Components Standard
        v. TIA-606 – Administration Standard for the Commercial Telecommunications Infrastructure (including the requirements specified by the City, unless the City specifies their own labeling requirements)
2. Only trained technicians who have successfully attended an appropriate fiber optic training program, which includes testing with an OLTS and an OTDR, and have obtained a certificate as proof thereof shall be allowed to perform fusion splicing, fiber connectorization and fiber optic cable testing. These certificates must have been issued by any of the following organizations or a City-approved equivalent organization:
    a. Fiber optic cable manufacturer
    b. Fiber optic patch panel and/or connector manufacturer
    c. Test equipment manufacturer
    d. Approved training organizations:
        i. Association of Cabling Professionals (ACP)
        ii. Building Industry Consulting Service International (BICSI)
        iii. Electronics Technicians Association (ETA)
        iv. Fiber Optic Association (FOA)
        v. International Municipal Signal Association (IMSA)

    The Contractor shall provide a copy of each proposed technician's valid certificate or ID card to the Traffic Engineer for review and approval, including a list of task(s) associated with each technician.
3. The Traffic Engineer shall be invited to witness and/or review field testing.
    a. The Traffic Engineer shall be notified of the start date of the testing phase five (5) business days before testing commences.

C. Submittals

1. Manufacturers catalog cut sheets and specifications for fiber optic field test instruments including OLTS (power meter and source) and OTDR.
2. A list of all cable segments and corresponding fiber optic strands to be tested (unless already called out in Plans).
3. Test reports.
4. Acceptance of Test Results
   a. Unless otherwise specified in writing by the Traffic Engineer , each cabling link shall be in compliance with the following test limits:
      i. OLTS Testing
         - Single Mode Fiber - The link attenuation shall be calculated by the following formulas:
         - Link Attenuation (dB) = Cable Attenuation (dB) + Connector Attenuation (dB) + Splice Attenuation (dB)
         - Cable Attenuation (dB) = Attenuation Coefficient (dB/km) x Cable Length (km)
         - Attenuation Coefficient = 0.35 dB @ 1310 nm and 0.25 dB @ 1550 nm
         - Connector Attenuation (dB) = # of Connector Pairs x Connector Loss (dB)
         - Maximum Allowable Connector Loss = 0.50 dB
         - Splice Attenuation (dB) = # of Splices x Splice Loss (dB)
         - Maximum Allowable Splice Loss = 0.30 dB
      ii. OTDR Testing
         - Reflective events (connections) shall not exceed 0.50 dB.
         - Non-reflective events (splices) shall not exceed 0.30 dB.
   b. All installed cabling links shall be field tested and pass the test requirements and analysis described in 50.3.5 section C. Any link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements. Test results for all links shall be provided in the test results documentation in accordance with Part 3.
   c. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with the Contract and to the satisfaction of the Traffic Engineer.
5. Measurement and Payment Procedures
   a. Measurement of fiber optic cable warning tags and labels shall be as specified in 50.3.5 section C. Compensation for the fiber optic cable warning tags and labels shall be considered as included in the price paid for total LINEAR FEET of new fiber optic cable and no additional compensation shall be allowed thereof. The compensation for fiber optic cable warning tags and labels shall

include full compensation for furnishing all labor, materials, tools, equipment and incidentals required to perform the work.

b. Measurement of record copy drawings and as-built drawings shall be as specified in 50.3.5 Section D. Compensation for the record copy drawings and as-built drawings shall be considered as included in the price paid for total linear feet of new fiber optic cable and no additional compensation shall be allowed thereof. The compensation for record copy drawings and as-built drawings shall include full compensation for furnishing all labor, materials, equipment and incidentals required to perform the work.

c. Measurement of OLTS testing shall be as specified in Section 1.02D. Compensation for OLTS testing shall be based on the total number of new fiber STRANDS tested and no additional compensation shall be allowed thereof. The compensation for OLTS testing shall include full compensation for furnishing all labor, materials, tools, equipment, calibration and incidentals required to perform the testing, including completion of the End-to-End Attenuation Testing table(s) provided in the Plans in accordance with 50.3.5 Section C2i of these Specifications.

d. Measurement of OTDR testing shall be as specified in Section 1.02E. Compensation for OTDR testing shall be based on the total number of new fiber STRANDS tested and no additional compensation shall be allowed thereof. The compensation for OTDR testing shall include full compensation for furnishing all labor, materials, tools, equipment, calibration and incidentals required to perform the testing, including test results documentation in accordance with Sections 50.3.5 Sections C2J and D.

E. Products

1. Fiber Optic Cable Testers

a. The field test instrument shall be within the certified calibration period of one calendar year.

b. OLTS

i. Single mode fiber optic light source
- Provide dual laser light sources with central wavelengths of 1310 nm (± 20 nm) and 1550 nm (± 20 nm).
- Output power of -10 dBm minimum

ii. Power meter
- Provide 1310 nm and 1550 nm wavelength test capability.
- Power measurement uncertainty of ± 0.25 dB
- Store reference power measurement
  - Save at least 100 results in internal memory
  - PC interface (serial or USB)

iii. Length measurement (optional)
- Length measurements shall be made with an OLTS only if it is capable of measuring the optical length of the fiber using time-of-flight techniques

c. OTDR

i. OTDR shall have internal non-volatile memory and removable memory device with at least 8 MB capacity for results storage
ii. OTDR shall have serial and USB ports to transfer data to a PC
iii. OTDR shall provide wavelengths of 1310 nm (± 20 nm) and 1550 nm (± 20 nm)
1. OTDR shall provide event dead zones of 11.5 ft. (3.5 m) maximum at 1310 nm and 1550 nm
iv. OTDR shall provide attenuation dead zones of 32.8 ft. (10 m) maximum at 1310 nm and 39.4 ft. (12 m) maximum at 1550 nm
v. OTDR shall support a distance range of not less than 32,810 ft. (10,000 m)
vi. OTDR shall have a dynamic range of at least 10 dB at 1310 nm and 1550 nm

d. Integrated OLTS and OTDR

k. Test equipment that combines into one instrument an OLTS and an OTDR may be used

2. Identification

a. Fiber Optic Cable Warning Tag

Figure 1. Fiber Optic Cable Warning Tag

i. Tag shall have the following minimum dimensions: one point seven five feet height by three point eight seven five feet length (1.75 x 3.875)
ii. Each tag shall have three (3) point one six seven (0.167) inch holes on each side as shown in Figure 1 of this subsection
iii. Tag shall have an orange background with black foreground and text as shown in Figure 1 indicating: CAUTION - FIBER OPTIC CABLE
iv. Below the text FIBER OPTIC CABLE in Figure 1, the Contractor shall write-in SMFO for single mode fiber optic cable and XX for the fiber count of the cable, e.g., “SMFO 48” for forty-eight (48) strand single mode fiber optic cable. A permanent industrial marker shall be utilized for writing on the tag such as the Sharpie Mean Streak® Permanent Marking Stick or Sharpie Industrial Fine Pen.
v. Tag shall be made from point two (0.02) inch thick vinyl.
vi. Two (2) eight (8) inch black cable ties shall be included with each tag.

vii. Tag must have a minimum five (5) year written warranty for outdoor durability

viii. One tag shall be placed on each fiber optic cable (e.g., backbone or lateral) entering a pull box, splice vault, manhole, traffic signal controller cabinet or building as required in Part 3 of this document. Where a splice closure is located in a splice vault or manhole, tags shall be placed on each side of the splice closure for the backbone and lateral cable(s)

b. Fiber Optic Cable Label

Figure 2. Fiber Optic Cable Label

3. Label must have the following minimum dimensions:
   - A = one (1.00) inch
   - B = two point five (2.50) inch
   - C = point seven five (0.75) inch

   a. Label shall meet the adhesion, defacement, exposure and legibility requirements of UL 969 Marking and Labeling Systems
   b. Labels shall be temperature stable from negative ninety-four (-94) degrees Fahrenheit to positive one hundred fifty-eight (+158) degrees Fahrenheit
   c. Labels shall either be preprinted using a mechanical means of printing (e.g., laser printer) or field printable using a handheld or portable label printer (e.g., smear-proof ribbons or thermal printing)
   d. Labels shall have a vinyl substrate with a white printing area and a clear “Tail” that self laminates the printed area when wrapped around the cable.
   e. One label shall be placed on each fiber optic cable (e.g., backbone or lateral) entering a pull box, splice vault, manhole, traffic signal controller cabinet or building. Where a splice closure is located in a splice vault or manhole, labels shall be placed on each side of the splice closure for the backbone cable(s)
   f. The text on each label shall be as defined in Section 50.3.5.C.3

4. Administration

   a. Administration of the documentation shall include test results of each fiber link.
   b. The test result information for each link shall be recorded in the memory of the field test instrument upon completion of the test.

c. The test result records saved within the field test instrument shall be transferred into a Microsoft Windows™ -based spreadsheet or database utility that allows for the review, archiving and maintenance of these test records.

F. Execution:

1. General

a. All tests performed on single mode fiber optic cabling that use a laser in a test set shall be carried out with safety precautions in mind by the Contractor.
b. All cables, termination panels and associated components shall be fully assembled and labeled prior to the initiation of field testing. Any testing performed on incomplete systems shall be redone on completion of the work.

2. Fiber Optic Cable Testing

a. Contractor shall verify that the test jumpers (OLTS) and test fiber box (OTDR) are of the same fiber core size and connector type as the cable system.
b. Contractor shall verify that optical sources are stabilized and have center wavelengths within positive or negative twenty (± 20) nm as stipulated.
c. Contractor shall ensure that the power meter and light source are calibrated at each of the nominal test wavelengths and traceable to the National Institute of Standards and Technology (NIST) Special Publication 250-54 calibration standard. The OTDR must also be calibrated and traceable to the NIST calibration standard. Calibration certificates shall be provided to the Traffic Engineer for review and approval to ensure that the power meter, light source and OTDR have each been calibrated within the past calendar year. Any test equipment whose calibration certificate is over two (2) years old, must be recalibrated and a copy of the new calibration certificate provided to the Traffic Engineer for review and approval prior to use on this Contract.
d. Contractor shall verify that all field test instruments have the latest software and firmware installed.
e. Contractor shall verify that the power meter and the light source are set to the same wavelength.
f. Contractor shall ensure that all system connectors, adapters and jumpers are properly cleaned prior to and during measurement.
g. Link test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) shall be generated.
h. Testing of the cabling shall be performed using high quality test jumpers of the same fiber type and core diameter as the cabling under test. The test jumpers for OLTS testing shall be between three point three (3.3) feet (1 m) and sixteen point four (16.4) feet (5 m) in length. The test fiber for the OTDR testing shall be approximately nine hundred eighty-four (984) feet (300 m) for the launch cable so that the first connector on the link is visible in the trace.
   i. OLTS Testing
      - Single mode links shall be tested at one thousand three hundred ten (1310) nm and one thousand five hundred fifty (1550) nm in accordance with TIA-526-7 for patch panel to patch panel testing.

- The Contractor shall follow the test procedures established by the referenced standard to accurately conduct performance testing.
- Prior to the initiation of OLTS testing, a reference reading shall be made and recorded between the light source and power meter using the test jumper. The reference reading shall be re-measured after every two hundred (200) measurements or every eight (8) hours, whichever occurs first. The reference readings shall be provided to the Traffic Engineer.
- End-to-end link attenuation does not include any active or passive devices other than cable, connectors and splices.

i. OTDR Testing

i. Single mode links shall be tested at the appropriate operating wavelength for anomalies and to ensure uniformity of cable attenuation, determine connector insertion loss and measure splice loss.

ii. Each fiber link shall be tested at the dual-wavelength and bi-directionally to meet transmission equipment certification.

iii. A test fiber box shall be installed between the OTDR and the first patch panel, unless otherwise recommended by the OTDR manufacturer.

iv. Cable Acceptance: The Contractor shall evaluate the integrity, overall length and fiber attenuation in dB/km for each fiber strand in the cables before and after installation. The City will use this information to check the cable against its specification, uncover point defects due to handling during transport or installation and effectively measure terminated and unterminated fibers.

- Before Installation Cable Inspection – Prior to cutting a reel into sections and installing the various cable segments, the Contractor shall utilize an OTDR to evaluate the fiber optic cable's initial quality and integrity. The Contractor shall access one cable end from the reel to verify the length and attenuation of each fiber in the cable for comparison to the cable manufacturer's factory test results. All detected point faults and/or discontinuities caused by shipping and handling shall be brought to the attention of the Traffic Engineer. All test results shall be provided to the Traffic Engineer and approved in writing before cable installation can begin.

v. Trace Documentation: All OTDR traces shall be stored electronically.

vi. Connector and Splice Loss: The Contractor shall measure and document all field-installed connectors and fusion splices so that a determination can be made about their acceptability or if they need to be redone.

3. Identification

a. Labeling

i. Fiber Optic Cable Warning Tag: The fiber optic cable type and fiber count shall be handwritten by the Contractor as specified in this Section.

ii. Fiber Optic Cable Label: The labeling strategy for this type of label shall conform to the requirements below, as specified in in this Section and as shown in Figure 2.

- Highway where the fiber optic cable is located.

- Backbone (BB) or lateral (LT) fiber optic cable.
- Destination of fiber optic cable from building, traffic signal controller cabinet, pull box, splice vault or manhole.
- Allowable abbreviations consist of the following:
  - Building (BLDG)
  - City Hall (CH)
  - East (E)
  - Eastbound (EB)
  - Manhole (MH)
  - North (N)
  - Northbound (NB)
  - Pull box (PB)
  - Quadrant of intersection or interchange (QD)
  - South (S)
  - Southbound (SB)
  - Splice vault (SV)
  - Traffic Signal controller cabinet (TS)
  - West (W)
  - Westbound (WB)

G. Administration:

1. Test Results Documentation:

   a. Provide one (1) digital copy either by email or CD-ROM version of test results documentation to the Traffic Engineer for review and approval
   b. Test results shall be organized and bound in a logical order. It shall start at one end of a corridor and logically progress to the end of the corridor rather than skipping around. OLTS and OTDR test results shall be separated within the same document.
   c. Results of every attenuation test shall be included.
   d. The Contractor shall expand the vertical and horizontal scales used on the OTDR display to maximize the amount of detail shown on the OTDR traces, even if these parameters can be adjusted later using the display software. The software and applicable licenses required to read the OTDR traces shall be provided to the City at no extra charge.
   e. OTDR traces must identify the end points of the fiber under test and the fiber designation. If this information is not provided by the trace itself, the Contractor shall provide a cross-reference table between the stored trace file name and the fiber designation.
   f. For each field-installed connector and fusion splice performed by the Contractor, an OTDR measurement shall be made bi-directionally unless approved by the Traffic Engineer at the 1310 and 1550 nm wavelength and averaged to ensure it meets the required specifications.
   g. Test results saved within the field test instrument shall be uploaded to the PC unaltered. The file format, Comma Separated Value (CSV), shall not be accepted because it does not provide adequate protection of these records.

h. The test results documentation shall be provided to the Traffic Engineer within ten (10) working days of completion of tests. The Contractor shall retain a copy to aid preparation of as-built documentation.
i. The detailed test results documentation data is to be provided for each tested optical fiber and shall contain the following information:
    i. The identification of the highway corridor where the fiber was installed (as specified by the Traffic Engineer).
    ii. The name of the test or test limit and its relationship to the segment of the highway corridor.
    iii. The name of the Contractor and its personnel performing the test
    iv. The date and time that the tests were conducted.
    v. The manufacturer, model number and serial number of the field test instrument.
    vi. The name and version of the test software and firmware.
    vii. The fiber identification number.
    viii. The length for each optical fiber as calculated by the OLTS or OTDR.
    ix. The index of refraction used for length calculation when using a length capable OLTS.
    x. Test results of OLTS attenuation for each link at the appropriate wavelengths and the margin (difference between measured and calculated).
    xi. Test results of OTDR link traces and event tables at the appropriate wavelengths.
    xii. The overall Pass/Fail evaluation of the link under test for OLTS and OTDR measurements.

2. Record Copy and As-built Drawings

a. The intent of the as-built drawings is to provide accurate and detailed information, in a useful format, to any party, private or public, that has a need to locate, excavate, modify or expand installed infrastructure. Questions regarding as-built drawings shall be directed to the Traffic Engineer. Discretion shall be employed in the drafting of as-builts in terms of the functional quality of the drawings. If too much information is included on one (1) sheet as to make its use impractical to comprehend, a second or third drawing shall be required.
b. It is recommended that the Contractor maintain a tabloid sized set of approved plans on site and, during construction, accurately mark these plans with record information. As an example, the color green could be used to indicate all additions and the color red to indicate all deletions. Clear and concise notes and sketches shall accompany changes marked on the plans to document the basis for the modifications.
c. The following requirements shall be applied to each as-built plan developed for the City. As-built drawings shall be prepared by revisions to the original, approved plans. At no time shall the original plan data be accepted as the as-built data. The following general requirements shall be required for all as-built drawings:
    i. All drawings shall bear the name, address and telephone number of the firm preparing the drawing and the date the as-built data is added to the original via the revision block.

ii. All drawings shall bear the name of the Contractor(s) along with a statement (with an original signature on each sheet) stating that the as-built drawings reflect the true conditions in the field and that all construction standard specifications and product qualities have been met or exceeded.
iii. "As-built drawing" shall be clearly labeled on each sheet.
iv. Street names shall be on all streets. All easements and right-of-way shall be shown and clearly labeled.
v. If the fiber optic infrastructure is to be private (not to be dedicated to the City), then it shall be clearly stated on each sheet.
vi. The locations and description of any existing utility lines (overhead or underground, as applicable) known to exist within the construction area.
vii. The locations and dimensions of any changes to poles, cabinets and buildings, as applicable.
viii. Changes in details of the design or additional information such as approved placement details, conduit sizes, material changes, etc.
ix. Where plans or specifications allow options, only the option actually used in the construction shall be shown on the as-built drawings.

d. Record copy drawings shall be provided by the Contractor to the Traffic Engineer at the end of the project in electronic format. The drawings shall be in AutoCAD or other approved format, per the City format and include notations reflecting the as-built conditions of any additions to or variation from the drawings provided such as, but not limited to, cable routing, fiber assignments and terminations. AutoCAD or other approved format drawings shall include OLTS results in a tabular format for historical baseline information. The project will not receive final acceptance and retainage or bond until record drawings are in a form acceptable to the city's Asset Manager and integrated into the city's GIS system.
e. The as-built drawings shall include, but are not limited to, network layout diagrams, splice diagrams and port-to-port jumper terminations. The as-builts shall include all field changes made up to construction completion including:
f. Field directed changes to splicing
i. Field directed changes to terminations
ii. Backbone cable type or routing changes
iii. Lateral cable type or routing changes
iv. Pull box or splice vault type or location changes
v. Splice closure and associated component changes
vi. Termination patch panel changes
vii. Jumper and/or connector type changes
viii. End equipment changes
ix. Associated detail drawings to help explain changes

Section 809.00 Street Lighting

Streetlights shall be provided at all arterial street/road intersections and as required on all newly developed streets in the City to deliver adequate and uniform lighting coverage. Streetlights shall not be placed within sidewalks or curb ramps.

Lighting on residential streets shall be ninety to one hundred twenty-five (90-125) watt LED on galvanized metal or fiberglass poles, twenty-five (25) feet in height unless otherwise approved by the City. The poles shall be spaced three hundred (300) feet apart on alternating sides of the street. All intersections and cul-de-sac bulbs shall have a minimum of one (1) light. If a segment of street between intersections is greater than four hundred and fifty (450) feet and less than six hundred (600) feet, a light shall be installed at the center of the segment.

Lighting on arterial streets shall be ninety to one hundred twenty-five (90-125) watt LED on galvanized metal or fiberglass poles, thirty-five (35) feet in height. The light fixture shall be the round style with a flat lens (hockey puck) on ten (10) foot long mast arms, unless otherwise approved by the City. The poles shall be spaced three hundred (300) feet apart on alternating sides of the street. A minimum of two lights shall be placed on diagonal corners at all intersections and signalized locations.

Lighting on collector streets shall be ninety to one hundred twenty-five (90-125) watt LED on galvanized metal or fiberglass poles twenty-five (25) feet in height. The light fixture shall be the round style or with a flat lens (hockey puck), unless otherwise approved by the City. The poles shall be spaced three hundred (300) feet apart on alternating sides of the street. A minimum of two lights shall be placed on diagonal corners at all intersections and signalized locations.

The Developer shall a submit street light plan and design during the plan review process. The developer must provide a copy of the proposed site plan with proposed streetlight layout design and appropriate photometric analysis as required during the development application process.

Junction boxes and poles shall be installed within landscaping area, outside of the pedestrian path.

Streetlights shall be installed when development occurs and shall be funded by the Developer. Construction of the new streetlights shall be coordinated between the developer, appropriate electrical utility and the electrical contractor.

The type and style of light within the subdivision are up to the developer to choose the character they want to create for the neighborhood, subject to availability from the serving electric utility.

Section 810.00 Traffic Control

Section 810.01 Traffic Control

A. Measurement: (Lump Sum) - No separate measurement will be made for maintaining and channelizing traffic as required by the latest revision of the "Manual on Uniform Traffic Control Devices for Streets and Highways" and the Colorado Department of Transportation supplement thereto.

B. Payment: Payment of the contract amount bid will be paid as follows: twenty-five (25) percent will be paid upon the first utilization of traffic control devices or flag persons.

C. Seventy-five (75) percent balance will be prorated and paid according to the percent of the original contract amount approved for payment, but subject to retainage.

D. Payments made shall be full compensation for: furnishing, erecting, maintaining, moving, removing and disposing of temporary control devices; providing traffic control management, flagging and pilot car operation.

Section 810.02 Traffic Control Devices

A. Measurement: (Each) - Traffic control devices will be measured by the actual number of the various types specified on the Bid Schedule, installed.

B. Payment: Accepted quantities of traffic control devices will be paid for at the contract unit price bid. No separate measurement or payment will be made for excavation, concrete footings, pedestals, posts, structural frame members, sign panels, mounting brackets, backing angles, hardware, lighting fixtures, electrical equipment, lamps, switch boxes, photo-electric controls, controllers, conduit, wiring, cable, cabinets, faces, loop detectors, magnetometer detectors, sensors, amplifiers, mast arms, cable, painting, messages, pavement cutting and sawing, backfill, asphalt replacement, electrical hookup between power source and switch, etc., but shall be included in the work.

SECTION 900 CONCRETE MIX DESIGN AND CONSTRUCTION

Section 900.00 Contractor Responsibilities

The Contractor shall be responsible to be fully informed of and shall comply with all sections of these Standards and Specifications, applicable laws, ordinances, rules, regulations and orders of the city, county, state, federal or public bodies having jurisdiction affecting the work.

Section 901.00 Scope

This section applies to all Portland cement concrete work within any street, common facility or ROW or in any part of the water system, sanitary sewer system, or storm drainage system of the City of Littleton.

Section 902.00 Inspections

Refer to Section 152.00 Inspections and Section 1006.00 Roadway Inspections of these Standards and Specifications.

Adequate inspections assure compliance to City requirements and are the basis for the City's recommendation that improvements be accepted for maintenance and/or for release of performance guarantees. It is the responsibility of the Contractor to contact the City Inspector a minimum of one (1) full working day (twenty-four (24) hours) in advance of the required inspections. All inspections should be requested through eTRAKiT under the appropriate Permit. Concrete shall not be placed until all forms, subgrade and reinforcement have been observed by the City Inspector. Required inspections shall include:

A. Subgrade – Verify that material on which concrete shall be placed is to the line, grade, and cross-section shown on the approved plans, is not frozen or excessively dry at the surface, and meets all compaction requirements.

B. Forms/Reinforcing Steel – Verify that forms are set to proper grade and alignment, adequately braced, and set for proper thickness of concrete. Rebar is properly placed and spaced, at least fifty (50) percent of intersections are tied, and proper distances from surface grade and forms are maintained. Verify that electrical isolation of the forms/reinforcing steel is obtained from all other metallic piping, conduits, and structures.

C. Concrete Delivery and Testing – Confirm that mix design submittals are approved by the City, and testing/sampling frequency, slump, air, and minimum/maximum air and concrete temperatures comply with approved mix designs and applicable ASTM's.

D. Cure and Flush – Verify that finished concrete complies with approved grades and alignment and is properly cured and protected from freezing. Contractor shall verify that concrete pavement surfaces comply with the smoothness requirements of Section 412.17 - Surface Smoothness Test of the CDOT Standard Specifications for Road and Bridge Construction.

E. General Items Include:

1. All temporary structures, debris, mud and waste materials shall be removed from public property.

2. Grout and seal all cracks in concrete using "Deery Super Gray 800-13" or approved equal. Fill all gouged areas of concrete with an approved epoxy. Remove and replace all areas of broken concrete. Subgrade failures shall be corrected before pouring back.

F. Construction Acceptance Into Warranty – Refer to Section 208.00 Initial Warranty Acceptance of these Standards and Specifications.

G. Final Acceptance/Release from Warranty – Refer to Section 210.00 Final Acceptance of these Standards and Specifications.

Section 903.00 Concrete Mix Design

Concrete utilized for miscellaneous, or sidewalk flatwork shall comply with Item 30 of the MGPEC Design Standards and Construction Specification Manual and shall be reinforced with steel bars where required as per the project management and referenced by the project standard details. Concrete pavement shall comply with all specifications as mentioned in Item 32 of the MGPEC Design Standards and Construction Specification Manual.

All Portland cement concrete mixes utilized within any street, parking lot or ROW shall be from the CDOT Pre-Approved Concrete Mix Designs list. If utilizing an alternative mix design, concrete mix design information shall be prepared in accordance with ACI 301 Section 4.2 and submitted to the City for approval. At least two (2) sets of certified twenty-eight (28) day strength test results shall also be submitted. No concrete shall be placed until the concrete mix design has been approved.

A separate mix design submittal shall be required for concrete to be pumped. Mix designs shall be prepared in accordance with ACI 211 and 304, as applicable.

Section 904.00 Materials

Section 904.01 Cement

All cement used in concrete work shall comply with MGPEC Item 30 – 30.2 - Section B. When requested by the City, the Contractor shall furnish the City with a certificate from the manufacturer or an acceptable testing laboratory stating that the cement meets the requirements of these Standards and Specifications.

Section 904.02 Fly Ash

All fly ash used in concrete work shall comply with MGPEC Item 30 - 30.2 - Section C. The City may require a certificate from an approved testing laboratory stating that the fly ash meets the requirements of these Standards and Specifications. Class C fly ash shall not be permitted where sulfate resistant cement is required.

Section 904.03 Water

Potable, non-alkaline water in accordance with MGPEC Item 30 - 30.2 - Section E and devoid of salts and other injurious elements for concrete mixing shall be used.

Section 904.04 Admixtures

All admixtures used in concrete work shall comply with MGPEC Item 30 – 30.2 - Section D and with City approval.

Section 904.05 Aggregate

Fine and coarse aggregates are regarded as separate ingredients and each shall be well graded and in accordance with MGPEC Item 30 -30.2 - Section A

Section 904.06 Curing Materials

Curing Materials shall be in accordance with MGPEC Item 30 – 30.2 – Section H

Section 905.00 Ready-Mixed Concrete

The use of ready-mixed concrete shall in no way relieve the Applicant of the responsibility for proportion, mix, delivery, or placement of concrete. All ready-mixed concrete shall comply with ASTM C94.

Concrete shall be continuously mixed or agitated from the time the water is added until the time of use, and discharge from the truck should begin within ninety (90) minutes or three hundred (300) revolutions after it comes in contact with the mixing water or with the aggregates. In accordance with ASTM C94, water may be added to ready-mix concrete one (1) time in order to get slump within range, as long as the specified water-cement ratio is not exceeded. After installation of concrete has begun, no water may be added.

A. The Contractor shall collect delivery or batch tickets from the driver for all concrete used on the project and shall deliver them to the City Inspector. Handwritten batch tickets will not be accepted. Batch tickets shall provide the following information in accordance with ASTM C94:

   1. Name of ready-mix batch plant
   2. Serial number of ticket
   3. Date
   4. Truck number
   5. Name of purchaser
   6. Specific designation of job (name and location)
   7. Mix # or specific class or designation of the concrete
   8. Amount of concrete in cubic yards
   9. Time loaded or of first mixing of cement and aggregates
   10. Water added by receiver of concrete and their initials
   11. Weights of fine and coarse aggregates
   12. Type, brand and amount of cement
   13. Type, brand and amount of admixtures
   14. Weight (in gallons) of water, including surface water on aggregates
   15. Allowed water (in gallons) to be added.
   16. Gallons of water added by truck operator.

B. The Contractor shall add the following information to the batch ticket at the placement site:

   1. Discharge time
   2. Water-cement ratio (bridge deck concrete only)
   3. Air content
   4. Slump
   5. Revolutions
   6. Location of batch in placement

Section 906.00 Mix Properties

Mix properties of Portland cement concrete for flatwork shall comply with MGPEC Item 30 – 30.3 -Concrete Mixture Proportioning, augmented with additional specifications for Class B requirements found in CDOT Specifications Section 815.00 Structural Concrete. Additional concrete mix designs may be approved for decorative, non-structural concrete at the discretion of the City.

Section 906.01 Colored Concrete

Where required on the approved plans, or as approved by the City, colored concrete shall comply with the following:

A. All typical properties of flatwork as specified in Section 904.00 Materials and Section 906.00 Mix Properties of these Standards and Specifications.

B. Color shall be per plan.

C. The Contractor shall pour a mock-up for approval by the City prior to initiating work.

Section 906.02 Textured Concrete

Where required on the approved plans, or as approved by the City, colored and textured concrete shall comply with the following:

A. All typical properties of flatwork as specified in Section 904.00 Materials and Section 906.00 Mix Properties of these Standards and Specifications.

B. Color shall be from the Littleton approved products list or approved equal and mixed per manufacturer's recommendation. Color shall match adjacent existing median materials.

C. Stamp patterns shall be from the Littleton approved products list or approved equal.

D. Color hardener shall be specially formulated for installation of patterned concrete, grade "Heavy Duty".

E. Color curing compounds shall comply with ASTM C309 and with all applicable air pollution regulations.

F. Normal set or retarded set water reducing admixture shall comply with ASTM C494.

G. No calcium chloride shall be added to the concrete mix.

H. Antiquing release shall be two (2) parts Stone Gray and one (1) part Deep Charcoal.

I. Acrylic Sealer shall be used from the Littleton Approved Products List.

J. The Contractor shall pour a mock-up for approval by the City prior to initiating work.

Section 906.03 Controlled Low Strength Materials (CLSM) "Flowable Fill"

CLSM may be used as structure backfill, as backfill for pipelines and service lines, or as backfill for "dry utility" (electric, gas, telephone, fiber and/or cable) service repair work trenches. CLSM ("flowable fill") mix designs shall be from the City and County of Denver Approved CLSM list and submitted to the City for approval prior to placement.

CLSM shall be placed in confined areas and under pipe haunches with methods approved by the City. When backfilling pipelines and service lines, CLSM shall be properly layered to prevent pipe from floating.

CLSM shall conform to MGPEC Section 19.

Section 906.04 Controlled Low Strength Materials (CLSM) "Flash Fill"

CLSM ("Flash Fill") mix designs shall be from the City and County of Denver Approved CLSM list and submitted to the City for approval prior to placement. CLSM used as backfill for isolated pipeline and/or service line repair/replacement, or to fill abandoned pipelines and appurtenances shall conform to MGPEC Section 19.

CLSM shall be placed in confined areas and under pipe haunches with methods approved by City. When backfilling pipelines and service lines, CLSM shall be properly layered to prevent pipe from floating.

Section 907.00 Concrete Construction

Section 907.01 Concrete Placement

Before placing concrete, debris shall be removed from the space to be occupied by the concrete. The forms and all concrete surfaces shall be thoroughly wetted. The concrete shall be placed on soils prepared in accordance with Section 421.00 Embankment Construction of these Standards and Specifications. Soils should be slightly moistened but not muddy prior to concrete placement. Concrete shall be placed and vibrated so that it is free from honeycomb and free from pockets of segregated aggregate. Sections of segregation or honeycomb revealed by removal of the forms shall be removed and replaced or otherwise repaired as approved by the City Inspector.

Concrete shall not be placed until all forms and reinforcing steel have been inspected and approved by the City Inspector. Verify that electrical isolation of the forms/reinforcing steel is obtained from all other metallic piping, conduits, and structures. All permanent features within the concrete shall be isolated by means of foam expansion material. Concrete shall be handled from the mixer to the place of final deposit as rapidly as possible by methods that prevent separation or loss of ingredients. The concrete shall be deposited in the forms as close 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 twelve (12) inches. Concrete shall be placed in a manner to avoid segregation and shall not be dropped freely more than five (5) feet. If segregation occurs, the Littleton Inspector may require the concrete to be removed and replaced at the Contractor's expense. Cement, which for any reason has become partially set or which contains lumps shall be rejected.

Concrete shall be placed in one (1) continuous operation, except where keyed construction joints are shown on the plans or as approved by the City Inspector. Delays in excess of thirty (30) minutes may require removal and replacement of concrete by the City Inspector. At the end of the workday, or in case of an unavoidable interruption of more than thirty (30) minutes, a transverse construction joint shall be placed at the point of stopping work, provided that the section on which work has been suspended shall not be less than five (5) feet long. Sections less than five (5) feet in length shall be removed. Concrete shall not be placed when the weather is stormy, dusty, or inclement to a degree that precludes good workmanship.

Section 907.02 Concrete Testing

The requirements of this section shall apply to testing services for all concrete curb and gutter, sidewalk, pavement, slope paving, retaining walls, structures, and for all miscellaneous concrete testing.

A representative of the concrete testing agency shall inspect, sample, and test material and production of concrete as required by the City. Minimum testing frequency shall be as specified below.

Table 907.01 – Concrete Testing

Concrete	AASHTO	ASTM	Minimum Test Frequency
Sampling	R60	C172	One Test First Load of the Day, then every 50 Cubic Yards
Compressive Strength**	T22	C39	One Set First Load of the Day, then every 50 Cubic Yards
Temperature	N/A	C1064	One Test First Load of the Day, then every 50 Cubic Yards
Slump	T119	C143	One test First Load of the Day, then every 50 Cubic Yards
Air Content	T196 / T121 / T152	C173 / C138 / C231	One test First Load of the Day, then every 50 Cubic Yards

Notes:

*Concrete samples must be taken in accordance with AASHTO R60 or ASTM C172

**One set of cylinders shall consist of five (5) cylinders (1 @ 7 day break, 3 @ 28 day break, 1 @ 56 day break) additional cylinders may be requested as directed by the City

Any test failures shall trigger testing for the next three (3) loads. The concrete testing agency shall report all test and inspection results to the City and Contractor immediately after they are performed. All 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.).

The concrete testing agency or its representative is not authorized to revoke, alter, relax, expand or release any requirements of these Standards and Specifications, nor to approve or accept any portion of the work. When it appears that any material furnished or work performed by the Contractor fails to fulfill specification requirements, the testing agency shall report such deficiencies to the City and the Contractor.

Section 907.03 Vibrating

All concrete shall be compacted by internal vibration using mechanical vibrating equipment. Concrete in floor slabs, sidewalks, or curb and gutter which is not placed against form linings shall be either tamped or vibrated. Care shall be taken 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 309R, Chapter 5. Vibrators shall not be used to move or spread the concrete.

Any evidence of lack of consolidation or over-consolidation shall be regarded as sufficient reason to require removal and replacement of concrete at the Contractor's expense. The Contractor shall be responsible for any defects in the quality and appearance of the concrete.

Section 907.04 Workability

The consistency of concrete shall be kept uniform and shall be checked by means of certified slump tests. At all times 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 laitance on the surface. If concrete fails to conform to the proportions of the approved mix design for any reason, such concrete shall not be incorporated in the work but shall be discarded from the project site as waste material at the Contractor's expense. Water may not be added at the job site without permission of the City Engineer. “Blessing” of the concrete surface will NOT be acceptable and may warrant removal of the concrete per the City Inspector or Project Manager.

Section 907.05 Installation of Colored Patterned Concrete

Special concrete mix with integral color shall be placed and screeded to the proper grade and floated to a uniform surface in the normal manner for slabs on grade. While the concrete is still plastic, the imprinting tools shall be applied to make the desired patterned surface. The pattern shall be matched at imprint edges and joints.

Color curing compound, thinned in the proportion of one (1) part curing compound to one (1) part mineral spirits (paint thinner), shall be applied uniformly with a roller or sprayer. The coverage shall be approximately six hundred (600) to six hundred fifty (650) square feet per gallon of unthinned curing compound. At times when the air temperature is at or near freezing, the slab shall be cured using suitable curing blankets. The slab shall later be sealed with the color curing compound when the air temperature is above freezing.

Use of blankets and/or heaters may be necessary to maintain the concrete at or above fifty (50) degrees Fahrenheit for three (3) days after placement. The cured surface shall be cleaned to remove any residual materials.

Section 907.06 Weather Limitations

A. Extreme Weather Concreting

During extreme weather conditions, placement of concrete shall be allowed only when the temperature of the concrete placed in the forms is between fifty (50) degrees Fahrenheit and ninety (90) degrees Fahrenheit. Cold weather placement of concrete shall comply with the minimum concrete placement temperature table below.

No concrete shall be placed, regardless of the present temperature, when the weather forecast predicts freezing weather before final set of the concrete unless special means of heating and protection are used. Protection against freezing is the Contractor's responsibility regardless of the weather forecast or climatic conditions at the time of placement. Minimum concrete temperatures, as listed below, shall be maintained for a minimum of seventy-two (72) hours after the concrete has been placed or until at least sixty (60) percent of the twenty-eight (28) day field strength has been obtained, whichever is greater.

Table 907.02 Minimum Concrete Placement Temperature

Air Temperature	Section Thickness, Minimum Dimension (inches)	
	< 12 in.	12-36 in.
Above 30°F	60°F	55°F
0°F-30°F	65°F	60°F
Below 0°F	70°F	65°F
Minimum Concrete Curing Temperature		
	55°F	50°F

Small structures and slabs shall be protected by completely covering fresh concrete with suitable curing blankets to prevent freezing. Large structures and vertical walls shall be protected against freezing by enclosing the structure with heating devices capable of providing uniform and even heat throughout the structure. Heaters shall be vented so that combustion gases are exhausted outside the enclosure in order to avoid carbonation of the fresh concrete. If in the opinion of the Inspector, the protection provided is inadequate, concreting shall cease until conditions or procedures are satisfactory to the Inspector.

Cold weather is defined as a period when, for more than three (3) consecutive days, the following conditions exist:

1. The average air temperature is less than forty (40) degrees Fahrenheit.
2. The air temperature is not greater than fifty (50) degrees Fahrenheit for more than one half (½) of any twenty-four (24) hour period.

Concrete placed in cold weather shall be protected from extreme temperatures as follows:

1. A temperature of at least fifty (50) degrees Fahrenheit for the first seventy-two (72) hours shall be maintained.
2. After the first seventy-two (72) hours and until the concrete is seven (7) days old, it shall be protected from freezing temperatures.
3. Concrete adjacent to heating devices shall be insulated from direct heat of the unit that may dry it out prior to being properly cured.
4. Temperatures shall be measured by maximum and minimum thermometers furnished by the Contractor and installed adjacent to the concrete.

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 is not allowed. If the City Inspector determines that the cold or inclement weather protection is inadequate, concrete placement shall stop until adequate weather conditions exist or until protection procedures are acceptable to the City Inspector. Concrete which has been frozen shall be removed and replaced as required by the City Inspector.

B. Hot Weather Concreting

Except by written authorization, concrete shall not be placed if the temperature of the plastic concrete cannot be maintained at ninety (90) degrees Fahrenheit or lower. Placement of concrete in hot weather shall comply with ACI 305R.

Section 908.00 Steel Reinforcing and Forms

This section intentionally left blank.

Section 908.01 Epoxy Coated Steel Reinforcing

The placement, fastening, splicing and supporting of epoxy coated reinforcing steel (in accordance with AASHTO M284) and wire mesh or bar mat reinforcement shall comply with the plans and the latest edition of CRSI Recommended Practice for Placing Reinforcing Bars and ACI 117. Before being positioned, all reinforcing steel shall be thoroughly cleaned of mill and rust scale and of coatings that may destroy or reduce the bond. Where there is delay in depositing concrete, reinforcement shall be re-inspected and cleaned if necessary.

Reinforcement shall be carefully formed to the dimensions indicated on the approved plans by the cold bending method. Cold bends shall be made so that the inside diameter of the bend measured on the inside of the bar shall be as follows:

Table 908.01 - Cold Bending Diameters

Bar Size	Grade 60
#3 through #8	6 bar dia.
#9, #10, and #11	8 bar dia.
#14 and #18	10 bar dia.

The inside diameter of bend for stirrups and ties shall not be less than four (4) bar diameters for sizes number five (#5) and smaller, and five (5) bar diameters for sizes number six (#6) and number eight (#8). Reinforcement shall not be bent or straightened in a manner that may injure the material. Bars with kinks or bends shall not be used except were shown on the plans. Heating of reinforcement shall not be permitted.

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. A minimum of fifty (50) percent of intersections shall be secured. Where necessary, reinforcing steel shall be supported by metal chairs or spacers, precast mortar blocks, or metal hangers. Splicing of bars, except were shown on the plans, shall not be allowed without approval of the City.

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 A185) or “Specifications for Welded Deformed Steel Wire Fabric for Concrete Reinforcement” (ASTM A497).

Contractor shall submit shop drawings of the reinforcement to the City for approval. Unless otherwise shown on the plans, the minimum clear cover for reinforcing steel shall be the following, as specified in Section 3.3 of ACI 301 (current edition):

Table 908.02 – Minimum Reinforcement Cover

Concrete Exposure	Member	Reinforcement	Specified Cover, (inches)
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	All	No. 6 through No. 18 bars	2
		No. 5 bar, W31 or D31 wire, and smaller	1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars	1-1/2
		No. 11 bar and smaller	3/4
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	1-1/2

Section 908.02 Forms and Form Setting

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 which has not had the surface prepared with commercial form oil to effectively prevent bonding, staining, and softening of concrete surfaces shall not be used.

Forms may generally be wood or metal and shall have a depth equal to or greater than the slab thickness. Plywood forms, plastic coated plywood forms, or steel forms shall be used for all 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.

Forms that have become worn, bent, or broken shall not be used. Each section of form shall be straight, not warped, and free of defects likely to cause irregular surfaces. The Contractor shall set a minimum length of three hundred (300) feet of forms to grade prior to placing concrete. In cases where the length of one run is less than three hundred (300) feet, the Contractor shall set forms to grade for the entire run.

The face of curbs shall be formed, unless otherwise permitted by the City Inspector. Forms shall be secured to resist the pressure of the poured concrete without springing or settlement. The connection between sections shall be performed by a method in which the joint shall be free from movement in any direction.

Forms shall not deviate more than one-quarter (¼) inch from the design line and grade. All grade stakes shall either be removed in their entirety or shall be completely pounded into the subgrade.

In the interest of safety to the passing public, the contractor shall ensure that all form staking is equipped with stake caps.

When concrete pavement is constructed on a curve, flexible forms shall be used having a radius of two hundred (200) feet or less, unless otherwise directed by the City Inspector. Face forms shall be pre-formed to the proper radius. Care shall be exercised to ensure the required cross section is maintained around the entire radius.

The Contractor shall provide an approved metal straight edge, ten (10) feet in length, to check the alignment of the forms prior to placing the concrete, and to check the concrete surface during the finishing operation.

Forms shall not be disturbed until the concrete has hardened sufficiently to permit removal without damaging the concrete, or until forms are not required to protect the concrete from mechanical damage. Crowbars or other heavy tools shall not be used against green concrete when removing forms. Forms shall be thoroughly cleaned before re-oiling and reuse.

Walks shall not be opened to pedestrian traffic for a minimum twenty-four (24) hours after placement. Curb cuts, curb and gutter and cross plans shall not be opened to vehicular traffic for a minimum of seven (7) days after placement or until concrete has attained eighty (80) percent of its specified twenty-eight (28) day field strength.

Section 908.03 Forms

Refer to Section 908.02 Forms and Form Setting of these Standards and Specifications for requirements for appurtenant concrete structures.

Section 909.00 Finishing, Curing and Protection

Concrete finishing, curing, and protection shall comply with ACI 301 except were described differently below.

Section 909.01 Finishing

Where applicable, finishing shall be performed with a metal screed designed to give proper shape to the section as detailed. Particular care shall be used to finish the gutter flowline to a true uniform grade. Face forms shall be left in place until the concrete has hardened sufficiently so that they can be removed without injury to the curb.

The Contractor shall use at all times, a ten (10) foot straight edge for finishing curb and gutter sections. Irregularities shall be corrected by adding or removing concrete. All disturbed places shall be floated with a wooden or metal float that is not less than three (3) feet long and not less than six (6) inches wide, and screeded. No water or cement shall be added to the surface of the concrete to aid in finishing. Edges of the concrete and joints shall be carefully finished with an edger having a one-eighth (⅛) inch radius prior to the concrete reaching initial set.

Concrete shall be finally finished with a wood float and lightly broomed to a slightly roughened surface. On grades less than one (1) percent, the Contractor shall check for depressions before final finish so that no ponding exists.

Exposed faces of curbs and sidewalks shall be finished to the line and grade 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 indicated by the City Inspector. After completion of

brooming and before concrete has initial set, all edges in contact with the forms shall be tooled with an edger having a three-eighth (⅜) inch radius.

No dusting or topping of the surface or sprinkling with water to facilitate finishing shall be permitted.

Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be waterproofed. On all 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. The surface shall be left sound, smooth, even, and uniform in color. Mortar used in pointing shall not be more than thirty (30) minutes old. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

Section 909.02 Curing and Protection

Fresh concrete shall be adequately protected from weather damage and mechanical injury during the curing periods. Should damage occur, the concrete shall be removed and replaced at no cost to the City. The selected curing process shall be started as soon as it can be performed without injury to the concrete surface.

Curing compounds shall be white pigmented liquid membrane forming on non-colored concrete and conform to AASHTO M 148. Curing compounds shall be clear on colored concrete or as recommended by the manufacturer. All curing compounds shall be installed per manufacturer's recommendations.

Allowable curing compound types and specification shall vary depending upon when an expected snow or freeze condition may occur, or when de-icing materials will be soon used.

<u>For Concrete placed between April 1 through September 14:</u>

For normal Portland Concrete Pavement, related flatwork, sidewalks, and vertical surfaces, white pigmented curing compound conforming to ASTM C-309 Type 2, (white pigmented dye) shall be used unless another method conforming to ACI 308, Section 2, is approved by the City in writing. For colored concrete, products must meet ASTM C-309 Type 1 (clear) or 1-D (fugitive dye).

<u>For Concrete placed between September 15 and March 31:</u>

A combination cure-sealer shall be used for Portland Concrete Pavement and other related flatwork, sidewalks, and vertical surfaces placed during these dates, or when the City Engineer predicts an event where they expect to receive snow, freezing conditions and/or the need for use of de-icing materials within twenty-eight (28) days after concrete is placed. Provide adequate texture to surfaces prior to applying the cure-seal, as the solvent-based product has a high gloss finish and can pose visual distractions to drivers at nighttime if applied to smooth concrete surfaces.

The combination cure-seal products for PCCP, related flatwork, sidewalk, Class B (pigmented, some yellowing allowed). For colored concrete, products must meet ASTM C-1315 Type I, Class A (clear, non-yellowing). The compound must be an acrylic copolymer type, non-freezing solvent based, with a minimum of twenty-five (25) percent

solids content. Compound must be VOC compliant in accordance with EPA 40 CFR Part 59. The final gloss appearance will serve as proof of application.

The contractor shall use a sealer that when applied according to manufactures recommendations will not adversely affect the skid resistance of the pavement. The use of cure-Sealer shall not be a substitute for best cold weather curing practices according to ACI 308.

Burlap cloth made from Jute or Kenaff shall conform to AASHTO M 182. Sheet materials for curing concrete shall conform to AASHTO M 171.

Section 910.00 Backfill of Concrete Work

When 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 approved plans or as directed by the City.

Section 910.01 Ponding

Ponding of water in concrete pavement and flatwork shall not exceed one-eighth (⅛) inch in depth. Where ponding exceeds one-eighth (⅛) inch in depth, pavement or flatwork shall be removed and replaced at the Contractor's expense.

Section 910.02 Cleanup

The exposed surfaces of concrete shall be thoroughly cleaned upon completion of the work. Within forty-eight (48) hours after forms are removed, the area behind the sidewalk or curb shall be cleaned, backfilled and graded to provide a smooth even surface.

Section 911.00 Repairs and Restoration

After stripping concrete forms, any concrete found to be inconsistent with the approved plans, is out of alignment, not level, or showing a defective surface shall be removed and replaced at the Contractor's expense as directed by the City Inspector. The City may give written permission to patch the defective area. Ridges and bulges may be removed by grinding if approved by the City Inspector. Honeycombed and other defective concrete that does not affect the integrity of the structure may be chipped out and the vacated areas filled if approved by the City Inspector.

The repaired area shall be patched with a non-shrink, non-metallic grout with a minimum compressive strength of five thousand (5,000) psi in twenty-eight (28) days. All repair areas treated with an epoxy-bonding agent shall have the approval of the City before the repair filling is placed.

Section 911.01 Flatwork Repairs and Replacement

All edges of the existing flatwork to remain shall be saw cut. Flatwork repairs and replacement shall be as directed by the City Inspector and at the Contractor's expense.

Section 911.02 Concrete Structure Repairs

Bolt-holes, tie-rod holes, and minor imperfections as approved by the City Inspector, shall be filled with dry-patching mortar composed of approximately 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 sticks together when 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.

Section 911.03 Exploratory Pothole/Core Repair

When exploratory utility potholing is performed, the Contractor shall repair the pothole in the following manner.

Concrete:

A. Exploratory potholing voids are to be backfilled and the core patched with a temporary patching material immediately after initial potholing is complete.

B. All material disturbed and/or removed during the exploratory operation shall be replaced with an approved CLSM.

C. Squeegee shall not be allowed as backfill material except for use as pipe bedding with a twelve (12) inch maximum depth over the pipe.

D. Within seventy-two (72) hours of initial drilling, or within a reasonable and practical amount of time after completion of the projected work, potholes will be permanently patched.

E. Any exploratory pothole and/or patch that are deemed dangerous shall be repaired immediately.

F. Any exploratory potholing in concrete such as, but not limited to; sidewalk, curb & gutter,

G. cross-pans, curb-ramps, concrete median structures, roadways, or driveways, shall require the complete stone of concrete replaced.

H. Colored or patterned concrete shall be replaced with the same color and pattern of the existing concrete.

Section 912.00 Protection Against Vandalism

It shall be the responsibility of the Contractor to protect all concrete work against damage or vandalism. When required, a guard shall be stationed over fresh work until the concrete is sufficiently set to prevent damage at the Contractor's expense. Concrete damaged in any way by vandals shall be removed and replaced at the Contractor's expense.

Anti-graffiti materials shall be installed as shown on the approved plans or as required by the City Inspector. Prior to installation, technical information regarding proposed anti-graffiti materials shall be submitted to the City for approval.

Section 913.00 Defective Concrete

If concrete is found defective from testing, placing, curing or for other causes, and if the Contractor is so directed, he must remove and replace the concrete at no cost to the City.

Strength requirements shall be in accordance with ACI 214, Section 4.2. Strength level will be determined acceptable if the averages of all sets of three (3) consecutive strength test results equal or exceed the specified strength (f'c). No individual test result may fall below the specified strength (f'c) by more than five hundred (500) psi.

If either of these requirements are not satisfied, steps shall be taken to increase the average of subsequent strength results. Evaluation of strength test results, and investigation of low strength-test results shall be in accordance with ACI 301 and ACI 318. When twenty-eight (28) day strength test results are below the minimum specified strength, fifty-six (56) day cylinders can be evaluated to verify minimum specified strength. Core specimens must be obtained following ASTM C42.

Sidewalks, and vertical surfaces must meet ASTM C-1315 Type II800.26

Section 914.00 Flatwork

A. Installation of flatwork shall be in accordance with CDOT Specification 608 and 609.

B. Items: Crosspans, curbs, gutters, pavement, sidewalk, driveway pans, slabs on grade, median.

C. Measurement: (Square Yard) (Lineal Feet) - Concrete flatwork will be measured as the actual number of square yards or lineal feet of exposed surface concrete placed to the thickness, shape and length specified in the Contract Documents.

D. Payment: Accepted quantities of concrete flatwork will be paid for at the contract unit price bid for the applicable type of concrete flatwork specified in the Bid Schedule. No separate measurement or payment will be made for base course material and/or subgrade preparation including compaction, fine grading, expansion joint, reinforcing steel, dowels, tie bar, joint filler, etc., but shall be included in the work.

Section 915.00 Structural Concrete

A. Structural concrete shall be in accordance with CDOT Specification 601.

B. Items: Bridges, box culverts, catch basins, cut off walls, diversion structures, head and wing walls, inlets, vaults.

C. Measurement: (Cubic Yard) (Each) (Linear Foot)- Bulk structural concrete will be measured by the cubic yard in accordance with the neat line dimensions called for in the Contract Documents. Deductions in the bulk measurement will be made for voids, wherein the volume of concrete displaced exceeds one (1) cubic foot. No deduction will be made for the volume of reinforcing steel contained therein.

D. Minor structures such as catch basins, diversion structures, cut off walls, etc., may be measured as the actual number installed, when so specified in the Bid Schedule.

E. Payment: The accepted quantity of structural concrete and or structures cast in place will be paid at the contract unit price bid. No separate measurement or payment will be made for structural excavation, dewatering, foundation stabilization, forming, embedded frames, grates, access covers, reinforcing or structural steel, colored concrete, etc. but shall be included in the work.

NOTE: Deck concrete within plan limits for curb, gutter, sidewalk and transitions shall be included in the contract unit price bid, when basins and inlets are to be paid for on the per each basis.

Section 916.00 Concrete Pavement and Flatwork

The installation of Portland cement concrete pavement, including materials, equipment, foundation and construction methods shall comply with MGPEC Item 30 - 33 and these Standards and Specifications.

Concrete pavements shall be installed as shown on the approved plans or as approved by the City. The Contractor shall furnish steel pins to use in setting grades for concrete pavement.

The subgrade shall conform to the specified cross section. Immediately prior to placing concrete, the subgrade shall be tested for adequate compaction and moisture to a minimum depth of six (6) inches or as specified in the approved Geotechnical Report. Concrete shall not be placed on any portion of the subgrade that has not been inspected by a Littleton Inspector. There shall be no puddles or pockets of mud when the concrete is placed, and the subgrade shall be cleared of any loose material.

Curb, curb ramps, gutter, sidewalk, cross pan, and driveway construction shall conform to all applicable provisions, Detailed Drawings of these Standards and Specifications, and U.S. Access Board PROWAG Guidelines.

Section 916.01 Portland Cement Treated Base

In those instances where deemed necessary by the project Geotechnical engineer and approved by the City, Portland cement treated base may be required.

Section 916.02 Curb and Gutter

The section to be constructed shall be as identified on the approved plans and as shown on the Detail Drawings of these Standards and Specifications.

Section 916.03 Sidewalks

Detached sidewalks along local residential streets shall be a minimum of four (4) inches thick and all other sidewalks shall be a minimum of six (6) inches thick, and shall be constructed as shown on the approved plans. Areas of sidewalk or concrete trails crossed by driveways or in parks, open spaces or greenbelts shall be constructed with a minimum of six (6) inch thick concrete. All new sidewalks are required to have a minimum of four inches of aggregate base course placed and compacted prior to placement of concrete. Sidewalks being replaced may be required to have base course at the direction of the City, based upon the suitability of the subgrade.

Section 916.04 Crosspans and Curb Return Fillets

Typical crosspan sections are shown in the Detail Drawings found in these Standards and Specifications. Where unusual conditions exist, additional reinforcing steel and special joints may be required by the City. Crosspans should only be used where speed limits are 35 miles per hour or less unless approved by the City Engineer.

Section 916.05 Curb Cuts and Driveways

Curb cuts in six (6) inch vertical curbs shall be constructed at all driveway locations and at additional locations, as shown on the approved plans and in the Detail Drawings found in these Standards and Specifications

Section 916.06 Curb Ramps

Curb ramps shall be installed at locations designated by the City and as shown on the approved plans. Directional curb ramps, rather than diagonal or corner curb ramps, shall be installed unless site conditions or constraints prohibit their placement; or their placement creates an unsafe or undesirable condition for pedestrians or wheelchair travel along the sidewalk. The curb ramps shall be constructed with slopes, landings, and detectable warnings (truncated domes) as shown in the latest revision of the Colorado Department of Transportation M&S Standards.

Truncated domes shall be cast iron and from the Approved Products List, and the contractor shall follow specific installation details per the manufacturer. No panel material other than cast iron will be accepted by the City and any other material will be removed at the contractor's expense. Panel size shall have a depth of two (2) feet.

Section 916.07 Medians and Islands

Medians and islands shall be constructed as identified on the approved plans and as shown on the Detail Drawings of these Standards and Specifications.

Section 916.08 Joints

Joint materials shall comply with the following specifications:

Table 916.01 - Joint Material Specifications

AASHTO	
Preformed expansion joint filler (Bituminous Type)	M33
Preformed sponge rubber and cork expansion joint fillers	M153
Preformed expansion joint fillers (fiber board)	M213

Non-bituminous type materials shall be placed in widths shown on the approved plans or three-eighths (⅜) inch wide when not specified. Bituminous type materials shall be used for concrete paving and structural construction where joint sealers are not required.

All joints shall be constructed straight and plumb and shall extend through the entire section from edge to edge and to the depths specified.

Section 916.09 Expansion Joints

Expansion joint filler, which is one-half (½) inch thick, preformed, non-extruding bituminous-treated fiber board conforming to AASHTO Specification M-213, shall be used to form transverse expansion joints. Concrete tie-ins shall have reinforcing steel bars (number four (#4) minimum) extending a minimum of twelve (12) inches into the concrete in each direction.

A. Expansion Joints

Expansion joint material shall be provided at the following locations and shall be in place prior to placement of concrete:

1. Between back of sidewalk and driveways, alleys, or service walk
2. Between new concrete and existing buildings
3. At other unyielding structures or elements (hydrants, power pole, etc.)
4. As shown on the approved plans
5. As directed by the City Inspector

Reinforcing steel bars (number three or four (#3 or #4) eighteen (18) inches long minimum) shall be used to tie together new and existing concrete pavements and flatwork. Refer to the Detail Drawings found in these Standards and Specifications for expansion joints.

Expansion joint filler, which is one-half (½) inch thick, preformed, non-extruding bituminous-treated fiber board conforming to AASHTO Specification M-213, shall be used to form transverse expansion joints. Concrete tie-ins shall have reinforcing steel bars (#4 minimum) extending a minimum of twelve (12) inches into the concrete in each direction.

B. Contraction Joints

Transverse joints shall be placed at maximum intervals of ten (10) feet to control random cracking. Joints shall be formed, sawed, or tooled to a minimum depth of one-third (⅓) of the total thickness of the pavement or flatwork. 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 fifteen-sixteenths (5/16) inch thick. Refer to the Detail Drawings found in these Standards and Specifications for contraction joint details.

The curb and gutter or sidewalk shall be divided into blocks not less than five (5) feet or more than ten (10) feet long using metal templates not less than one-sixteenth (1/16) inch or more than one-quarter (¼) inch thick. Templates shall be a minimum of four (4) inches deep. Templates shall be designed to attach securely to the forms in such a manner as to prevent movement while the concrete is being placed and consolidated. Templates shall be removed prior to the concrete taking its initial set.

If a curbing machine or other method not requiring the use of templates is approved, dummy joints formed by a jointing tool or other approved means shall be used. Dummy joints shall extend into the concrete for at least one-third (⅓) of the depth (no less than two (2) inches) and shall be approximately one-eighth (⅛) inch wide.

C. Tooled Joints

Tooled joints shall be spaced as follows:

1. Not more than ten (10) feet or less than five (5) feet apart in curb and gutter, sidewalk, and combination curb-walk
2. Joints in both directions, equally spaced at not greater than ten (10) foot intervals, as applicable in driveways and plazas
3. As directed by the City Engineer

Section 917.00 Miscellaneous Concrete

A. Items: Anchor blocks, pipe encasement.

B. Measurement: (Each) (Lineal Feet) (Cubic Yard) - The quantity of anchor block concrete will be computed as the volume of concrete placed between end bulk heads. Set perpendicular to the pipe and between two (2) vertical planes; one (1) which clears the pipe springline by the lessor of one half (½) the pipe outside diameter or twelve (12) inches, and one (1) passing through the pipe centerline, less the concrete volume displaced by one half (½) the pipe end area. Pipe encasement will be measured along the pipe centerline, between bulkheads and neat lines specified in the Contract Documents.

C. Payment: Accepted quantities of miscellaneous concrete will be paid for at the contract unit price bid, in accordance with the various items called for in the Bid Schedule. No separate measurement or payment will be made for excavation, dewatering, bulkheads, reinforcing steel, curing, frost protection, etc., but shall be included in the work.

Section 918.00 Precast Concrete

A. Box Culverts shall be in accordance with CDOT Specification 603.

B. Items: - Box culverts, catch basins, inlets, pre-stressed members, manholes, vaults, flared end sections

C. Measurement: (Each) - Actual number of precast structures of the various sizes and shapes specified in the Contract Documents.

D. Payment: Accepted quantities of precast structures will be paid for at the contract unit price bid. No separate measurement or payment will be made for excavation, dewatering, rock stabilization, shaped inverts or bases, eccentric cones, flat top covers, joint and outlet gasket or sealants, exterior drop pipe and fittings, concrete cast outs, steps, leveling rings, sump pit frame and grate; vent and sump piping; access frames and covers, backfill, etc., but shall be included in the work.

E. NOTE: Concrete curb, gutter, sidewalk and transitions cast in place shall be included in the contract unit price bid for catch basin and inlet.

Section 919.00 Payment Reduction for Concrete

All work performed and all materials furnished shall conform to the line, grades, cross sections, dimensions, and material requirements, including tolerances, shown in the contract. For those items of work where working tolerances are not specified, the Contractor shall perform the work in a manner consistent with reasonable and customary manufacturing and construction practices.

When the Owner determines that the material furnished, work performed, or the finished product is not in conformity with the contract and has resulted in inferior or unsatisfactory product, the finished product or materials shall be removed and replaced or otherwise corrected by, and at the expense of, the Contractor unless the City Engineer determines that the work can be accepted at a reduced price. Payment reduction (CIP work only), when allowed, shall be accomplished by adjusting pay quantities as indicated herein and applying the contract unit prices to the reduced quantities. If allowed, the Owner shall:

A. Document the basis for acceptance by a notice which shall provide for an appropriate adjustment in the payment quantity for such work or materials not otherwise provided for in this section.

B. Notify the Contractor in writing that the payment shall be adjusted in accordance with this section.

C. In lieu of payment (quantity) adjustment, permit correction or replacement of the finished product provided the correction, or replacement does not adversely affect the work or the Owner.

Materials shall be sampled and tested by a qualified testing laboratory in accordance with the sampling, testing schedules, and procedures contained in Section 907.02 Concrete Testing. The approximate maximum quantity represented by each sample shall be as set forth in the testing schedule. An additional number of samples, in relation to the quantity of materials represented, may be selected and tested at the Owner's discretion. The quantity represented by five consecutive random samples shall constitute a lot, whenever production schedules and material continuity permits. When, it is necessary to represent short production runs, significant material changes, or other unusual characteristics of the work, the Owner may establish a lot consisting of the quantity represented by any number of consecutive random samples from one to seven inclusive. Testing results that are determined to have sampling or testing errors, as determined by the Owner, shall not be used.

Materials or work shall only be evaluated for price adjustment when deviations from Specification occur on any of the individual tests for the lot. The several individual test values shall be averaged and the percentage of payment (quantity) reduction for the lot shall be determined by the applicable table. This shall apply only when a payment reduction element is listed in a table below.

Payment adjustment for those elements not included in a table shall be determined by the Owner.

The Contractor shall not have the option of accepting a payment reduction in lieu of producing material meeting the specifications. Continued production of non-specification material shall not be permitted. Material that is obviously defective shall be isolated and rejected without regard to sampling sequence or location within a lot.

The pay factor for concrete that is allowed to remain in place at a reduced price shall be determined according to tables below and shall be applied to the quantities for the Item. If deviations occur in air content and strength within the same batch, the pay factor for the batch shall be the product of the individual pay factors.

Table 919.01 – Pay Factors

Percent Total Air	
Deviations from Specified Air (percent)	Pay Factor
0.0 - 0.2	0.98
0.3 - 0.4	0.96
0.5 - 0.6	0.92
0.7 - 0.8	0.84
0.9 - 1.0	0.75
Over 1.0	Reject
Strength	
Below Specified Strength (psi)	Pay Factor
1 – 100	0.98
101 – 200	0.96
201 - 300	0.92
301 - 400	0.84
401 - 500	0.75
Over 500	Reject

SECTION 1000 ASPHALT MIX DESIGN AND CONSTRUCTION

Section 1000.00 Contractor Responsibilities

The Contractor shall be responsible to be fully informed of and shall comply with all sections of these Standards and Specifications, applicable laws, ordinances, rules, regulations and orders of the city, county, state, federal or public bodies having jurisdiction affecting the work.

Section 1001.00 Scope

The intent of this section is to specify materials and methods to be used for the construction, overlaying, sealcoating and other surface treatments along with pavement rejuvenating of streets, parking lots, and other miscellaneous work requiring the use of asphalt pavement. This section shall cover work associated with aggregate base course, bituminous base and pavements of the plant mix type, bituminous prime coat, bituminous tack coat, rejuvenating applications and asphalt overlays. All workmanship and materials shall comply with these Standards and Specifications and shall conform to the lines, grades, depths, quantities and the typical pavement cross section(s) shown on the approved plans or as directed by the City.

Section 1002.00 Asphalt Pavement Design

This section intentionally left blank.

Section 1003.00 Asphalt Mix Design Properties

All asphalt pavement material (APM) shall be plant-mixed asphalt unless otherwise approved in writing by the City. Materials and construction shall comply the Metropolitan Government Pavement Engineers Council (MGPEC) Pavement Design Standards (latest edition) with the following modifications:

A. Grading ST(⅜) shall be used at the discretion of the City Engineer as a leveling course, in an effort to remove irregularities and provide a smoother final lift.

B. The gradation of the mineral aggregate shall be grading SG (one (1) inch nominal), S (three quarters (¾) inch nominal) or SX (one-half (½) inch nominal). A combination of SG and S, or S and SX (in varying lifts) may be used for new street construction. In no case shall grading SG be used for a permanent final lift of asphalt; however, the City may require the use of grading SG in a pavement section. Grading SX (one-half (½) inch nominal) shall be used for the permanent final lift or overlay of all asphalt, unless approved by the City.

C. All asphalt pavement mix designs shall be based off of MGPEC Item 20 and any other applicable mix design standards.

Asphalt mixes shall be from the CDOT Approved Mix List t and shall be submitted to the City for approval fourteen (14) days prior to placement.

Section 1004.00 Asphalt Sampling and Testing

Materials testing shall be performed by a qualified geotechnical engineer working under the direction of a Colorado Registered Professional Engineer and shall be paid for by the developer on private projects. Testing will be performed and/or paid for by the City-on-City projects unless otherwise noted in the Special Conditions for the project.

At any time during construction and/or the warranty period, the City may require a Colorado Registered Professional Engineer to certify the quality of materials or construction procedures, at

the Contractor's expense. All commercial testing and laboratory work necessary to establish the job mix formula and to ensure conformance of materials and workmanship shall be by recognized methods and as specified in these Standards and Specifications. An electronic copy of all test reports shall be submitted to the City.

Table 1004.01 – Asphalt Sampling and Testing

HOT MIX ASPHALT (HMA)	AASHTO	ASTM	Minimum Test Frequency
Sampling	T168	D979 / D3665	One Test Per Every 1,000 Tons or Fraction Thereof (Not Less Than One Test Per Day)
In Place Density	T310-01	D1188 / D2950	Nuclear One Test Every 200 Lineal Lane Feet Per Lift of In Place Hot Bituminous Paving Mixtures. Minimum 4 Tests Per Intersection.
Longitudinal Joint Density	T166-93	D1188	One Test Per 1,000 Lineal Feet (Or Fraction Thereof) Per Lift
Maximum Specific Gravity of HMA	T209	D2041	One Test Per Every 1,000 Tons or Fraction Thereof (Not Less Than One Test Per Day)
Asphalt Content	T164 / T269 / Tp53	D2172 / D3202 / Ps90	One Test Per Every 1,000 Tons or Fraction Thereof (Not Less Than One Test Per Day)
Air Voids and VMA	T269	D3203	One Test Per Every 1,000 Tons or Fraction Thereof (Not Less Than One Test Per Day)

Section 1005.00 Asphalt Pavement Construction

This section intentionally left blank.

Section 1006.00 Roadway Inspections

Refer to Section 152.00 Inspections of these Standards and Specifications.

Adequate roadway inspections assure compliance to Littleton requirements and are the basis for Littleton's recommendation that roadway improvements be accepted for maintenance and/or release of the performance guarantee. It is the responsibility of the Contractor to schedule inspections online in advance of the required inspections. Required roadway inspections shall include:

A. Utilities and Culverts – All utility pipes, conduits and culverts have been installed in accordance with the approved plans and these Standards and Specifications.

B. Curb and Gutter, Sidewalks and Crosspans – Verify that all concrete improvements have been installed in accordance with the approved plans and these Standards and Specifications.

C. Structures – Verify that all structures have been installed in accordance with the approved plans and these Standards and Specifications.

D. Subgrade/Base Course – Verify that the surface proposed to be built upon meets all requirements including, but not limited to, depth of treatment, type of treatment, moisture content, compaction and an approved proof-roll.

E. Paving and Testing – Verify that mix design and submittals are approved. Verify that minimum air and asphalt temperatures adhere to these Standards and Specifications. Verify that thickness of asphalt pavement, rolling equipment and patterns, and grade of utility castings comply with the approved plans and these Standards and Specifications. If during paving operations specified surface tolerances are not maintained paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

F. Construction Acceptance into Warranty – Refer to Section 200 Development Acceptance Procedures of these Standards and Specifications. General items include:

   1. Pavement Deflection Testing in accordance with Section 1011.00 Pavement Acceptance Testing of these Standards and Specifications.

   2. Remove and replace areas of failing asphalt. Subgrade failures shall be corrected before patching areas, in accordance with these Standards and Specifications, may be required by the City.

   3. Major areas of ponding on a new pavement should be milled and repaved or the area fixed with infrared patching.

G. Final Acceptance/Release from Warranty – Refer to Section - 210.00 Final Acceptance of these Standards and Specifications. General items include:

   1. Pavement deflection testing and/or core sampling of all areas of failing asphalt.

   2. Crack seal all cracks including edge cracks.

   3. Remove and replace areas of failing asphalt. Subgrade failures shall be corrected before placing asphalt.

   4. The final asphalt overlay or seal coat shall be determined by the City based on the visual and structural quality of the roadway at the end of the warranty period. All areas requiring any final surface treatment including, but not limited to; slurry seal, chip seal, cape seal and/ormicro-chip seal, a final top lift or an overlay of asphalt shall be cleaned and prepared, including, but not limited to:

      a. All lips of gutters, inlets, and crosspans shall have concrete exposed to a depth equal to the thickness of the final top lift or overlay of asphalt.

b. All joints shall be straight (vertical) and shall have a minimum elevation difference equal to the specified lift thickness. This is to ensure that an asphalt mat of consistent thickness is installed from edge of gutter to edge of gutter.
c. All weeds shall be cut, and debris, mud, and waste materials removed.
d. Before paving, tack coat shall be applied to the area(s) that are to receive a final top lift or overlay of asphalt, including exposed concrete faces and utility castings.

Section 1007.00 Hauling and Delivery

Each truck shall use covers to protect the mix during transport. Asphalt shall have a "weather-proof" tarp. The beds of trucks hauling asphalt shall be clean, and the asphalt shall be free of debris. A load of mix that is delivered with improper gradation, thermal segregation or temperature below the specified minimum delivered temperature shall be rejected. Delivered mix temperature shall be measured behind the paver screed.

Asphalt pavement materials shall be discharged from production facilities at temperatures presented in Table 20.4B-1 in MGPEC Item 20 (latest edition). The minimum delivered mix temperature, measured behind the paver screed, shall be two hundred thirty-five (235) degrees Fahrenheit for PG 58-28 and PG 64-22 binders and two hundred eighty (280) degrees Fahrenheit for PG 76-28. Initial compaction shall begin immediately after placement and be continuous until the desired relative compaction is achieved. Once the surface temperature of the layer being compacted drops to or below one hundred eighty-five (185) degrees Fahrenheit, further compaction effort shall not be applied unless approved by tester or City Inspector. If the mixture contains modified asphalt cement (PG 76-28) and the surface temperature falls below two hundred thirty (230) degrees Fahrenheit, further compaction effort shall not be applied unless approved by tester or City Inspector.

Section 1008.00 Weather Limitations

Hot mix asphalt shall be placed only on properly constructed subgrade and interim lifts that are free from water, snow, ice, and frozen subgrade. The asphalt shall be placed only when weather conditions permit the pavement to be properly placed and finished as determined by the City Inspector. The Hot mix asphalt shall be placed only when both the air and surface temperatures equal or exceed the temperatures specified in Table below:

Table 1008.01 – Weather

Compacted Layer Thickness (Inches)	Minimum Air and Surface Temp. (Degrees F and rising)	
	Top Layer	Layers Below Top Lift
2 to < 3	50	40
3 or more	45	35

Air temperature shall be taken in the shade. Surface is defined as the existing base on which the new pavement is to be placed.

The City may waive minimum temperature requirements for placing prime coats and layers of asphalt below the top layer of the pavement section.

Section 1009.00 Construction of Pavement

The minimum allowable compacted lift thickness shall be two (2) inches. The generally accepted standard for compacted lift thickness is three times (3X) the nominal maximum particle size (NMPS). In no case shall the compacted asphalt layer thickness be greater than four times (4X) the nominal maximum particle size (NMPS).

Table 1009.01 -Pavement Thickness

Gradation	Minimum lift thickness	Maximum thickness
SG	3”	4”
S	2 ½”	3”
SX	2”	3”
ST	1 ⅛”	2 ¼”
SMA ½”	1 ½”	3
SMA ¾”	3”	4 ½”

Manholes, valve boxes and survey range boxes shall be adjusted to within one-quarter (¼) inches below finish grade before the final surface course of asphalt is placed. The Contractor shall remove all foreign matter found or introduced into them in the performance of this work, and it shall be their responsibility to ensure proper compaction around them after they have been adjusted. manholes, valve boxes and range boxes should be set to final grade just prior to the final lift of asphalt being placed on newly constructed or newly re-constructed streets. Manholes, valve boxes and range boxes that are not raised prior to placement of the final surface course of HBP (either due to oversight or at Contractor’s option) shall be raised and/or adjusted in accordance with the following:

If manholes are not set to grade prior to the final lift of HBP being placed, the Contractor shall complete the repair of the manhole to the satisfaction of the city inspector. Manholes shall be raised to proper grade using concrete riser rings, or an approved equivalent if the prevailing grade requires sloped rings. If more than twelve (12) inches of concrete riser rings are required to raise the manhole lid to final grade, then a new manhole barrel section must be installed to allow the lid to be set to grade with less than twelve (12) inches of concrete riser rings. If range boxes and valve boxes are not set to grade prior to the final lift of asphalt being placed, the asphalt mat shall be core drilled full depth twelve (12) inches diameter centered on the valve box or range box. Auger drilling shall not be allowed. Range boxes shall then be set on compacted subgrade at the proper elevation to match final grade. Adjustable range boxes shall be screw adjusted to within one-quarter (¼) inches below existing grade. Valve boxes shall also be screw adjusted to within one-quarter (¼) inches below final grade. Drop in type valve box risers shall not be allowed on newly constructed or newly re-constructed streets.

New hot mix asphalt (Grading SX, one-half (½) inch mix) shall be placed and properly compacted in the excavated area. The entire area in the vicinity of the raised manhole, valve box or range box shall then be infrared repaired to blend the patch with the existing asphalt and to eliminate any vertical joints in the final lift of asphalt.

On streets that are being sealed, the Contractor shall cover the manholes, valve boxes and survey range boxes with roofing paper or other suitable material prior to sealing.

The covering shall be left in place for a minimum of forty-eight (48) hours after which it shall be removed and disposed of. All covers shall be clean when work is complete.

On streets that are being overlaid with asphaltic concrete the Contractor shall adjust the valve and range boxes by screwing the adjustable rings upward to finish grade, prior to final rolling.

In the case of manhole rings, the Contractor shall vertically and uniformly cut the existing asphalt mat eight (8) inches from the ring and remove the mat and base to a depth of six (6) inches below finish grade. Rings shall then be removed, and the existing riser rings adjusted and pointed to provide the required subgrade for resetting the set rings, free of pressure points. Once the ring is reset to finish grade the collar eight by six (8 x 6) inch void between the mat and the ring) shall be filled with asphaltic concrete and compacted in accordance with these Standards and Specifications.

Section 1009.01 Base Course Composite

All work shall be observed and tested by the project Geotechnical engineer or representative and certified by a Colorado Registered Professional Engineer. The standard procedures for base course composite construction include the following:

A. The subgrade shall be prepared and conditioned to comply with the approved pavement design using all specifications. After passing compaction tests, the subgrade shall be proof-rolled in accordance with Section 430.00 Proof-Roll Observation and Testing of these Standards and Specifications.

B. All failing areas shall be delineated by both the City Inspector and/or the project Geotechnical engineer and shall be reworked and retested until passing.

C. Base course (Aggregate Base/Recycled Concrete) shall be placed, prepared, and conditioned to meet approved pavement design using these Standards and Specifications.

D. After passing all compaction tests, the base course shall be proof-rolled.

E. All failing areas shall be delineated by both the City Inspector and/or project Geotechnical engineer and shall be reworked and retested until passing.

F. In the event the subgrade, base course or any step of this process is subject to rain, snow or other factors after the proof-roll has been performed, the City Inspector and/or Geotechnical engineer shall evaluate the areas proposed to be paved and shall make a recommendation to the City. Paving shall not commence unless approved by the City.

Section 1009.02 Lime Stabilized Composite

Lime stabilization shall comply with Section 429.00 Lime-Treated Subgrade of these Standards and Specifications.

Section 1009.03 Full Depth Asphalt

Subgrade preparation for full depth asphalt sections approved by the City Inspector will comply with Section 421.00 Embankment Construction of these Standards and Specifications.

Section 1009.04 Asphalt Placement and Compaction

Asphalt placement and compaction shall comply with MGPEC Item 20 (latest edition).

The mixtures shall be laid upon an approved surface, spread and struck off to obtain the required grade and elevation after compaction. Along the lip lines of gutters and crosspans sufficient bituminous material shall be deposited so that, after compacting, the wearing surface will remain not less than one-eighth (⅛) inch nor more than one-quarter (¼) inch above the concrete. The median curb wearing surface will be from one-quarter (¼) inch to one-half (½) inch below concrete.

In 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 twenty-five (25) percent. Carefully move or minimally work the HMA mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt cement require more rapid completion of handwork areas than for unmodified 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 at any time the paver stops, and the screed drops enough to cause a surface dip in violation of Section 11.13.1, Surface Tolerances; or the mat temperature falls below the breakdown temperature allowed in Section 11.12, 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 is preferred.

Asphalt density tests shall be taken by a Certified Materials Testing Agency per Section 404.00 Minimum Testing Requirements of these Standards and Specifications. Densities shall be between ninety-two (92) percent and ninety-eight (98) percent of the Rice unit weight (theoretical maximum density) as determined by an independent asphalt testing laboratory. Other methods of determining unit weight are subject to approval by the City.

The joints in any pavement layer shall not fall in a wheel track or path. Longitudinal joints shall be in a staggered manner, as to eliminate one longitudinal joint throughout the lifts of the whole mat. 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. The longitudinal joints shall be compacted to a target density of ninety-two (92) percent of the theoretical maximum specific gravity. The tolerance shall be positive to negative four (± 4) percent. The theoretical maximum specific gravity used to determine the joint density will be the average of the daily theoretical maximum specific gravities of the material that was placed on either side of the joint. Density (percent relative compaction) will be determined in accordance with CP 44. Longitudinal joint density tests shall be taken by a Certified Materials Testing Agency as specified in Section 404.00 Minimum Testing Requirements of these Standards and Specifications.

Rocks generated from raking at joint tie-ins or vertical projections shall not be broadcast on the new mat, but shall be placed back in the paver hopper or asphalt truck. Racking will not be allowed except to correct major problems of grade and elevation.

Section 1009.05 Tack Coat

Materials and construction shall comply with MGPEC Item 20 (latest edition).

Section 1009.06 Seal Coat

Seal coat materials and construction shall comply with MGPEC Items 24, 25 and 26. The type of bituminous material, cover aggregate, and rates of application shall be as shown on the approved plans.

Section 1009.07 *Rejuvenating Agent*

Rejuvenating agent materials and construction shall comply with Section 407 of the CDOT Standard Specifications for Road and Bridge Construction.

Section 1009.08 *Joint and Crack Sealant*

Sealant materials and construction shall comply with MGPEC Item 23.

Section 1010.00 Trench Cuts and Exploratory Pothole/Core Repair

Section 1010.01 *Trench Cuts*

Utility trench patches shall be in accordance with the Detail Drawings found in these Standards and Specifications. Backfill of utility trenches shall comply with Section 424.00 Trenching, Backfilling and Compacting of these Standards and Specifications.

The Contractor shall place a temporary, cold mix, asphalt patch in all street cuts immediately after completing backfill and compaction if a permanent hot mix asphalt patch cannot be installed. Portions shall not be left on any trench patch at the end of the working day if the depth of the patch is lower than the existing street surface.

When pavement cuts are required, the following conditions shall be met so as to avoid interference with traffic:

A. Pavement cuts in streets shall be completed between 7:00AM and 7:00PM or as specifically directed in the Permit Conditions.

B. Two (2) way traffic shall be maintained at all times around the construction area. A Traffic Control Plan (TCP) shall be prepared in accordance with Section 131 Traffic Control, Barricades and Warning Signs and submitted to the Traffic Engineer for approval prior to the start of construction.

Trench cut asphalt repairs in streets less than five (5) years old shall be subject to approval by the City Engineer and special asphalt repair requirements in accordance with the Detail Drawings found in these Standards and Specifications. The applicant shall be responsible for maintenance of the permanent patch for a period of two years.

Section 1010.02 *Exploratory Pothole/Core Repair*

When exploratory utility potholing is performed, the Contractor shall repair the pothole in the following manner.

<u>Asphalt:</u>

A. Exploratory potholing voids are to be backfilled utilizing a flowable controlled low strength material and the core patched with a temporary patching material immediately after initial potholing is complete.

B. All material disturbed and/or removed during the exploratory operation shall be replaced with an approved flow-fill mix.

C. Squeegee shall not be allowed as backfill material except for use as pipe bedding with a twelve (12) inch maximum depth over the pipe.

D. Within seven (7) days of initial drilling, or within a reasonable and practical amount of time after completion of the projected work, potholes will be permanently patched utilizing the original core, and set using a non-shrink grout, as per the permit conditions of the city.

E. Portions shall not be left on any trench patch at the end of the working day if the depth of the patch is lower than the existing street surface.

F. Any exploratory pothole and/or patch that are deemed dangerous shall be repaired immediately.

G. All permanent repairs shall be made to look symmetrical and/or uniform. No jagged, uneven patches will be allowed.

H. All edges and patch areas shall be dried, cleaned and tacked. All newly placed asphalt shall be maximum one-half (½) inch mix (SX) and shall be compacted properly in two (2) inch lifts.

I. See Detail Drawings found in these Standards and Specifications for more information.

Potholing in streets less than five (5) years old shall be subject to approval by the City Engineer and special asphalt repair requirements. The applicant shall be responsible for maintenance of the permanent patch for a period of two years.

Section 1010.03 Patching and Mill and Overlay Repair

For multiple patches along the frontage of a Project mill and overlay shall be required from the lanes line passed the cut parallel with the roadway and a minimum of 10’ beyond the trench on either side. The City Engineer, at his discretion, may require mill and overlay the limits of the frontage depending on the impact.

Section 1011.00 Pavement Acceptance Testing

At the discretion of the City, the Developer may be required to furnish the City with an electronic copy of a Pavement Evaluation Report utilizing non-destructive deflection testing to assess and predict the performance of the pavement prior to Acceptance into Warranty. The pavement evaluation shall be performed in accordance with accepted engineering practices. The report shall generally incorporate the following testing and pavement evaluation techniques:

A. Pavement surface evaluation

B. Soil borings in areas of high deflection

C. Pavement deflection analysis (Falling Weight Deflectometer, Dynaflex or other method approved by the City)

The Pavement Evaluation Report shall evaluate the existing condition of the base and binder course by performance of deflection tests at a minimum of one-hundred fifty (150) foot spacing per traffic lane over the deepest utility trench, at every manhole and storm inlet, and at all areas of visual distress. The report shall determine the Remaining Service Life (RSL) of the roadway. Pavement deflection testing and the final top lift or overlay of asphalt shall only be performed between April 1st and October 1st, unless permission is granted by the City.

If the pavement section is not projected to meet a twenty (20) year or greater pavement life from the time of installation based on the pavement deflection test results, the report shall detail the deficiencies and associated causes and shall recommend remedial measures to develop a twenty (20) year design life. The City will evaluate the report and inform the responsible party of the required pavement remediation.

Pavement Deflection Testing is not required for the City of Littleton Capital Improvement Projects (CIP's) or street reconstruction, unless otherwise specified in the contract documents.

Section 1012.00 Grinding

Grinding shall consist of "milling", "grinding", or "cold planning" 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 that is uniform and resistant to raveling or traffic displacement. This textured surface shall have grooves of one-quarter (¼) inch plus or minus one-eighth (± ⅛) inch.

Grinding shall consist of milling the existing pavement to a minimum depth of two (2) inches and as required by the Pavement Deflection Testing Report or specified in the contract documents, unless otherwise directed by the City. Grinding around utility castings shall be to a minimum depth of one and one-half (1½) inches and as required by the Pavement Deflection Testing Report or specified in the contract documents. The maximum deviation between the top of the milled pavement and top of the manhole or water valve box shall be no more than three-quarters (¾) of an inch in areas open to traffic. This condition may be achieved by placing a temporary wedge of hot mix asphalt (HMA) around the structure. This temporary taper shall be removed prior to placement of new HMA pavement.

Contractor shall protect existing concrete adjacent to milling areas so not to chip or gouge the existing concrete.

Repair of valve boxes and/or manholes damaged during all milling operations will be the sole responsibility of the Contractor. Repair to include saw cutting positive to negative three feet by three feet by six inch (+/- 3'X3'X6"), excavating, replacing all damaged parts to final resurfacing grade and repaving.

Material recovered during the milling operation shall be disposed of by the Contractor at their expense, unless otherwise directed.

Unless otherwise approved, overlay of a milled street shall be within fifteen (15) days after the street is milled.

The Contractor shall remove the cuttings immediately behind the grind machine by belt loader, end loader, power sweeper and/or by hand. The grinding machine shall be equipped with a pressurized watering system for dust control. Flushing into Littleton's storm drainage system as a means of cleanup shall not be allowed.

Section 1013.00 Acceptance of Public Roadways

Workmanship shall meet all Littleton Standards and Specifications. This includes thickness, crowns, drainage, areas around manholes and service covers, trench settlement and edges against curb and gutter and drain pans. Acceptance of roadways shall comply with Section 200 Development Acceptance Procedures of these Standards and Specifications. Pavement shall not exhibit any distress such as alligator cracking, block cracking, edge cracking, potholes, trench settlement, raveling, heaving, sinking, separation from curb and gutter, patching or ponding at the completion of the warranty period. Ponding of water in asphalt pavement shall not be accepted by the city and pavement shall be removed and replaced, milled and repaved, or the area fixed with infrared patching at the discretion of the City. Material that is obviously defective shall be isolated and rejected by the City without regard to sampling sequence or locations within a lot.

When disagreements concerning determination of specification compliance occur only valid tests from both the City and Contractor will be considered. The City shall determine validity.

Generally, valid tests are those in which sampling and test 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.

Section 1013.01 Asphalt

A. Aggregates and Asphalt Materials

1. Items: Base course, cover coats, foundation drains, gravel underdrains, patching, pit run, plant mix asphalts, seal coats, special backfill, treated base.

2. Measurement: (Ton) (Square Yards) - Measurement of aggregates and asphalt materials shall be the actual tons, evidenced by certified weight tickets, of the various types, grades or classes of materials, or placed in the work or the number of surface square yards when specified on the Bid Schedule.

3. Payment: The accepted quantities of materials will be paid for at the contract unit price bid. No separate measurement or payment will be made for barricading, traffic control, sweeping, disposal of waste materials, subgrade preparation, hauling, placing, wetting, rolling, shaping, compacting, etc., but shall be included in the work.

4. Pay items for patching on City projects shall be complete-in-place to include sawcutting, removal of existing asphalt, excavation to subgrade of the specified patch section, placement of base and new hot bituminous pavement material, and compaction of all layers.

5. The pay items for overlaying on City projects shall be complete-in-place to include sweeping and tack coating of existing bituminous pavement.

B. Liquid Agents for Asphalt Surface Treatment

1. Liquid Agents shall be in accordance with CDOT Specification 407.

C. Cold Milling

1. Cold Milling shall be in accordance with CDOT Specification 202.

2. Measurement: (Square Yards/Vertical Inch) - Cold milling will be measured as the actual number of square yards of surface area milled to an average depth of one (1) inch, or fraction thereof.

3. EXAMPLE: A milled section twenty-seven (27) feet long, uniformly tapered from two and one-quarter (2 ¼) inches below the gutter lip line and which daylights with the existing asphalt surface eight (8) feet and perpendicular therefrom will be measured as: (27 ft. x 8 ft./9 ft./sq. yd.) (2-1/4 in./2) = 27. 0 square yards.

4. Payment: The accepted quantities will be paid for at the contract unit price per square yard per inch of depth bid. No separate measurement or payment will be made for traffic control, disposal of milled materials, maintenance of milled surface, prior to resurfacing etc., but shall be included in the work.

D. Slope and Ditch Paving

1. Items: Bituminous, concrete, dry or grouted rubble.

2. Measurement: (Cubic Yards) (Ton) - Bituminous slope and ditch paving will be measured by the number of tons in place and accepted. Measurement of the various other types will be by the cubic yard based on dimensions shown on the plans, as directed or measured by the average end area method.

3. Payment: Accepted quantities of the various types of slope paving specified in the Bid Schedule will be paid for at the contract unit price bid. No separate measurement or payment will be made for excavation, haul, mortar or concrete used for grout, top coat, etc., but shall be included in the work.

E. Hauling

1. Measurement: (Mile) – Haul shall be obtained by the shortest milage from the distance of origin to the destination.

2. Payment: The quantity of haul measured as provided above will be paid for at the contract unit price bid. Unless specifically specified in the Bid Schedule, no separate payment will be made for haul but shall be included in the various items of the work.

F. Mud Jacking

1. Measurement: (Pound) - The quantity to be measured will be the exact poundage measured by a property calibrated device.

2. Payment: The accepted quantity of material will be paid for at the contract unit price bid. No separate measurement or payment will be made for drilling and plugging of holes, dewatering, soil cement materials, etc., but shall be included in the work.

G. Painting

1. Items: Pavement marking with paint, thermoplastic or tape; steel, wood and concrete structures

2. Measurement: (Lineal Feet) (Square Feet) (Each) - The quantity to be measured shall be the actual exposed length or surface area of marking or painting installed. Painting of structures will be the actual number of the various types and sizes thereof, specified in the Bid Schedule, and no measurement of the surface area will be made.

3. Payment: Accepted quantities of pavement marking, and structure painting will be paid for at the contract unit price bid. No separate measurement or payment will be made for traffic control, dewatering, sand or grit blasting, protection of existing cathodic protection systems, protection of adjoining properties during blasting and/or painting, site restoration, disposal of surplus materials, etc., but shall be included in the work.

H. Subgrade Treatment

1. Items: Heating and scarifying bituminous surface, reconditioning subgrade, treatment at the base of cuts and fills.

2. Measurement: (Square Yard) - Subgrade treatment will be measured by the square yard of existing surface area treated and reconditioned.

3. Payment: The accepted quantities of the various types of treatment, called for in the Bid Schedule, will be paid for at the contract unit price bid. No separate measurement or payment will be made for removal, windrowing or tilling in place and recompacting, wetting, rolling, blading, shaping, finishing and maintenance of the finished surface prior to acceptance, but shall be included in the work.

I. Payment Reduction for Asphalt

1. All work performed and all materials furnished shall conform to the line, grades, cross sections, dimensions, and material requirements, including tolerances, shown in the contract. For those items of work where working tolerances are not specified, the Contractor shall perform the work in a manner consistent with reasonable and customary manufacturing and construction practices.

2. When the Owner determines that the material furnished, work performed, or the finished product is not in conformity with the contract and has resulted in inferior or unsatisfactory product, the finished product or materials shall be removed and replaced or otherwise corrected by, and at the expense of, the Contractor unless the City Engineer determines that the work can be accepted at a reduced price. Payment reduction (CIP work only), when allowed, shall be accomplished by adjusting pay quantities as indicated herein and applying the contract unit prices to the reduced quantities. If allowed, the Owner shall:

    a. Document the basis for acceptance by a notice which shall provide for an appropriate adjustment in the payment quantity for such work or materials not otherwise provided for in this section.
    b. Notify the Contractor in writing that the payment shall be adjusted in accordance with this section.
    c. In lieu of payment (quantity) adjustment, permit correction or replacement of the finished product provided the correction or replacement does not adversely affect the work or the Owner.

Materials shall be sampled and tested by a qualified testing laboratory in accordance with the sampling, testing schedules, and procedures contained in Section 907 Concrete Testing. The approximate maximum quantity represented by each sample shall be as set forth in the testing schedule. An additional number of samples, in relation to the quantity of materials represented, may be selected and tested at the Owner’s discretion. The quantity represented by five consecutive random samples shall constitute a lot, whenever production schedules and material continuity permits. When, it is necessary to represent short production runs, significant material changes, or other unusual characteristics of the work, the Owner may establish a lot consisting of the quantity represented by any number of consecutive random samples from one to seven inclusive. Testing results that are determined to have sampling or testing errors, as determined by the Owner, shall not be used.

Materials or work shall only be evaluated for price adjustment when deviations from Specification occur on any of the individual tests for the lot. The several individual test values shall be averaged and the percentage of payment (quantity) reduction for the lot shall be determined by the applicable table. This shall apply only when a payment reduction element is listed in a table below.

Payment adjustment for those elements not included in a table shall be determined by the Owner.

The Contractor shall not have the option of accepting a payment reduction in lieu of producing material meeting the specifications. Continued production of non-specification material shall not be permitted. Material that is obviously defective shall be isolated and rejected without regard to sampling sequence or location within a lot.

The pay factor for pavement that is allowed to remain in place at a reduced price shall be determined according to tables below and shall be applied to the quantities for the Item. If deviations occur in multiple Items within the same batch, the pay factor for the batch shall be the product of the individual pay factors.

For thickness deficiencies, payment reductions shall be per Lot, based upon a Lot encompassing 500 lineal lane feet or the quantity between tests, and shall be at the cost of the entire pavement system. The entire pavement system shall include only those items placed as part of this contract and those items impacted: mobilization, traffic control, subgrade preparation, pavement materials and installation, striping, and traffic signal loops need to be considered.

Table 1013.01 – Pay Factors:

Density	
Density (percent)	**Pay Factor**
98.01 - 100.00	Reject
97.01 - 98.00	0.95
93.00 - 97.00	1.00
92.00 - 92.99	0.95
91.00 - 91.99	0.90
90.00 - 90.99	0.80
Below 90.00	Reject
Asphalt Content	
Deviation from Mix Design (percent)	**Pay Factor**
Less than 0.30	1.00
0.3 - 0.55	0.90
Greater than 0.55	Reject
Thickness	

Deficiency from Plan Minimum Thickness (inch)	Pay Factor
Less than 0.25	1.00
0.26 - 0.50	0.90
0.51 - 0.75	0.80
0.76 - 1.00	0.60
Above 1.00	Reject

SECTION 1100 GROUNDS OPEN SPACE AND NATURAL RESOURCES

Section 1100.00 Scope

All right-of-way, open space, or areas owned and/or maintained by the City of Littleton shall comply with these specifications, approved plans, and the terms and provisions of any development agreement, including any subdivision improvement agreement. Areas owned but not maintained by the City, and under the management of South Suburban Parks and Recreation District ("SSPRD"), shall be governed by the design specifications of SSPRD, unless otherwise agreed upon in writing by the City and SSPRD.

\

Section 1101.00 Privately-Owned Landscaping

Common open space and other areas not owned or maintained by the City, but privately owned or maintained by a property owner, property owner's association, homeowner's association or other maintenance organization shall be designed and constructed in accordance with the Littleton Unified Land Use Code.

Section 1102.00 Site Design and Preparation

Site preparation shall be completed in accordance with Section 400 Soils and Earthwork of these Standards and Specifications.

Adequate drainage shall be taken into account for all site design and preparation. Grades shall not exceed 4:1 (horizontal:vertical) in shrub beds, mulched areas, or turf areas. Grades shall not be designed to drain onto residential lots.

Section 1103.00 Furnishings and Structures

Every project is unique in nature and the furnishing manufacturer/style may vary. Submittals for site furnishings such as benches, picnic tables, trash cans, dog waste stations, etc. are required for all new park and open space projects and shall be submitted to the City for approval prior to installation, and approved by the Manager of Grounds, or an Authorized Agent. All site furnishings shall be surface mounted and meet current local and state ADA requirements.

Park shelters and pavilions shall include a minimum of one (1) accessible picnic table and a minimum of two (2) trash receptacles.

The following furnishing and structure locations, requirements and exceptions shall be coordinated with the City:

A. Park Rules signs shall be installed for all parks.

B. Dog bag dispenser stations shall be installed in all parks. Locations will be determined on a case-by-case basis as operational needs dictate.

C. All fences shall be installed with an eighteen (18) inch wide concrete mow band (no metal edging). Fencing material shall be approved by a Littleton representative.

D. Seating areas shall be installed near playgrounds and other strategic locations to take advantage of shade and views.

E. Site furnishings or signposts installed in manicured turf shall be installed with twelve (12) inch concrete maintenance buffers.

F. All passive park locations shall include a minimum of one (1) trash receptacle.

Section 1104.00 Dog Parks

A. Dog park surfacing shall be turf or pea gravel material as approved by the City.

B. Dog park pea gravel color shall be approved by Littleton.

C. Dog park fencing shall be forty-eight (48) inches minimum height.

D. Dog park shall have two (2) separate areas for large dogs and small dogs with separate entrances to access each area.

E. A potable water source for dog drinking water must be available.

F. Benches and/or shade structures are recommended where feasible.

Section 1105.00 Lighting

The work covered in this section involves the purchase and installation of park and trail lighting. Lighting in open spaces shall comply the Unified Land Use Code. These standards provide the tools needed to understand the design goals of the City of Littleton for lighting pedestrian trails. The following have been identified as most important regarding lighting design:

A. Create a design that enhances the pedestrian experience.

B. Provide safety and security for the people using the trails and parks.

C. Create a design that reflects Littleton’s history.

D. Use of efficient lighting technologies.

E. Ease of maintenance and vandal resistance.

F. Exercise fiscal responsibility.

Section 1106.00 Lighting Design Considerations

Luminaire Mounting Height: The luminaire mounting height can range from ten (10) feet to fifteen (15) feet above finished grade with the lower range more subject to vandalism and the higher range marginal for pedestrian-scale lighting. Luminaire mounting height of twelve (12) feet is generally acceptable for pedestrian lighting but can be higher based on budgetary constraints.

Minimum Initial Footcandles for Trail Lighting: The minimum initial footcandles (Fc) level shall be one (1.0) Fc.

Spacing Between Poles: The normal spacing is between five to five point five (5.0 - 5.5) times the luminaire mounting height for an efficient pedestrian trail lighting luminaire's optics, so the pole spacing can range from fifty (50) feet to approximately eighty (80) feet on center.

Corrected Color Temperature of the Light Source: The corrected color temperature of the LED light source shall be three thousand 3000K.

Color Rendering Index of the Light Source: The color rendering index (CRI) of the LED light source shall be seventy (70) CRI.

The Design Engineer or Landscape Architect Engineer shall calculate the lighting levels using a computer-aided program that produces a point-by-point photometric calculation to ensure the proper lighting level is achieved.

A light loss factor of point nine (0.9) shall be utilized for all LED lighting calculations.

Types of Conditions: The following trail conditions must be considered during the lighting design process:

A. Pedestrian trails
B. Trail intersections
C. Trails next to buildings
D. Crosswalks
E. Bridges
F. Wayfinding and interpretive illumination

Power: The power source for the trail lighting system shall be two-hundred forty (240) volts single phase. Where possible, the power supply for new trail lighting shall be an extension of the existing trail lighting circuit. The Design Engineer shall conduct a load study to determine the available spare capacity of the existing lighting circuit to determine the available spare capacity. Where the existing circuits are not adequate to supply the new lighting, a new electrical service shall be installed. The meter pedestal consists of a Tescoflex 26-000 (metered), Milbank CP3A, or approved equal.

Construction Documents shall include, but not limited to, the following:

1. Proposed Lighting: All luminaires shall be graphically located on the plans including all light standards, fixtures, pull boxes, transformers and other construction components.
2. Point of Connection: The electrical utility service point shall be shown on the plans. If the point of connection is not within the project site, the service point shall be identified in a vicinity map detail. Any fees associated with the connection to the utility shall be enumerated by an appropriate bid item.
3. Light Fixture Legend: Shall include symbols for luminaires, poles, fixture types, conduit size, panels and utility service points.
4. Lighting Fixtures Schedule: Shall identify the fixture type as shown on the plans, the manufacturer and model number, lamp type and wattage, voltage required and any notes that pertain specifically to each fixture type.
5. Panel Schedule: Shall designate circuits with the number of devices being served, voltage, number of phases, short circuit rating, load continues amperage, etc.
6. Lighting Details: Shall be provided within construction documents to further define special construction details pertaining to the lighting equipment and construction and so that contractors can provide consistent competitive bids.
7. Lighting Specifications: Shall be provided on the plans or provided in the specifications. Specifications must include at a minimum, everything included in the Light Fixture Schedule, plus fixture cut sheets for each luminaire, standard and lamp used.

Section 1107.00 Lighting Materials

A. Luminaries and Poles: The consultant shall submit luminaries and poles to the Manager of Grounds for approval.

B. Bases: All lighting poles shall be mounted to reinforced concrete pole bases as approved by Manager of Grounds. Top of pole bases shall be set flush with grade and include concrete mow strips around the perimeter of the bases. Poles shall be located to maintain twenty-four (24) inches of clearance from the pole to the edge of the trail as required to conform with bike trail safety standards. Exact location shall be coordinated with the existing utilities and trail easements.

C. Conduit and wire: Wiring for all lighting circuits shall be copper conductors concealed in conduit. Minimum wire size shall be #8 to limit voltage drop to an acceptable level and allow for future additions. All underground conduits shall be Schedule 40 PVC conduit, and all above grade exposed conduit shall be rigid steel. Conduit inside of a building is allowed to be EMT conduit where it is not subject to physical damage. The minimum size for underground conduit feeding trail lighting poles shall be one and one-half (1½) inch Schedule 40 PVC. Underground conduit shall be buried thirty (30) inches below grade.

   1. Direct buried cable: Direct buried cable is not allowed.

   2. Trenches for underground conduit shall be coordinated with existing utilities and landscape. Adjust location of the trench as required to avoid conflict. Locate conduit trenches outside the existing tree drip line. Where it is not possible to locate outside the drip line, the conduit shall be bored under the tree roots. Conduit bore shall be a minimum of three (3) feet deep.

   3. The Design Engineer shall conduct voltage drop calculations for all lighting circuits. Limit the voltage drop in all circuits to three (3) percent of the nominal voltage rating.

D. Controls: The trail lighting shall be turned on at dusk and off at dawn with a single photoelectric control located at the power source. Photoelectric control devices mounted on each pole or luminaire are not allowed. A bypass switch shall be installed at each photoelectric control device to allow the photocell to be bypassed for manually turning on the lighting for testing. Lighting controls shall also include a time clock to allow the trail lighting to be turned off late at night or early morning to conserve energy.

   All lighting control panels shall have a laminated control diagram attached to the inside of the panel. Control diagram shall identify circuit numbers and a list of the pole identification numbers that are powered by each circuit.

Section 1108.00 Street Landscaping

Section 1108.01 Medians and Parking Islands

All elevated center islands and medians shall have an eighteen (18) inch minimum width, from back of curb to back of curb, colored and patterned concrete border. Islands and traffic medians with turf shall have mower access ramps for maintenance for each individual turf area. Parking lot areas shall have stop blocks or buffer zones for vehicle overhang. Stop blocks shall be a minimum of 70” long x 5.75” wide x 3.5” high.

Section 1108.02 Amenity Zone/Tree Lawn

An amenity zone is the area between the back of curb and edge of detached sidewalk. Amenity zones shall follow these requirements:

A. No plants shall be placed within two (2) feet of the back of curb.

B. Trees require eight (8) feet minimum width.

C. Shrubs and plants require four (4) feet minimum width.

Section 1109.00 Soil Preparation

Section 1109.01 General

Soil preparation amendments shall be provided on all areas to be seeded, sodded, or otherwise planted. The Contractor shall provide all labor, equipment and materials necessary to complete the topsoil preparation as required by the approved plans and these Standards and Specifications.

Section 1109.02 Weed Seed Eradication

Perform pesticide treatment over the entire area to be planted during the growing season. Allow enough time to successfully complete the entire pesticide treatment process (germinate / terminate) before proceeding with planting.

Water surface one half (½) inch per week for two (2) weeks prior to application if natural precipitation does not supply this amount to encourage weed seed germination.

Notify City forty-eight (48) hours in advance of each pesticide treatment.

Apply pesticide in accordance with manufacturer's recommendations.

Two (2) weeks after the first pesticide application, review surface for evidence of plant growth.

If there is no evidence of plant growth, obtain the City's approval of surface conditions to proceed with Soil Preparation.

If more than ten (10) percent of the area to be planted contains new plant growth, the pesticide and watering application shall be repeated until new plant growth is satisfactorily eradicated.

Section 1109.03 Site and Soil Preparation

Remove plant debris from treated area.

Prior to seeding or sodding and in accordance with the requirements of the applicable section of the City Standard Specifications, the area to be landscaped shall be cleared, grubbed, and graded to within one-half (½) inch of finish grade.

All irregularities in the ground surface, except the saucers for trees and shrubs in rough grass seeding areas, shall be removed. Special measures shall be taken to eliminate all low spots and pockets that would trap water and to clear the area of one to one and one-half (1-1½) inches and larger rocks or other debris. No ponding water will be allowed and shall be corrected.

All property pins shall be set and clearly marked before construction begins and shall be preserved until Final Acceptance.

Locate all utilities (sewer, water, irrigation, gas, electric, phone, and other conduits and subsurface equipment) prior to commencing work. The Contractor shall be responsible for the protection of

all new and existing infrastructure and repair any damages caused by work under this Section at no additional cost to the City.

In general, turf and planting areas shall receive Soil Amendments unless otherwise noted or specified by the City. For the purpose of bidding, the Contractor shall assume all areas to receive soil amendments will be at four (4) cubic yards per one thousand (1,000) square feet. Once soils tests have been received and determination is made on the proper amount to be added the site-specific soils the rate to be applied may be adjusted per the price based on the Schedule of Values for Soil Amendments.

Deficiencies: The City will specify deficiencies to the Contractor who shall make satisfactory adjustments and shall again notify the City for an additional inspection.

The Contractor shall ensure that the grade adjacent to site features, including walks follows the requirements of this Specification section prior to requesting Substantial Completion.

If the prepared soil or subgrade is disturbed or contaminated prior to planting or installation of sod/seed, the Contractor shall restore or replace the prepared soil or subgrade as directed by the City at no cost to the City.

Section 1110.00 Landscape Materials

Section 1110.01 Soil Amendments and Fertilizer

The contractor shall submit bag tags and/or truck load tickets for all products. The contractor shall apply one or more of the following as directed by the City:

Organic slow-release fertilizer (6-1-1, NPK): Biosol, or city approved equal.

A. Natural soil conditioner: Earthgreen Menefee Humate All Natural Organic Soil Conditioner, or City approved equal.

B. Mycorrhizal inoculum: AM-120 Standard, or City approved equal.

C. Triple superphosphate (P2O5 with an N-P-K of 0-46-0)

D. If a soil analysis indicates sufficient amounts of the above elements or in areas where xeriscaping is proposed, the City may, at its discretion, modify or adjust the requirement to fertilize.

E. Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from: agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (less than one (< 1) by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. The product shall be certified through the U.S. Composting Council's (USCC) Seal of Testing Assurance (STA) Program.

Table 1110.01 - Product Parameters

Parameters	Reported as (units of measure)	General Range
pH	pH units	6.0-7.5
Soluble Salt Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 5
Moisture Content	%, wet weight basis	30-60
Organic Matter Content	%, dry weight basis	30-65
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through ¾" screen or smaller
Stability Carbon Dioxide Evolution Rate	Mg CO2-C per g OM per day	<2
Maturity Indicator	Carbon to Nitrogen Ratio (C/N)	<12
Maturity Indicator	Ammonia N/Nitrate N Ratio	<4
Maturity (Cucumber Bioassay) Seed Emergence and Seeding Vigor (each)	% relative to positive control	Minimum 80% (each)
Maturity (Red Clover lopyralid Sensitive Plants - Bioassay) Seed Emergence and Seed Vigor (each)	% relative to positive control	Minimum 80% (each)
Physical Contaminants (inerts)	% dry weight basis	

Notes:

1. Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, The US Composting Council)
2. US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels = Arsenic 41ppm, Cadmium 39ppm, Copper 1,500ppm, Lead 300ppm, Mercury 17ppm, Molybdenum 75ppm, Nickel 420ppm, Selenium 100ppm, Zinc 2,800ppm.
3. US EPA Class A standard, 40 CFR § 503.32(a) levels = Salmonella <3 MPN/4grams of total solids or Fecal Coliform <1000 MPN/gram of total solids.
4. City Manager of Groundsor an Authorized Agent may modify the allowable compost specification ranges based on soil analysis, specific field conditions and plant requirements.

   *Before delivery of the compost, the supplier must provide a copy of the lab analysis, performed by a STA Program certified lab, verifying that the compost meets the product parameters listed above. The lab analysis should not be more than ninety (90) days old. *Truck delivery tickets must match the approved compost.

Organic materials shall be applied at a rate of five (5) cubic yards per one thousand (1,000) square feet in all manicured turf areas and shrub beds. Native areas will require three (3) cubic yards per one thousand (1,000) square feet. Organic material shall be a certified Class I or II compost product, depending upon specific project applications. Lab analysis of the organic material shall be submitted for approval prior to delivery. Organic materials shall contain less than ten (10) mmhos/cm of soluble salts and shall have a pH in the range of six to eight point two (6.0-8.2) and a thirty to thirty-five (30-35) percent moisture content. Due to the difference in moisture content of organic materials, certification of material volume may be required. Mountain peat will not be accepted.

Starter fertilizer shall be a complete starter fertilizer having the minimum chemical analysis of Nitrogen-18, Phosphorous, Potash. Fertilizer shall be delivered to the site in new, unopened bags bearing the manufacturer's name and the chemical analysis. Fertilizer shall conform to all Colorado Department of Agriculture fertilizer laws.

Starter fertilizer shall be applied at five (5) pounds per one thousand (1,000) square feet after fine grading is complete and before sod or seed is planted.

Section 1110.02 Topsoil

Areas to be revegetated shall be prepared with topsoil and soil preparation amendments. The City has the prerogative of deleting all or a portion of the soil preparation requirements when topsoil is imported, depending on topsoil quality and quantity. Topsoil amendments shall meet the requirements of Section 1109.01 General and 1101.01 Soil Amendments and Fertilizer of these Standards and Specifications.

The Contractor shall salvage within the project limits, or acquire when needed, loose friable loam (“topsoil”) reasonably free of admixtures of subsoil, refuse, stumps, roots, rocks, brush, weeds, heavy clay, toxic substances or other material which would be detrimental to the proper development of vegetative growth.

Topsoil shall not be placed until the areas to be covered have been properly prepared and grading operations in the area have been completed. Topsoil shall be placed, spread and keyed to the underlying material at locations and to the thickness shown on the approved plans.

Topsoil shall not be incorporated into any embankment fill or backfill material without prior approval of the project Geotechnical engineer and the Project Manager.

Areas to receive topsoil shall be scarified to a six (6) inch depth to improve the bond of topsoil to subsoil. Place topsoil to a minimum depth of six (6) inches after settlement. Spread evenly and grade to elevations and slopes shown on the approved plans. Hand rake areas inaccessible to machine grading.

If sufficient on-site material is not available, the contractor shall furnish and install imported topsoil in the manner described above. Topsoil shall be mixed thoroughly with the salvaged topsoil prior to placement.

Utilize manufactured topsoil as the top layer, placing over scarified subgrade to a depth of six (6) inches.

Protect completed areas where topsoil has been spread from traffic to prevent compaction. Any areas that, as determined by the City Engineer, Manager of Grounds, or an Authorized Agent, become compacted due to the contractor’s construction traffic shall be reconstructed.

All imported topsoil shall be a loam or sandy loam conforming to ASTM D 5268. At least ten (10) days prior to topsoil delivery, notify the city of the source(s) from which topsoil is to be furnished. Topsoil shall be furnished by the contractor and shall be a natural, friable soil representative of productive soils and shall meet the following conditions. Topsoil shall be free from weeds, sod, and material larger than one (1) inch, toxic substances, litter or other deleterious material. The topsoil shall have an acidity in the range of pH 6.5 to pH 8.5, and shall be screened and meet the following mechanical analysis:

Table 1110.02 – Topsoil Gradation

Screen Size	Percent PASSING	PERCENT RETAINED
1 Inch Screen	100	0
½ Inch Screen	97-100	0-3
#100 Mesh Sieve	60-40	40-60

Soil Texture:

Sand: thirty to fifty (30 – 50) percent

Silt: thirty to fifty (30 – 50) percent

Clay: five to thirty (35-30 percent

Soluble Salts: Electric conductivity (EC) shall be less than two (2) mmhos/cm for turfgrass areas, dryland areas, and planting beds.

Section 1111.00 Process

A. No sod or seeding shall occur until the Inspector has inspected and approved the soil preparation. The following process shall apply to native areas as well.

B. Upon establishment of approved grades, the soil surface shall be loosened by rototilling to a minimum of eight (8) inches (for a twenty to thirty (20 – 30) percent inclusion rate), and all materials over two (2) inches in diameter shall be removed and the soil surface shall be reasonably free of large clods, roots, and stones greater than two (2) inches, and other material which will interfere with seeding and subsequent site maintenance. Higher inclusion rates are necessary for upgrading marginal soils, as determined by the city engineer. All amendments, fertilizers, and compost shall be mixed thoroughly into the soil surface to a depth of eight (8) inches by means of a rototiller, soil mixer or similar equipment. Do not leave mycorrhizal inoculum exposed to sunlight for more than four hours. The surface shall then be finish-graded, compacted to the approved elevations and the soil surface shall be raked smooth prior to seeding.

C. Seeding shall take place within forty-eight (48) hours of soil preparation, unless otherwise approved by the City.

D. Organic materials shall be applied when the surface is within two-tenths (0.2) of a foot of final grade. No organic material containing manure shall be stockpiled on the site for more than eight (8) hours before it is incorporated into the soil.

E. After tilling, the areas to be sodded/seeded shall be raked, graded, and rolled to final grade with gently sloping surfaces to adequately drain surface water run-off. The finished surface shall be even and uniform, with no soil clumps or debris larger than one (1) inch in diameter. The prepared soil surface shall be on an even plane with all sidewalks, curbs, or borders for both seeded and sodded areas. On sloping ground, the final disc harrowing operation shall follow on the general contour. In no case shall slopes or sodded or seeded areas exceed four horizontal to one vertical (4:1).

Section 1112.00 Grass Specifications

Section 1112.01 Bluegrass/Turfgrass Sod

A. Prior to installation, the sod blend shall be submitted for approval by the City.

B. The variety of sod may vary based upon projected land use. An approved variety of drought-tolerant sod shall be used in passive park and right-of-way areas to ensure low water use. Athletic grass blends shall be used in high use park areas and on athletic fields. Due to water considerations, bluegrass varieties are generally discouraged but allowed where compliant with the Unified Land Use Code.

C. Sod shall be strongly rooted and free of noxious weeds, undesirable plants, roots, stones, and other foreign materials that are detrimental or may hinder proper development of the sod. The sod shall be procured from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. The sod shall be cut from living, thickly matted turf. The sod shall be mowed to a height not to exceed two and one half (2½) inches and thoroughly watered before the sod is cut. All sod shall be cut to provide a minimum thickness of three-fourths (¾) inch of soil adhering to the roots. The Contractor shall furnish written proof of sod variety to Littleton. Sod shall be tested by the Colorado State University laboratory or a certified laboratory at the Contractor's expense if requested by Littleton.

Section 1112.02 Bluegrass/Turfgrass Seed

Seed shall be furnished in sealed, unopened, standard containers and labeled in accordance with the USDA Rules and Regulations and the Federal Seed Act. Seed certification tags shall be delivered to Littleton to verify compliance with these Standards and Specifications. Seed shall be fresh, clean, pure live seed equal in quality to the standards for "Certified Seed" and shall pass the USDA test for germination of eighty-five (85) percent and for purity of ninety (90) percent.

Section 1112.03 Turf Seed

A. Due to water considerations, bluegrass varieties are generally discouraged but allowed where compliant with section 10-1 of the Littleton City Code.

B. Seed shall be fresh, clean and new crop mixture mixed by an approved method.

C. Blend: Kentucky bluegrass minimum ninety (90) percent and Perennial ryegrass maximum ten (10) percent:

Include at least four (4) improved Kentucky bluegrass cultivars, each of a different type of classification. At least one cultivar shall be an aggressive type and one shall be shade tolerant. Submit list of proposed varieties to the City a minimum of ten (10) days prior to seeding.

Application rate:

1. Mechanical Seeding: Four (4) pounds pure live seed (PLS) per one thousand (1,000) square feet.
2. Hand Broadcast Seeding: Eight (8) pounds pure live seed (PLS) per one thousand (1,000) square feet.

D. The formula used for determining the quantity of PLS shall be: *Pounds of Seed x (Purity x Germination) = Pounds of PLS.*

E. Seed shall be free of Poa annua and all noxious or objectionable weed and shall have a maximum weed crop of one-tenth (0.1) percent. Littleton Parks may require tests of seed verification at the Contractor’s expense. Seed specifications and application rate may vary based on projected land use.

F. Seeding Season: Seeding shall occur as specified below.

Seed Type	Irrigated Areas Only	Non-Irrigated Areas

Bluegrass Lawn	April 15-Sept 1	N/A

F. Fertilizer: Inorganic mixture with following chemical composition: (20-5-10) with fifty (50) percent of the nitrogen source being slow release, or as recommended by testing lab based on soil sample results.

G. Water: Water shall be free of substances that may be harmful to seed growth. Hoses and other watering equipment necessary to water the seed to be furnished by Contractor.

H. Warranty for Seeded Turf Areas: Warrant areas in seed to be in a healthy, vigorous growing condition, and for consistency and completion of coverage for a period of one (1) year from date of Substantial Completion as a full stand of grass. After seed germination, re-seed any spots where seed has not germinated within the total seeded area. Continue this procedure until a successful stand of grass is growing and accepted by the City.

I. Reseeding will not be allowed in any season considered unfavorable for seeding by the City.

J. Final Acceptance will be granted when turfgrass seed areas have uniform and consistent growth over the entire seeded area and are in a healthy, vigorous growing condition. Turf installations shall meet the following criteria as determined by the City

K. Sixty (60) days after seeding, the seeded areas shall be reviewed by the City and the Contractor.

L. Any areas as determined by the City where the seed has failed to germinate shall be reseeded and raked to cover the seed.

M. In any area where the seed has failed to grow, reseeding shall be at the Contractor's expense until grass is established and accepted.

N. Acceptable uniform plant growth shall be defined as scattered bare spots, not greater than one (1) square foot, and do not exceed two (2) percent of the seeded area.

O. Use approved materials to reestablish turf that does not comply with the requirements of these specifications and continue maintenance until turf meets the requirements and reaches Final Acceptance.

P. After Final Acceptance, the turfgrass areas will become the responsibility of the City.

Section 1112.04 Native Seed

All areas shall be prepared according to these Standards and Specifications before seeding will occur. Seed blends shall be pre-approved by Littleton prior to seeding. Seed shall be furnished in sealed, unopened, standard containers and labeled in accordance with the USDA Rules and Regulations and the Federal Seed Act. Seed certification tags shall be delivered to Littleton to verify compliance with these Standards and Specifications. Seed shall be fresh, clean, pure live seed equal in quality to the standards for "Certified Seed". Littleton may require seed verification tests at the Contractor's expense. Seed specifications and application rate may vary based on

projected land use. The Manager of Grounds will provide required seed mixture and application rate based on the site and application equipment.

Cover crops may be required in certain applications.

Table 1112.01 – Native Seed Application Rate

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Triticum aestivum x Secale cereale	Sterile triticale	60	18	100
	Total	60	18	100

Drill Seeded Rate: 60.0 PLS#/Acre

Mechanical Broadcast Rate: 70.0 PLS#/Acre

Hand Broadcast Areas Rate: 80.0 PLS#/Acre

Section 1113.00 Seed Top Dressing

Mulching material shall be applied immediately after seeding.

For hydroseeding, slurry mix shall not be combined with hydroseeding. Apply hydro-mulch (wood fibers in a water slurry) at a minimum rate of two thousand (2,000) lbs/acre with a three (3) percent guar gum tackifier. Hydromulch shall be applied to both native and bluegrass seed installations immediately after seed application. Only acceptable for irrigated areas.

For drill-seeded areas: Grain straw shall be used at an application rate of four thousand (4,000) lbs/acre of air-dried material. Straw shall be certified weed-free and shall be used on native seeding only. Straw shall be applied over the seeded surface at the minimum rate of two thousand (2,000) pounds per acre and with partial embedment into the soil by a crimper or similar implement. Straw shall be applied immediately after seed application.

For steep slopes hand or mechanical broadcasted:

Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, six (6) inches long.

Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of point nine two (0.92) lb/sq. yd., with fifty (50) to sixty-five (65) percent open area. Include manufacturer's recommended steel wire staples, six (6) inches long.

Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of three (3) inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

Section 1114.00 Process - Sod

The sod bed shall be lightly watered immediately prior to installing the sod. All sod strips shall be placed tightly against each other so there are no apparent open joints. Joints between ends of strips shall be staggered at least one (1) foot between adjacent rows. At the end of walks and drives, the sod root mass shall have the same final grade as the abutting surfaces. At curbs, the sod root mass shall have the same final grade as the top of the curb. Sod placed on slopes equal to four horizontal to one vertical (4:1) shall be staked with wire pins not less than six (6) inches long and spaced not more than thirty (30) inches apart. The pins shall be driven into the ground at an angle against the flow of the water until the top of the stake is just below the top of the soil and root mat. Sod shall be installed at the bottom of the slope and shall progress upward with strips laid transverse to the slopes. Immediately after the sod has been laid, it should be tamped or rolled with approved equipment to eliminate all air pockets and to provide a smooth, even surface.

Immediately after rolling or tamping the sod, sufficient water shall be applied to completely saturate the sod. The sod shall be watered as often as required to prevent drying out. In settled areas, the sod shall be removed, settled areas shall be regraded and the sod shall be reinstalled.

Section 1114.01 Care, Handling, and Transportation

Care shall be exercised at all times to retain native soil on the sod roots during transportation, handling and planting. Dumping sod from vehicles shall not be permitted. The sod shall be transported to the site within twenty-four (24) hours from the time it is cut, unless it can be stored to the satisfaction of Littleton. During delivery and while in stacks, all sod shall be kept moist and protected from exposure to the wind, sun and freezing. All sod delivered to the site shall be installed within twenty-four (24) hours of delivery. All damaged or dry sod shall be rejected.

Sod may be transported on or across the site on pallets by forklift. Damage to the sod bed by vehicles shall be kept to a minimum, and any damaged areas shall be re-graded prior to sodding. Damage caused to paving, curbs, fence, plants or other objects during sodding, shall be repaired or replaced as directed by Littleton at the Contractor’s expense.

Section 1115.00 Process

This section intentionally left blank.

Section 1115.01 Seed General

Seed shall be drilled into the prepared seedbed. The seeder shall be equipped with a satisfactory feeding mechanism, an agitator, double disc furrow openers, depth bands and packer wheels.

On sloping land, the seed shall be applied following the general contour. Top-dressing shall be applied immediately after seed application following section 1113.00 Seed Top Dressing of these Standards and Specifications. In areas where seed drilling is not feasible, a broadcast method may be substituted. If a broadcast method is used, the seeding rate shall be doubled, and the area shall be dragged after seeding and top-dressing applied.

Seeding shall not be performed during windy weather or when the ground is frozen or otherwise untillable. Seeding portions of the designated areas may be permitted before construction is complete in order to take advantage of the growing season, with prior approval of the City.

Section 1115.02 Bluegrass/Turfgrass Seeding

Seed shall be sown to a depth of one-quarter (¼) inches into the prepared seedbed. Seed drilling shall be performed in two (2) separate applications, crossing the area at right angles to one another to guarantee proper coverage.

All seeding shall occur between April 1st and September 15th unless approved in writing by the Manager of Grounds.

Section 1115.03 Native Seeding

Approved methods are drill seeding, mechanical broadcast, or hand broadcast. Areas larger than 1 acre with slopes of 4:1 or flatter may be drill seeded and areas with slopes greater than 4:1 may be hand broadcast, if approved by the City. The contractor shall submit seed bag tags for all seeding methods.

If approved, seed may be drill seeded. Mechanical power-drawn drills shall have depth bands set to maintain a planting depth between one and one-quarter (1¼) inch and one and one-half (1½) inch and shall be set to space the rows not more than two (2) inches apart. In addition, the drill shall be equipped with multiple seed boxes from which large smooth, small smooth, and appendaged (i.e., fluffy or trashy) seed can be metered evenly. Seed that is extremely small shall be sowed from a separate hopper adjusted to the proper rate of application. Seed shall not be drilled or sown during windy weather or when the ground is frozen or otherwise untillable. If inspections indicate that strips wider than the specified space between the rows planted have been left or other areas skipped, the city may require immediate re-sowing of seed in such areas at the developer's expense. During all seeding operations, proper functioning of the seed drill will be demonstrated to the satisfaction of the city upon request.

If approved, seed may be hand or mechanical broadcasted. Hand method of broadcasting seed will be permitted only on small areas not accessible to machine methods. All seed sown by broadcast-type seeders shall be "raked in" or otherwise covered with soil to a depth of at least one one-quarter (1¼) inches.

The minimum standard for any dryland grass is eight (8) seedlings of the seeded species per square foot. If requested by the city, this count/inspection shall be taken four (4) weeks after germination by a qualified botanist. Any area not meeting the specifications on germination will be touch up seeded in one of the following methods:

A. Hand Broadcast and Incorporation

B. Mechanical Broadcast and Incorporation

C. Interseeding with Seed Drilling Equipment

Seed shall be sown to a depth of one and one-half (1½) inches into a prepared seedbed as specified in Section 1109.00 Soil Preparations and 1115.01 Process Seed General of these Standards and Specifications.

Section 1116.00 Maintenance

This section intentionally left blank.

Section 1116.01 Sod Grass Areas

The proper care and maintenance of the sodded areas shall be the responsibility of the Contractor until Initial Warranty Acceptance. Maintenance operations shall begin as soon as each portion of the area is sodded. The maintenance shall consist of repair and replacement of eroded areas, watering, mowing (once sod is established), weeding, fertilizing, and re-sodding as necessary to provide an even, consistent stand of grass. All sod replacement required by Littleton shall be done at the Contractor's expense. Any areas determined by Littleton to be thin, weak or dead shall be replaced.

Section 1116.02 Seed Grass Areas - Bluegrass/Turf grass and Native

The Contractor shall guarantee the health of the stand of grass until the entire project has been accepted by the City Parks representatives. Any new grass deemed by the City of Littleton to be thin, weak, or dead shall be reseeded according to these Standards and Specifications and germinated prior to the beginning of the warranty period.

The Contractor shall erect suitable signs at strategic points notifying the public to keep off the seeded areas until the lawn is well established. Any traffic damage that may occur prior to Final Acceptance/Release from warranty of the work shall be repaired and reseeded at the Contractor's expense. Construction fencing may also be necessary to protect newly seeded or sodded areas. The need for construction fencing will be determined by the Manager of Grounds.

Section 1116.03 Mowing

During the maintenance period, after a suitable stand of Bluegrass or turfgrass has been established, the Contractor shall mow all lawn areas a minimum of two times to a height of two (2) inches in the field. Frequency of mowing shall be determined by the growth rate of the grass, and at no time should the clippings exceed more than one-third (⅓) of the total leaf blade. Only turf-type mowers shall be used for this operation. Grass clippings shall be disposed of and not allowed blown or otherwise left in the right-of way or storm drainage systems.

Native grass mowing may be necessary as designated by the City. If mowing of native grasses is required it shall be to a height no shorter than five (5) inches. At no point should native grasses have more than fifty (50) percent of their leaf surface removed during any one (1) mowing. It is recommended that clippings are not collected during mowing operations for native areas in an effort to spread the seed throughout the area.

Section 1116.04 Additional Fertilizing

At the time of the first mowing, the Contractor shall apply a commercial fertilizer to Bluegrass areas or turfgrass areas with the chemical analysis Nitrogen-20, Phosphorous-5, Potash-5 plus two (2) percent Fe, at an application rate of five (5) pounds per one thousand (1,000) square feet. When applied, the fertilizer shall be dry and free-flowing, and care should be taken to prevent burning. Fertilizer containing iron shall be cleaned off from any structures or concrete areas. Any areas disturbed or damaged by the Contractor during fertilizing operations shall be repaired in accordance with these Standards and Specifications at the Contractor's expense.

Section 1116.05 Watering

The Contractor shall be responsible for watering newly seeded and sodded area(s) a minimum of two (2) times per day (early-morning and early evening) and for keeping areas moist until the lawn

is established. The Developer shall be responsible for the cost of water usage until Initial Warranty Acceptance of the Project. This shall also apply to native areas that have been constructed with irrigation zones.

Section 1117.00 Trees

Refer to the City of Littleton Tree Manual, most current edition.
In the event of conflicting design standards or specifications, the most restrictive standard shall apply.

Section 1118.00 Planting Materials

The following section shall discuss the specifications for the materials used during the installation of plant materials for the City of Littleton.

Section 1118.01 Ornamentals, Perennials, Shrubs, and Trees

The Contractor shall furnish and install all plants shown on the approved plans. All plant materials shall:

A. Be alive, healthy and established in the container in which they are sold

B. Have a normal, well developed branch structure typical of the chosen species and a well-developed root system

C. Show sufficient annual growth

D. Have plump buds, well fitted for the species

E. Have an attached tag indicated the species

F. Meet ANSI standard Z60.1 All plant materials shall be free from:

G. Defects or mechanical damage

H. Disfiguring knots

I. Bark abrasions and discolorations

J. Plant diseases, insect eggs, wood bores, and all forms of insect infestation

K. Wilted or dried out leaves

Section 1118.02 Additional Requirements for Trees

A. All trees supplied are to come ball/burlap and/or containerized. Preference shall be given to trees grown and/ or established in air pruned containers.

B. All trees shall have the typical form or shape characteristic of the species with healthy, sound growth. Excessive shoot growth suggesting heavy fertilizer use shall be rejected.

C. All trees shall have a single trunk with a dominant leader unless indicated as a "clump form."

D. Root systems shall be fibrous and healthy in nature.

Section 1118.03 Tree rejection criteria:

A. Any tree with a shape or form that does not meet the characteristics of the species.

B. Obvious defects in the root system such as girdling roots, circling roots, root bound/ container bound root systems, undersized root systems, broken or loose root balls/ systems, etc.

C. Any tree lacking a strong central lead and single trunk unless indicated as "clump form"

D. Any tree with a topping cut made during the current growing season.

E. Any tree with large pruning wounds (one (1) inch or greater) that do not show signs of compartmentalization.

F. Any tree with damage from sun scald, frost damage, transportation/ poor handling, etc.

G. Any tree damaged during the process of transportation or planting

H. Trees with lateral limbs that have undesirable aspect ratios indicating codominance of the limbs.

I. The City of Littleton reserves the right to reject any tree for reasons not specifically indicated above. A reasonable explanation will be provided to the contractor in this instance.

All plant materials shall conform to the measurements noted in the plant specifications and on the approved plans. Rejected plant material shall be indicated with red marking tape upon inspection. Trees shall be inspected before they are planted. Trees that are planted previous to being inspected and are found to meet rejection criteria shall be replaced at the contractor's expense.

Section 1118.04 Transportation of Plant Materials

All plant material shall be properly prepared and shipped in accordance with recognized industry standards. Plant material shall be kept moist, fresh, and protected from injury, and excessive drying or other adverse conditions due to changes in climate or caused by transportation. Such protection shall encompass the entire period the plant material is in transit.

Section 1118.05 Storage of Plant Material

The contractor shall be responsible for any and all temporary storage of plant material prior to and during tree planting operations. Plant material shall be planted on the day of delivery if possible. Any plant material not planted upon arrival shall be stored in an area in which the plant material is protected from weather and mechanical damage. Any material stored for more than twelve (12) hours shall be healed in with mulch and the root system kept moist until installation. Failure to properly store plant material will result in the rejection of the plant material.

Section 1118.06 Backfill

Backfill for tree planting operations shall consist of soil excavated from planting pits. Excavated material shall be free from wood, rocks, trash, packaging material, or large stones/rocks when added back into the planting pit. Care shall be taken to break up any large clumps of soil before backfilling.

Section 1118.07 Soil Amendments

The only approved soil amendments shall be a pre-approved mycorrhiza product. The product shall be approved by the Manager of Grounds before application. All newly planted trees shall receive this soil amendment. No fertilizer(s) shall be applied at any time.

Section 1118.08 Staking

All trees shall be staked and guyed using the following materials:

A. Stakes: Two six (6) foot tall posts.

B. Tree tie: Three fourths (¾) inch wide nylon strap.

Section 1118.09 Water

Water for plant material shall be clean and fresh. The Contractor shall be responsible for transporting water to all tree planting sites.

Section 1118.10 Mulch and Edging

All trees and planting beds shall be mulched with natural, reground/recycled wood chips between two (2) inches and four (4) inches in length. Where approved by Littleton, cobble or rock mulch may be substituted for fibrous mulch. However, a ring of natural mulch will still be placed under the drip line of any newly planted trees. Edging, if included, will be shown on the drawings.

Section 1118.11 Weed Barrier Fabric

Weed Barrier fabric shall not be installed for any and all planting bed areas, including areas with wood mulch, cobble, or rock. Any weed barrier fabric that is installed will be removed at the contractor's expense.

Section 1118.12 Planting Plan Design

The planting plan shall include a broad range of plant materials to prevent a monoculture. Landscaping projects are encouraged to follow the urban tree diversity goals set forth in the City of Littleton's Urban Forestry Management Plan:

A. Within each of the large tree and shrub categories, not more than ten (10) percent of the deciduous or conifer trees installed on a subject property shall be of a single genus, and not more than five (5) percent of the deciduous or conifer trees installed on a subject property shall be of a single species.

B. The City Forester may require biodiversity of street trees that are planted in public rights-of-way in order to serve the purpose of this section.

The following are required sizes:

A. Deciduous Shade Trees: Caliper shall be between a minimum one- and one-half (1 ½) inch to a maximum two- and three-quarter (2 ¾) inch

B. Deciduous Ornamental Trees: Caliper shall be between a minimum one- and one-half (1 ½) inch to a maximum two- and three-quarter (2 ¾) inch

C. Coniferous Evergreen Trees: Height shall be between a minimum six (6) feet and a maximum eight (8) feet tall

D. Shrubs: Number five (#5) container

E. Ornamentals and Perennials: number one (#1) container

F. Groundcover Plants: number one (#1) container

Plant size changes may be necessary based on availability. Substitutions shall be approved by Littleton Forestry Manager.

Section 1119.00 Planting

The following section shall discuss the processes for the installation of plant materials for the City of Littleton.

Section 1119.01 Location Staking

The Contractor shall stake the proposed locations of all trees and shrubs on-site for approval by Littleton prior to planting. The Contractor shall arrange to have the locations of all utility lines (including but not limited to water, sewer, storm, gas, electrical, phone, and irrigation) marked prior to the inspection. The contractor shall be responsible for informing the City of Littleton when the utility mark outs are completed. Littleton reserves the right to move, shift or adjust any or all of the stakes to better achieve the planting design intentions as shown on the approved drawings.

Section 1119.02 Planting Seasons

Planting may occur whenever the soil conditions are favorable or as authorized by the Manager of Grounds. Tree planting shall occur, when possible, during April-June or in the Autumn after leaf drop as authorized by the Manager of Grounds.

Section 1119.03 Pruning of Tree Material

Pruning shall be performed before installation of the plant material if required. Pruning should be limited to removing any small broken or dead limbs that did not result in the rejection of the plant material. All pruning shall be performed with clean, sharp, sterile tools designed for arboricultural use. A good set of hand pruners should suffice. All pruning will conform to currently approved arboricultural practices.

Section 1119.04 Planting Procedures for Trees

Site Excavation: All tree planting holes shall be dug by hand. Alternate forms of excavation may be used if approved by the City Forester. The diameter of the planting hole shall be at least two (2) times the diameter of the root system. Depth of the planting hole shall be equal to the vertical dimension of the true root ball. Excessive soil built up on top of the root ball above the root flare should not be included in determining this depth. The depth of the hole shall be set so that the root flare sits two (2) inches above grade for ball and burlap root systems and at finished grade for containerized trees. Soil at the bottom of the hole shall be left undisturbed and firm as to prevent settling of the root ball.

A. Equipment: If equipment is used to excavate the planting site, such as an auger, time shall be taken to scour the edges of the planting hole to remove glazed sides. Time shall be taken to ensure the planting hole remains as close to circular as possible.

B. Root System: All containers shall be completely removed from the root ball before backfilling the hole. No wire, burlap, twine, or plastic shall remain on the root ball or in the planting hole. All efforts shall be made to prevent the root ball from breaking during the process of removing the container. Any root balls that fall apart while removing the root system container shall not be planted. All traditional ball and burlap trees shall have any excessive soil above the root flare removed. Any trees grown in solid containers or air pruned containers shall be examined for circling root systems. If there is a circling root system, appropriate measures shall be taken to mitigate this such as slicing the roots or shaving the root system. Any tree found to be planted with the container still attached shall be replaced at the contractor's expense.

C. Placing the tree in the hole: The tree shall be placed carefully into the hole to prevent damage to the root system/ root ball. The tree shall not be lifted into the planting hole by the trunk or limbs. The tree shall be planted as close to the center of the hole as possible. The trunk shall be made to be plumb. Any trees planted crooked or leaning shall be removed and replaced at the contractor's expense.

D. Soil Amendment: The mycorrhiza product detailed in Section 1118.07 Soil Amendments of these Standards and Specifications shall be added during the backfill process or the watering process depending upon the label requirements of the product.

E. Backfill: The soil removed from the planting hole during excavation shall be used as the backfill material in accordance with Section 1118.06 Backfill of these Standards and Specifications. Do not compact the soil during backfill. No backfill material shall be placed on top of the root ball. A berm shall be constructed around the outer edge of the planting hole using backfill material. The berm shall be constructed using the remaining backfill material and shall be no less than three (3) inches in height and no more than six (6) inches.

F. Watering: All trees shall be watered at the time of planting. Trees shall be watered with a minimum of twenty-five (25) gallons of water. Care shall be taken to make sure large air pockets are removed from the back fill at this time. A shovel may be used to gently work the backfill into the planting hole while watering to ensure that the backfill is properly worked back into the planting hole and all large air pockets are eliminated. Replace any soil that settles after watering.

G. Mulching: Mulch shall be placed to a depth of no less than two (2) inches and no more than three (3) inches. The mulch shall be placed so that it fully covers the entirety of the planting hole, backfill, and berm. The mulch shall come out past the berm by at least one (1) inch but no more than three (3) inches. Mulch shall not be piled up or "volcanoed" around the base of the tree. Any mulch that is piled up against the trunk of the tree shall be corrected at the contractor's expense.

H. Staking: Immediately after installation, all deciduous and coniferous trees shall be staked. Staking shall be done with two (2) posts, each six (6) feet tall. Two (2) stakes shall be used for all trees, deciduous and conifer. Stakes shall be placed in undisturbed ground outside the edge of the tree mulch ring. The tree shall be guyed using an approved tree tie as detailed in Section 1118.08 Staking. The contractor shall be responsible for the removal of all tree stakes approximately one (1) year after installation date.

I. Tree installation on a hill: Planting procedure will follow the previous guidelines. However, the uphill side of the slope will be used to determine the planting depth of the tree. Soil will be built up forming a large berm on the downhill side of the planting hole in order to raise the ground level to be even around the root ball/tree

Section 1119.05 Clean-Up

A. The contractor shall keep all areas of work clean, neat, and orderly at all times. All rocks, concrete, gravel, containers, wires, ropes, equipment, excess soil, etc. and other tree planting debris must be thoroughly removed from each planting site.

B. All materials shall be cleaned up and removed from the work area daily. Under no circumstances shall accumulation of soil and/or other debris be allowed in such a manner as to result in a hazard to the public.

Section 1120.00 Maintenance

Following the installation of plant material, the Contractor shall be responsible for all maintenance until the project receives Initial Warranty Acceptance. Maintenance shall include hand-watering, weeding, spraying, cultivating, trimming, mulching, tree-wrapping, tightening and repairing guy wires, removal and replacement of all dead materials, and resetting plants to proper grade and an upright position as required. By the time of final inspection for final acceptance, plant grower tags shall be removed. The landscaping shall be finally accepted for warranty and guaranteed by the Contractor, after the following conditions have been met.

Section 1120.01 Tree Wrapping

After installation, all deciduous trees shall be wrapped by the contractor from November 1st until April 1st of the following year. No wrapping shall be permitted until the trees have been inspected by the City. The trunks of all trees shall be wrapped spirally from bottom to top, overlapping the seams and entirely covering the trunk from the ground up to the first branch. The tree wrap shall be neat, snug and secured with black vinyl electrical tape at the top, middle, and bottom sections of the wrap. If the wrap has a label on it, it shall be installed so that the label faces the trunk and is not visible once installation is completed. Only approved four (4) inch wide tree wrap shall be used. The tree wrap must be brown and designated for use as a tree/trunk wrap. No tree wrap with

an asphalt layer shall be installed. All tree wraps shall be removed and disposed of by the contractor beginning April 1st.

Section 1120.02 Watering

The contractor shall water all trees manually at least twice a month, but no more than once a week, with twenty-five (25) gallons of water.

Section 1121.00 Guarantee and Warranty of Plants

Littleton shall inspect plant materials for conformance to the approved plans and these Standards and Specifications. Unsatisfactory plant material shall be rejected. Inspections may be performed onsite for projects with less than twenty (20) plants and at the supplying nursery for projects with twenty (20) or more plants, unless plant material is coming from out of state in which case it will be inspected upon arrival.

Following is the sequence of required inspections:

A. Prior to installation

B. After installation

C. Six (6) months after Construction Acceptance into Warranty

D. Before Final Acceptance/Release from Warranty

The Contractor will replace all plants which die during the two-year warranty. Exceptions will be made for plants which die during this period due to vandalism or neglect. Replacement materials will be identical in size and species to the original plants specified. Replacement materials will conform to the standards in Section 1118.00 Materials of these Standards and Specifications.

The City Forester reserves the right to reject any replacement materials not meeting City of Littleton Standards.

Contractor agrees to replace dead plants within two weeks after notification or as directed by the City Forester. All warranty replacement of plant materials shall be performed according to the standards in this Section. The City Forester will maintain an accurate copy of the planting plan indicating which specimens were removed and/or replaced.

Section 1122.00 Landscape Irrigation Systems

Section 1122.01 General

If a developer/owner is responsible for installation of an irrigation system that will be privately owned, controlled and maintained, the following specifications apply to their installation through the vacuum breaker. Downstream of the vacuum breaker, the developer/owner and their contractor are not controlled by these specifications, unless the developer/owner chooses, by reference, to incorporate all or portions of these specifications in their project.

The Contractor will locate equipment in positions indicated on approved irrigation plans as much as possible. The City shall review and approve deviations prior to installation. Work of this Section generally includes provisions for the installation of an underground irrigation system including the following:

A. Static pressure verification and coordination of irrigation system installation with landscape material installation.

B. Trenching, refilling and compacting trenches.

C. Complete irrigation system including but not limited to piping, valves, fittings, heads, central control system, controllers and wiring, and final adjustments to insure complete coverage.

D. Water connections.

E. Replacement of unsatisfactory materials.

F. Clean-up, inspections, and approval.

G. Tests.

Section 1123.00 Warranty/Guarantee

A. Provide a two (2) year written Warranty for material and installation from date of Substantial Completion.

B. Expenses due to vandalism before Final Acceptance shall be the Contractor's responsibility.

C. Any settling or displacement of the concrete pad for Automatic Irrigation Controller that occurs during Warranty period shall be repaired at no expense to the City, including complete restoration of damaged property.

D. Once Final Acceptance is granted, the City will maintain turf and planting areas during Warranty period, unless maintenance by the Contractor is specified in the Contract. The Contractor is responsible to monitor and coordinate Automatic Irrigation Controller scheduling and maintenance with Parks Operations staff and/or the Automatic Irrigation Controller factory certified technician for any seeding, sodding, or planting areas under the Contractor's Warranty.

E. The City reserves the right to make temporary repairs during the Warranty period as necessary to keep systems in operating condition without voiding the Contractor's Warranty, nor relieving the Contractor of their responsibilities. The City reserves the right to change Automatic Irrigation Controller schedules should the Contractor not respond within seventy-two (72) hours of a written request to make changes to programming. Doing so does not relieve the Contractor of their contractual obligations.

F. The Contractor shall make repairs and replacements within three (3) days of notification. If the Contractor fails to make repairs within three (3) days, the City will make such repairs at the Contractor's expense.

Section 1124.00 Materials

Section 1124.01 Automatic Irrigation Control System

A. *Automatic Irrigation Controller

Central Control systems shall be WeatherTrak controller. Specific model to be determined by the Manager of Grounds.

1. The Contractor shall purchase fully assembled enclosure including back panel, terminal strips, power supply unit, interior fused disconnect with one hundred twenty (120) volt GFI duplex outlet, heavy duty transient surge protection boards, antenna(s) with cable and louver ventilation. Enclosure and pedestal shall be stainless steel. Enclosure shall have a heavy-duty hasp for locking. Model number is per plan as specified by WeatherTrak.
2. Automatic Irrigation Controller and remote-control equipment: Manufacturer and Model shall be noted on Drawing.
3. The Contractor shall provide concrete pad, 120V electrical power, conduits, grounding and control wire connections to controller.
4. Concrete Pad: Comply with plan detail.

Section 1124.02 Control Wiring

The Contractor will position wire alongside the pressure supply mainline or sub-mainline, where possible. If wire is not located with the mainline, the Contractor will position it alongside non-pressure piping. These requirements will be verified by the City.

A. Low Voltage:

1. Electrical Control Wire - AWG UFUL approved No. 14 direct burial copper wire.
2. Electrical Common Wire - AWG UFUL approved No. 12 direct burial copper wire.
3. Wire Colors:
   i. Control Wires - Red
   ii. Common Wires - White
   iii. Master Valve/Flow Meter Wires - 2 Blue, 2 Purple, 2 Orange (six (6) wires total to each unit)
   iv. Spare Control Wires – Black
   v. Spare Common Wires – Yellow
   vi. Tracer Wire – Green AWG UFUL No. 14 direct burial copper wire
4. If multiple controllers are utilized, and wire paths of different controllers cross each other, both common and control wires from each controller shall be different colors approved by the City.
5. Control and Tracer Wire connections and splices shall be made with 3M DBY or approved similar dry splice method in an approved splice box, such as a Carson #910-10
6. Installation
7. The Contractor will:
   i. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to the pressure supply lines.

The Contactor will position this wire consistently below and to one side of the pipe, or in separate parallel trenches.

ii. Bundle all twenty-four (24) volt wires at ten (10) foot intervals and lay with a pressure supply line pipe or other pipe to one side of the trench.

iii. Provide an expansion loop at every pressure pipe angle fitting, every electric control valve location (within the valve box), and every five hundred (500) feet. The Contractor will form an expansion loop by wrapping wire at least eight (8) times around a three-quarter (¾) inch pipe and withdrawing pipe.

iv. Master valve wires shall be run sub grade, in continuous conduit from irrigation controller pad to backflow/master valve assembly pad.

A. High Voltage: Type required by local codes and ordinances, of proper size to accommodate needs of equipment serviced.

1. Installation

a. The Contractor shall:

i. Provide 120-volt power connection to the automatic controller.

ii. All electric work shall conform to local codes, ordinances, and authorities having jurisdiction. All high voltage electrical work shall be performed by an electrician licensed in Littleton.

iii. All electric lines underground will be installed in UL approved schedule 40 P.V.C. pipe with warning tape placed above the pipe.

iv. Make all splices and E.C.V. connections using 3M DBY or similar approved, dry splice method.

v. Install all control wire splices not occurring at the control valve in a separate wire stub box.

vi. Install one control wire for each control valve.

vii. Run four spare #14 AWG UF control wires and two # 12 AWG UF common wire from controller pedestal to the end of each and every leg of the pressure supply mainline. The Contractor will label spare wires at the controller and at the wire stub box. Specification spare wires are in addition to spare wire stubs noted on Construction Documents.

B. Field Wiring Testing Requirements

1. The Contractor shall provide an Ohm test report of all field wires prior to installing any wires at the Automatic Irrigation Controller terminals. Provide a report to the City of each zone wire tested, the Ohm readings for each wire, date of test, Automatic Irrigation Controller location. Please indicate in the report any wires or solenoids that do not meet standards for the operating ranges of the specified or existing materials. The report shall include the Ohm readings prior to removal of the existing controller and after relocation or installation of new Automatic Irrigation Controllers.

2. All field wiring issues must be resolved prior to the connection of wires at the Automatic Irrigation Controller terminal strips.

a. Install Automatic Irrigation Controller and enclosure in accordance with the Contract Drawings and per the manufacturer’s instructions. All work

including but not limited to concrete pad, one-hundred twenty (120) volt electrical power, conduits, grounding and control wire connections to terminal surge strips shall be completed by the Contractor.

b. Automatic Irrigation Controller Grounding: Install earth ground in accordance with Article 250 of the National Electrical Code (NEC). Earth ground shall be ten (10) OHMS or less as measured by a Megger® or similar instrument, or as per manufacturer recommendation. The Contractor shall schedule testing with the City.

3. Ground rods and ground plates are to be installed per manufacturer's recommendations.

4. Copper wire shall be six (6) gauge bare copper wire connected to the ground rod using a Cadweld GR1161GPLUS "Plus One Shot" welding kit.

5. Install above ground wiring in rigid conduit in accordance with applicable codes.

C. Coordinate controller installation with electrical work to ensure electrical power supply line(s) are provided to Automatic Irrigation Controller location(s).

1. Permanently engrave date of installation and Xcel service pole number inside Automatic Irrigation Controller enclosure.

D. Wire control valves as shown on Contract Drawings.

E. Testing Controller Operations:

1. Functional test of the controller shall be performed and demonstrate that all parts of the control system function as specified or intended. The functional test for each system shall consist of not less than thirty (30) days of continuous, satisfactory operation of the complete system serviced by a controller.

2. The Contractor shall coordinate with City to arrange Central Control Certification meeting.

3. Required attendees are the Contractor and Manager of Grounds.

4. Any materials determined to be faulty as part of the installation shall be replaced or corrected by the Contractor at their expense in a manner respective to the Plans, Details, and other sections of this Specification. In the event of a system failure due to faulty installation, programming or workmanship, the thirty (30) day period will be repeated until testing is complete.

Section 1124.03 Completion Inspection

A. Project Inspection Walk-Through

A project inspection walk through shall include but is not limited to the following:

1. Confirm quality of controller enclosure and mounting (no gap allowed between Automatic Irrigation Controller and concrete), grounding, high voltage installation, low voltage wiring, ID tagging of wires in Automatic Irrigation Controller, and communication set up. Each controller must have a color-coded zone map and controller chart as per the Specifications.
2. The Contractor shall submit to the Owner written certification of testing that proper grounding for all controllers has been installed per the manufacturer's recommendations.
3. Within Limit of Work: Contractor shall fence, water, and keep weed free any turf, trees and any plantings within the Limit of Work. Contractor is responsible for maintenance which includes picking up trash, weed control and mowing of turf and native areas within the Limit of Work. Contractor is responsible for watering existing landscape within the Limit of Work. Turf and plants affected by mainline work or irrigation water service shutdown during irrigation season shall receive watering per Parks' schedule, with no interruption of watering greater than seventy-two (72) hours. The Contractor is responsible for maintenance until Final Acceptance is granted.
4. Outside Limit of Work: Coordinate Automatic Irrigation Controller scheduling and maintenance operations with Project Manager for portions of City property unaffected by Construction.
5. Additional Maintenance During Warranty Period:
    a. Make repairs and replacements needed due to defective workmanship and materials.
    b. Winterization: Include cost in bid for winterizing complete system at conclusion of irrigation season (during which system received Final Acceptance) within three (3) days of notification by the City. System shall be voided of water using compressed air. Coordinate with the Manager of Grounds to be present during the winterization procedures. The Contractor shall notify all persons that are to be present a minimum of forty-eight (48) hours prior to the winterization of the system.
    c. Spring Start Up: To take place the following season within three (3) days of notification by the City. Open, operate, adjust system, and make any necessary repairs. Coordinate with the Manager of Grounds to be present during the spring start up procedures. The Contractor shall notify all persons that are to be present at the spring start up a minimum of forty-eight (48) hours prior to starting of the system.

Section 1124.04 General

A. Equipment must have performance characteristics to operate per the design conditions indicated. If any discrepancy or conflict exists between the quantities of equipment listed in the schedule and quantities shown on the Contract Drawings, the greater quantity shall govern.

B. All material shall be of the highest grade possible and where applicable, shall be marked accordingly and shall be new.

Section 1125.00 Pipe and Pipe Fittings

A. Copper Pipe and Fittings:

1. Pipe: Type K, rigid, hard tempered.
2. Fittings - Wrought copper, solder joint type. Joints - Soldered with solder, forty-five (45) percent silver, fifteen (15) percent copper, sixteen (16) percent zinc, and twenty-four (24) percent cadmium and solidus at one thousand one hundred twenty-five (1125) degrees Fahrenheit and liquids at one thousand one hundred forty-five (1145) degrees Fahrenheit

B. Main and Lateral Lines:

1. Main Lines (pressurized, downstream of backflow prevention units):
   a. Class 200 PVC BE, size one (1) inch through two (2) inch
   Class 200 PVC RT/Gasketed, size two and one-half (2 ½) inches and larger
   b. Velocities in PVC mainline shall not exceed five (5) feet per second
   c. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-224
2. High Density Polyethylene (HDPE) pipe:
   a. Pressure rating DR 11 two hundred (200) PSI
   b. PE4710, ASTM F714.
      i. May be used by approval of the City for portions of irrigation system that require boring such as below trees and paving.
      ii. HDPE to PVC mainline and laterals require either an epoxy coated repair coupler with joint restraints and stainless-steel pipe stiffener or Series 730 Poly-Cam Transition Fitting or approved equal.
3. Polyvinyl Chloride (PVC)_ Lateral Lines:
   a. Class 200 PVC BE, size one (1) inch to three (3) inch
   b. Velocities in PVC mainline shall not exceed five (5) feet per second
   c. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-2241
4. Polyethylene Lateral Lines:
   a. One hundred (100) PSI High Density NSF Polyethylene Piping – one (1) inch minimum diameter
   b. Velocity of water flow in polyethylene pipe shall not exceed seven and one-half (7 ½) feet per second

C. Sleeving:

1. Horizontal sleeves under paved surfaces: Class 200 PVC
2. Vertical sleeves for access to drains and valves: Class 200 PVC
3. Horizontal sleeving for boring applications: DR 11 HDPE

D. Brass Pipe and Fittings:

1. Brass Pipe: Eighty-five (85) percent red brass, ANSI Schedule forty (40) threaded pipe
2. Fittings: Medium brass, threaded one hundred twenty-five (125) pound class

E. Pipe and Fittings:

1. Identification Markings: Identify all pipe with following indelible markings:
   a. Manufacturer's name
   b. Nominal pipe size
   c. Schedule of class
   d. Pressure rating
   e. NSF (National Sanitation Foundation) seal of approval
   f. Date of extrusion
2. Class 200 PVC Pipe (pressurized mainline one and one-half (1½) inches and smaller):
3. Pipe will be assembled with Schedule 80 PVC fittings and solvent welded using ASTM-F-656 purple primer followed with heavy bodied ASTM-D-2564 cement.
4. Class 200 PVC Pipe (pressurized mainline two (2) inches and larger):
   a. Manufactured from virgin Polyvinyl Chloride compound in accordance with ASTM D2241 and ASTM D1784; cell classification 1254-B, Type 1, Grade 1
   b. All fittings, service tees and pipe restraints shall be epoxy-coated ductile iron fittings
5. Class 200 PVC Pipe (all lateral lines)
   a. Pipe will be assembled with Schedule 40 PVC fittings and solvent welded using ASTM-F-656 purple primer followed with heavy bodied ASTM-D-2564 cement
6. High Density Polyethylene (HDPE)
   a. Must meet ANSI/AWWA C906, ASTM F714/D3035. Materials used for the manufacture of polyethylene pipe and fittings shall be made from PE 4710 high density polyethylene resin compound meeting cell classification 445574C/E per ASTM D3350. Certification ANSI/NSF 61/14. All fittings shall be installed using butt-fused fittings or thermo-fused fittings/couplings and must be approved by the City
   b. **[Polyethylene Lateral lines (non-pressure lateral lines):][*Include this if Polyethylene Pipe is part of the project.]**

[Manufactured from virgin polyethylene in accordance with ASTM D2239, designated as PE 3408. Maximum size two (2) inches; minimum size one (1) inch]

[Fittings: Manufactured in accordance with ASTM D2609; PVC Type 1 cell classification 12454-B.]

[Clamps: All stainless-steel worm gear screw clamps. Use two (2) clamps per connection on all insert fittings.]

Section 1125.01 Detectable Warning Tape

Tape shall be blue with "Caution Irrigation Line Buried Below" or purple with "Caution Recycled/Reclaimed Water Line Buried Below."

Section 1125.02 Valves

A. Gate Valve or Isolation Valve:

1. Valve for one and one-half (1½) inches and smaller mainline: Shall be Class 125, 304 Stainless Steel with screw-in bonnet, non-rising stem, left hand opening with a stainless steel cross top handle gate valve with clear waterway equal to full diameter of pipe. Able to withstand continuous working pressure of two hundred (200) PSI. Wheel type handle is unacceptable.
2. Valve for two (2) inch and larger mainline: Shall be epoxy coated interior and exterior ductile iron body which meets ASTM A-536, Grade 65-45-12, push-on, left-hand opening, square nut operated, resilient wedge, mechanical joint AWWA C153 gate valve with clear waterway equal to full diameter of pipe. Able to withstand continuous working pressure of two hundred fifty (250) PSI. Wheel type handle is unacceptable.

B. Stop and Waste Valve

1. For one (1) inch through two (2) inch mainlines. Must meet ANSI/AWWA C800 standard and certified to NSF 61 and rated for 175 PSIG. One-piece, closed bottom body, with no metal to metal contact between plug and body. Mueller Mark II Oriseal H-10284N or approved equal.

C. Automatic Control Valve:

1. Automatic Valve for Potable Water System: Rainbird EFB-CP Series Valve having manual flow adjustment and both internal and external manual bleed. Accu Sync shall be used if pressure at the heads is greater than ten pounds over the optimal pressure as stated on the plans or measured in the field.

2. Automatic Valve for Non-Potable Water System: Rainbird EFB-CP Scrubber Valve. Accu Sync shall be used if pressure at the heads is greater than ten (10) pounds over the optimal pressure as stated per the manufactures catalog, plans, or measured in the field.
3. Valve Riser: Epoxy coated ductile iron riser with integral stainless-steel angle valve or approved equal.
4. Valve ID Tag: Install one flexible marker tag on each valve. Mark each tag with indelible ink indicating zone number. Tags shall be: Potable water systems (yellow), Non-potable systems (purple)

D. Manual Drain Valve:

1. Drain Valve: Mueller Oriseal #H-10283N with brass swing joint assembly, or approved equal.

E. Quick Coupling Valves:

1. Buckner QB44LRCAR10 brass two-piece body with winged stabilizer, designed for working pressure of one hundred fifty (150) PSI; one (1) inch FIP. Size as shown on drawing.
2. Quick Coupling Valves immediately after the backflow are used for winterization and shall be constructed of all brass swing joint and fittings. All other Quick Coupling Valve swing joints shall be constructed as shown on the details.

F. Master Valve:

1. Mainline two and one-half (2 ½) inch and smaller, Master Valve shall be specified in construction documents.
2. Mainline three (3) inch, and larger, Master Valve shall be specified in construction documents.

G. Flow Meter Assembly:

1. Mainline one (1) inch through twelve (12) inch, flow meter shall be FloMec QS-200, sized according to mainline size.

H. Valve Boxes:

1. All valve boxes shall have a stainless steel hex bolt locking lid system
2. Isolation Valves, Quick Coupling Valves, Drain Valves, Wire Splices and Ground Rods: Shall be branded with equipment type as outlined in Part 3 - Execution
   a. Rain Bird VB10RNDH, round body
3. Electric Control Valve Box: Shall be branded with the zone numbers as outlined in Part 3 - Execution.
   a. Three-quarter (¾) inch through one (1) inch valves: Rain Bird VBSTDH, standard body
   b. One and one-half (1½) inch through two (2) inch valves: Rain Bird VBJMBH, jumbo body
   c. Sub-surface dripline valve assemblies: Rain Bird VBSPRH super jumbo body.

d. One (1) inch through two and one-half (2½) inch Master Valves: Rain Bird VBJMBH jumbo body
e. Three (3) inch through six (6) inch master valves: Rain Bird VB-MAX
f. Flow Meter: VBJMBH maxi jumbo body

4. Valve box cover color:

a. Green for potable systems
b. Purple for non-potable systems

5. Gravel Leveling Bed and Drainage Sump in Valve Boxes: three quarter (¾) inch crushed gravel covered in geotextile fabric, as indicated on the Contract Drawings

I. Backflow Preventer:

1. High hazard, reduced pressure type, approved by University of Southern California (USC) or other approved testing laboratory; fully ported, ball-type gate valves on units two (2) inch or smaller, as manufactured by Febco Model 825YA or approved equal. Resilient gate valves on units larger than two (2) inch; as manufactured by Febco Model 880V or approved equal

2. Backflow Preventer Cover: Guardshack enclosure of appropriate size, equipped with Lock Shield Brackets, manufactured by BPDI. Color: forest green.

3. Concrete Pad: Comply with Division 32 Section "Concrete Walks, Curbs and Miscellaneous Flatwork"

J. Air Relief Valve:

1. On mainlines three (3) inches or larger, as per plan: Bermad C31 two (2) inch combination vacuum/air release valve or approved equal.

K. Pressure Regulating Valve (where water supply pressures exceed one hundred (100) PSI):

1. Bermad 420 pressure regulating master valve for three (3) inches and larger mainlines.

2. Zurn 500XL3 pressure regulating valve for three-quarter (¾) inch thru two and one-half (2 ½) inches mainlines.

Section 1125.03 Irrigation Heads

A. Heads: Provide swing joints of the type and size as indicated on the Contract Drawings. Heads of a specific type or function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and identification in such a position that they can be identified without being removed from the system.

1. Pop-Up Sprinkler Heads in turf areas: Rain Bird RD-06-S-F series

2. P30 for spray nozzles

3. P45 for rotary nozzles

4. Pop-Up Sprinkler Heads in non-turf/native areas and shrub/flower bed areas: Rain Bird RD-12-S-F series
5. P30 for spray nozzles
6. P45 for rotary nozzles

7. Pop-Up Sprinkler Heads in non-turf/native areas and shrub/flower bed areas: Rain Bird RD-12-S-F series
8. P30 for spray nozzles
9. P45 for rotary nozzles
10. Pop-Up Sprinkler Heads for trees in native areas; Rain Bird RD-12-P45-S-F series with specified rotary nozzles as indicated on contract drawings
11. Pop-Up Sprinkler Nozzles shall be Rain Bird MPR Series nozzle. Strip series and HE-VAN nozzles may be used for specific approved applications at the direction of the City
12. Gear Driven Heads: Hunter I-20-06, I-20-12, I-25-06, I-40-06 with stainless steel risers, internal check valve, PRS and MPR as specified per Contract Drawings. Plastic risers are permitted on twelve (12) inch rotor heads used in native areas. Minimum riser height shall be six (6) inches in turf areas

B. Connections to Lateral Pipe:

1. Pop-up Heads: Shall be one-half (½) inch swing pipe, point four nine (0.49) inside dimeter with an operating pressure of eighty (80) PSI
2. Gear Driven Heads: Shall be Rain Bird TSJ Series swing joints

Section 1125.04 Low Volume Irrigation

A. Valve: Rainbird Drip Control Zone Kit with stainless steel filter and forty (40) pound pressure regulation, size per Contract Drawings
    1. Valve shall be installed in a valve box as noted in Section "Valve Boxes"
B. Supply Header: Class 200 PVC. All supply header piping to be installed at a twelve (12) inch depth
C. Sub-surface Irrigation: Landscape Dripline, emitter spacing and flow as per Contract Drawings. All sub surface laterals to be buried at a minimum four (4) inch depth in soil
D. Flush valve installed in a round valve box as noted in Section "Valve Boxes"
E. Operation Indicator Head - Rain Bird RD12 spray head with closed 6 series (orange) VAN nozzle shall be installed adjacent to flush valve at each end of the zone
F. Sub-surface Dripline: Sixteen (16) to seventeen (17) millimeter flexible polyethylene tubing. Internal emitters to be pressure compensating and self-flushing to clear debris. Must be designed to prevent root intrusion by incorporating copper oxide into the product. Also must include a check valve and have a sealed outlet when system is not irrigating.

Section 1125.05 Automatic Control System

See Section "Automatic Irrigation Controllers."

A. Electrical Control Wiring:

1. Two Wire Systems:

   a. Two-Wire Decoder Cable – Two (2), #12 or #14 AWG UL. parallel wires each with single, solid copper conductors with polyethylene insulation. Wires shall be contained within separate polyethylene jacket. Cable shall be Regency Maxi Cable or Paige P7072D with red jacket (NO SUBSTITUTIONS)
      i. 14 AWG for up to twenty-five hundred (2500) feet
      ii. 12 AWG for over twenty-five hundred (2500) feet
   b. Incoming (controller side) of the two-wire cable shall be identified by placing a black zip-tie tightly on the cable
   c. Two-wire single station decoders Toro SB-DAC-1 to be installed in each valve box, one per valve. Decoders shall have a serial number engraved on each decoder for future identification. Decoder to be mounted on the inside wall of the valve box
   d. Two-wire decoder cable shall have surge arrestors Toro SB-BLA installed every five hundred (500) feet along two-wire path or every eight decoders whichever is the shortest distance. Surge arrestors are to be placed in valve box containing automatic control valve or in separate round valve box as noted in Section "Valve Boxes". Surge arrestor grounding shall be installed per manufacturer's recommendations
   e. Copper wire shall be six (6) gauge bare solid copper wire connected to the ground rod using a Cadweld GR1161GPLUS "Plus One Shot" welding kit. Wire connection between surge arrestor and copper ground wire to be made using a high strength corrosion-resistant bronze alloy split-bolt
   f. Two-Wire Splice Box: To be installed in a round valve box as noted in Section "Valve Boxes"

2. Conventional Wire Systems:

   a. Electrical Control Wire for 24VAC Solenoid: Golf Course Sprinkler Wire - #12 to #14 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation point zero four five (0.045) inch thickness
   b. Electrical Common Wire: Golf Course Sprinkler Wire - #12 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation point zero four five (0.045) inch thickness
   c. Wire Colors: Match existing color system throughout

B. Miscellaneous control wiring materials:

Materials for both standard and two wire systems -

1. Data Wires: Paige 7171D-A direct burial shielded and armored signal cable with polyethylene jacket (NO SUBSTITUTIONS)
2. Data Wire connections and splices shall be made with Ranger Servi-Seal.
3. Control Wire and Two-Wire Decoder Cable connections and splices shall be made with 3M DBR/Y-6M direct bury splice, or approved equal, UL listed dry splice methods
4. Spare Wire and wire ends shall be capped with 3M DBR/Y.
5. Mainline Tracer Wire: One (1) continuous #10 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation point zero four five (0.045) inch thickness. tracer wire as detailed above all mainline
6. Splice Box: To be installed in a round valve box as noted in Section "Valve Boxes"

Section 1125.06 Preparation

A. Utility Locates

B. Landscape Plan Review and Coordination: Contractor will be held responsible for coordination between landscape and irrigation system installation. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the landscape plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor's expense.

C. Pressure Verification: Contractor shall field verify the tap size, static pressure and verify gallons per minute flow at the project site, prior to commencing Work or ordering irrigation materials, and submit findings in writing to the City. If Contractor fails to verify tap size, static water pressure and flow prior to commencing Work or ordering irrigation materials, Contractor shall assume responsibility for all costs required to make system operational and the costs required to replace any damaged landscape material. Damage shall include all required material costs, design costs, labor costs and plant replacement costs.

D. Inspection: Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.

E. Grading operations, with the exception of finish grading, shall be completed and approved by City before staking or installation of any irrigation system begins.

F. Layout: Layout and stake system before beginning installation. Staking shall occur as follows:

1. Mark, with paint, routing of pressure supply line and valve boxes. Flag heads for all new zones. Contact the City forty-eight (48) hours in advance and request review of layout and staking. The City will review layout and direct changes if required. Review does not relieve installer from coverage problems due to improper placement of heads after staking.

2. Valve boxes and mainline shall not be located in ball fields, multi-use sport fields, recovery zones, or below playground equipment.
3. If project has significant topography, free form planting beds, or other amenities which could require alteration of irrigation equipment layout as deemed necessary by the City, do not install irrigation equipment in these areas until the City has reviewed equipment staking.

G. The City will request the Office of the City Forester's approval of proposed trenching prior to start of trenching. The Contractor shall be following "Trees."

H. Review backflow prevention device location and operation with the City prior to mainline installation.

Section 1125.07 Excavation and Backfill

Refer to "Excavation and Backfilling of Trenches."

A. Directional Boring:

Directional boring locations as indicated on the Contract Drawings

B. Clearances and Depths:

1. Main pressure line: Make trenches of enough width to properly assemble and position pipe in trench
2. Clearances:
   a. Mainline and Lateral Piping clearance: Minimum clearance shall be two (2) inches horizontally on both sides of the pipe
   b. Line Clearance: Provide minimum six (6) inches of clearance between each line, and minimum twelve (12) inches of clearance between lines of other trades
   c. Installation of multiple runs of piping in one common trench is prohibited

C. Pipe and Wire Depth to finish grade:

1. PVC Pressure Supply Piping: Twenty-six to twenty-eight (26-28) inches from the top of pipe
2. HDPE Pressure Supply Piping: Thirty to thirty-six (30-36) inches from the top of pipe
3. HDPE Lateral Lines: Eighteen to twenty-four (18-24) inches from top of pipe
4. PVC Sleeving: At specified pipe or wire depth
5. Non-pressure Piping (gear driven heads): Eighteen (18) inches from top of pipe, maximum variation two (2) inches
6. Native seed zones using twelve (12) inch rotors: Twenty-four (24) inches from top of pipe, maximum variation two (2) inches
7. Non-pressure Piping (pop-up heads): Eighteen (18) inches from top of pipe.
8. Control Wiring and Two-Wire Decoder Cable: Side of mainline when installed in the same trench; twenty-four (24) inches deep when installed separately from the mainline trench.

D. Vibratory Plow: Not permitted without written approval from the City.

Section 1125.08 Installation of Irrigation Equipment

A. Locate all equipment as near as possible to locations designated. Deviations shall be reviewed and approved by the City prior to installation.

B. Service Line Piping (copper or ductile iron piping from water meter to connection to backflow prevention device) - When pipe installation is not in progress, or at the end of each day, close pipe ends with tight plug or cap.

1. Copper piping – Installation shall match specifications for copper service line as required by Denver Water and in accordance with City of Littleton Building Codes.

C. Sleeving:

1. Install sleeving under any hard surface prior to surface being installed to accommodate piping and wiring. If irrigation is not being modified, the Contractor shall work with the Manager of Grounds to identify locations and size for sleeves for future use.
2. Minimum depth to top of pipe shall be determined by depth of mainline and lateral lines.
3. Sleeving depth shall match pipe and wire depth for all pressure and non-pressure piping installed under all hardscape surfaces, asphaltic concrete, or concrete paving.
4. Sleeving under existing walks or concrete pavement shall be done by directional boring or hydraulic driving. Where cutting of asphalt and/or concrete is necessary, it shall be done per the Contract Drawings and Details and/or per the City of Littleton standards. When cutting concrete, the entire section or "stone" must be removed from joint to joint. The City shall approve the final locations prior to removal.
    a. HDPE pipe may be used for sleeving when directional boring takes place under existing hard surfaces, walks, roadways, trees, etc.
    b. A sleeve is not required if the irrigation line is installed via directional boring with HDPE pipe as indicated by the Contract Documents.
5. Compact backfill material in three uniform lifts, using mechanical tamping devices under pavement.
6. Do not allow sleeves to become filled with soil or other undesirable material. Tape ends of sleeves until commencement of pipe installation.
7. Mark sleeves on hard surfaces with a three by three (3"x3") inch "X" as per plans in a manner to ensure easy location in the future.
8. Sleeve size requirements for wire and pipe, control wire shall be placed in sleeving separate from pipe sleeving:

1" to 1-1/4" Pipe:	2" PVC
1-1/2" to 2" Pipe:	4" PVC
2-1/2" to 3" Pipe:	6" PVC
4" Pipe:	8" PVC

6” Pipe	10” PVC
8” Pipe	12” PVC
1 to 25 Control Wires:	2” PVC
26 to 50 Control Wires:	3” PVC
Two-Wire Decoder Cable:	2” PVC

D. Installation of Piping:

1. PVC Mainlines:

   a. Ensure that pipe is placed at a consistent depth and on a level base free of rocks and stones. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe laying is not in progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.
   b. Install mainlines a minimum of thirty-six (36) inches off any hard surface and thirty-six (36) inches away from swales.
   c. Solvent Weld PVC Pipe (required on all pipe two (2) inches or smaller and all PVC mainline within sleeves): Lay pipe and make all connections in accordance with manufacturer’s recommendations. Do not install pipe when air temperature is below forty (40) degrees Fahrenheit.
   d. Gasketed End Pipe (required on all pipe two and one-half (2 ½) inches or larger): Lay pipe and make pipe-to-fitting or pipe-to-pipe joint, following the manufacturer’s recommendations. Install joint restraint fittings and pipe restraints on all fittings and adjacent pipe runs per manufacturer’s recommendations and per the Contract Drawings.

2. PVC Lateral Lines:

   a. Ensure that pipe is placed at a consistent depth and on a level base free of rocks and stones. When pipe laying is not in progress, or the end of each workday, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.
   b. Install lateral lines a minimum of twelve (12) inches off any hard surface and thirty-six (36) inches away from swales.
   c. Solvent Weld PVC Pipe (required on all lateral lines): Lay pipe and make all connections in accordance with manufacturer’s recommendations. Do not install pipe when air temperature is below forty (40) degrees Fahrenheit.

3. Thrust blocks should be used in accordance with manufacturer recommendations.

4. HDPE Lines:

   a. All connections between HDPE pipe sections are to be made with fusion welded fittings per the manufacturer’s recommendations.
   b. All connections between HDPE and PVC are to be installed per manufacturer’s recommendations.
   c. All connection fittings between HDPE and PVC or any other pipe material being used are to be made a minimum of thirty-six (36) inches away from any hard surface.

E. Installation of Detectable Warning Tape:

1. Detectable warning tape shall be installed on all irrigation mainline and lateral lines.

2. Tape will be blue for potable water irrigation systems and purple for non-potable irrigation systems.

F. Joint restraints on all gasketed PVC mainline pipe two and one-half (2 ½) inches and larger:

1. Install joint restraints per the plans and or manufacturer's recommendations.

2. Joint restraints shall be installed as shown on the plans or per the manufacturer's recommendations. Prior to backfilling any joint restraints the City shall be present to verify that the restraints were installed in the proper locations and that all bolts have been tightened to the manufacturer's recommendations. Any restraints that are buried prior to inspection shall be excavated to allow for review and inspection at no additional cost to the City.

G. PVC Pipe Deflection

1. Solvent welded pipe will meet manufacturer's recommendations.

2. Gasketed pipe will not exceed one (1) inch or two (2) degrees offset per twenty (20) feet in length.

[Flexible Plastic (Polyethylene) Pipe: Lay pipe and assemble fittings according to manufacturer's recommendations and per the Contract Drawings and Details.]

H. Control Wiring:

1. Two-wire control wiring:

a. Bury two-wire decoder cable between Automatic Irrigation Controller and electric valves in pressure supply line trenches, strung as close as possible to mainline with such cable to be consistently located to one side of pipe, or in separate trenches.
b. Make wire/cable splices at electric control valve connections as follows:
i. Two-wire cable to two-wire cable - watertight connectors.
ii. Two-wire cable to electric valve solenoid wires - watertight connectors.
iii. Install all two-wire decoder cable splices not occurring at control valve in a separate round valve box as noted in section "Valve Boxes."

2. Standard Low Voltage Control Wire:

a. Install one control wire for each control valve on standard low voltage wire systems.
b. On standard low voltage wire systems install a total of five spare fourteen (#14) AWG UFUL control wires and one spare twelve (#12) AWG UFUL common wire from Automatic Irrigation Controller pedestal to the end of each leg of mainline. Label spare wires at Automatic Irrigation Controller and wire splice box.

c. Make all splices and electric control valve connections using 3M DBR/Y connectors

3. Bury control wiring between Automatic Irrigation Controller and electric valves in pressure supply line trenches, strung as close as possible to mainlines with such wires to be consistently located to one side of pipe, or in separate trenches.

   a. For standard low voltage wire systems bundle all twenty-four (24) volt wires at ten (10) foot intervals.

4. Provide an expansion loop at every mainline change of direction, every electric control valve location (in valve box), and every five (500) hundred feet.

   a. Form expansion loop in each control valve box by wrapping twenty-four (24) inches of wire around a one (1) inch pipe and withdrawing pipe.
   b. Leave seventy-two (72) inches of extra two-wire cable in each valve box.

5. Install all control wire splices not occurring at the control valve in a separate wire splice round valve box as noted in section “Valve Boxes.”

6. Wire Testing:

   a. Existing wiring indicated to remain on documents is to be ohm-tested for continuity prior to construction. The Contractor shall produce the report and copy the City of the results of such testing.
   b. New wiring: All new wiring to be tested for proper resistance prior to connection to valves and controller(s) for continuity. The Contractor shall produce the report and copy the City of the results of such testing.

7. Tracer Wire:

   a. One (1) continuous #10 AWG UL twenty-four (24) inches looped into each valve box, gate valve and quick coupler, and terminated inside the irrigation controller cabinet. Installed per the Contract Drawings.

8. Detectable Warning Tape:

   a. Refer to Section 1125

I. Installation of Valves:

1. Electric Control Valves: The Contractor shall install the valve cross-handle three (3) inches below finished grade where shown on the construction plans and as detailed. All electric Control Valves will have a True-Union Ball Valve installed on the inlet side of the valve.

2. Electric Control Valves for two-wire system: Install electric control valves as detailed on the Drawings. Install one valve decoder module per valve box.

   a. All low volume irrigation shall be zoned independently from turf, and product applications may not be mixed within zone.
   b. Quick Coupling Valves: Install quick coupling valves as detailed on the Contract Drawings.

b. Drain Valves: Install manual drain valves at all low points in pressure supply line, whether indicated on the Contract Drawings or necessitated by actual conditions, to ensure proper drainage of the mainline.
c. Isolation/Gate Valves: Install as detailed in locations shown on the Contract Drawings.
d. Valve Boxes: Install one valve box for each type of valve as detailed. Install compacted gravel leveling bed after compaction of subgrade and prior to setting of valve box.

   i. Install geotextile fabric over gravel prior to setting valves boxes. Ensure that geotextile fabric extends a minimum of six (6) inches from the bottom and no more than six (6) inches from the top of box. Secure the geotextile fabric to the side of box with duct tape.
   ii. Install valve boxes flush with finish grade and square to adjacent surface features and one another
   iii. When valve boxes are grouped together, allow at least twenty-four (24) inches between valve box sides.
   iv. Install valve boxes a minimum of eighteen (18) inches away from any hard surface.
   v. Cutting of valve boxes to give clearance for piping or valves is not permitted, except for the Master Valve and Flow Meter boxes.

J. Valve Box Identification Branding:

1. Brand Lids as follows in two (2) inch high, minimum letters:

Isolation/Gate Valve	“GV”
Quick Coupler Valve	“QC”
Manual Drain Valve	“DV”
Air Relief Valve	“AR”
Master Valve	“MV”
Flow Meter	“FM”
Wire Splice Box	“WS”
Grounding Rod	“GR”
Filter	“FIL”

Section 1125.09 Backflow Prevention

A. Backflow Prevention Device: Contractor must meet all applicable laws, rules and codes, including but not limited to Uniform Building codes and applicable amendments Plumbing Codes and State Water Regulations. Assemblies must be installed per the manufacturer's specifications.

1. Install in strict accordance with current requirements of Denver Water. Connections to the Denver Water System are to have an approved assembly for the type of protection they provide, either isolation or containment.
2. Successful Testing of backflow assembly by a certified Backflow Prevention Assembly Tester is Contractor's responsibility and any cost shall be considered incidental. Test reports shall be forwarded to Denver Water in accordance with the State of Colorado regulations. Copies of the report, the tester's certification and the certification of the testing equipment used are to be forwarded to the City.
3. Request for final payment will not be certified or processed until certification reports have been filed with Denver Water and received by the City.

Section 1125.10 Installation of Sprinkler Heads

A. Install sprinkler heads where designated after the City has approved staking. Set to finish grade as detailed.

1. Spacing of heads shall not exceed the maximum indicated on the Contract Drawings unless re-staked or as directed by the City. In no case shall the spacing exceed maximum recommended by manufacturer, with the exception of native areas as shown in the Contract Documents.
2. Install gear driven heads on swing-joint risers as detailed. Swing joints to non-pressure lines shall be set at no more than forty-five (45) degrees or less than ten (10) degrees.
3. Install pop-up heads on swing pipe as detailed.
4. Adjust part circle heads for proper coverage. Adjust heads to correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other equipment. The City may request nozzle changes or adjustments without additional cost to the City.

Section 1125.11 Backfilling

A. Refer to Section "Excavation and Backfilling of Trenches".

1. Ensure backfill compaction is adequate so that settling does not occur.
2. Repair of turfgrass areas shall be as follows:
    a. Seed is permitted for irrigation trenches up to twelve (12) inches in width.
    b. Sod is required for any turf repair wider than twelve (12) inches and shall be installed as full width.

Section 1125.12 Adjusting

A. Upon completion of installation, "fine-tune" entire system by regulating valves, adjusting arcs and radius, and setting pressure reducing valves at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible. Heads of same type shall be operating at same pressure within plus or minus ten (10) percent.

B. If it is determined by the Manager of Grounds that irrigation adjustments will provide improved coverage and water distribution, the Contractor shall make such adjustments prior to Final Acceptance. Adjustments may include but not limited to changes in nozzle sizes, degrees of arc, and adjusting flow control. Adjustments shall be completed at no additional costs to the City.

C. All sprinkler heads shall be set perpendicular to finish grade or within allowable limits shown on Contract Drawings.

D. Areas that do not conform to designated operation requirements, due to unauthorized changes or poor installation practices, shall be immediately corrected at no additional cost to the City.

Section 1125.13 Field Quality Control

A. Flushing: After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, quick coupler assemblies, and hose valves, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for five (5) minutes through furthermost valves. Cap risers after flushing.

B. Testing Pressurized Mainline: Prior to installing any plant materials (sod, seed, trees, shrubs, perennials) arrange and conduct pressure test(s) in the presence of the City. Arrange for testing a minimum of forty-eight (48) hours in advance. The contractor is responsible to supply the hydrostatic test pump and all other equipment required to complete the test.

   1. Set in place, cap and pressure test all piping under paving, in presence of the City prior to backfilling and paving operations.

   2. After installation and backfilling of all control valves, fill pressure supply line with water, and pressurize to forty (40) PSI over the static pressure or to one hundred twenty (120) PSI, whichever is greater, for a test period of two (2) hours. Testing pressure not to exceed one hundred forty-five (145) PSI.

   3. All isolation valves, angle valves, ball valves and zone valve flow controls are to remain open during testing.

   4. Leakage, Pressure Loss:

      a. Solvent welded PVC Pipe: Test is acceptable if zero (0) pounds of pressure is evident during the test period.
      b. Gasketed Pipe: Test is acceptable if two (2) pounds of pressure or less is evident during the test period.

5. Leaks: Detect and repair leaks. Replace defective PVC pipe with new full length pipe section. No pipe splices will be accepted within pipe sleeve. No PVC pressure couplings or slip-fix repair couplings will be allowed.
6. Retest system until test pressure can be maintained for duration of test.

Section 1125.14 Completion Inspection

A. Arrange for the City to be present. Provide a minimum of forty-eight (48) hours of notice in advance of walk-through.

B. Entire system shall be completely installed and operational and trenches shall be finish graded and sod and/or seed in place prior to scheduling of walk-through.

C. Electrically operate each zone in its entirety for the City the time of walk-through.

D. A project inspection walk through shall include but is not limited to the following:

1. Contractor shall adjust, straighten and nozzle all heads prior to walk through. Review operation, coverage, head/nozzle adjustment, and system adjustment per specifications.
2. Contractor shall have all valves boxes unlocked prior to walk through. Open valve boxes to confirm materials, geotextile fabric, gravel bedding, wire splices, compaction, elevation, workspace access within boxes, clearance from lid and bedding, locking mechanisms, and zone branding. Interior of boxes should be free of foreign material, only geotextile fabric shall be visible in the bottom of boxes. All valves must be tagged with zone identification, Christy's valve marker tags or equal and valve box lids must be branded with zone valve identification. Verify connections in all valve and wire splice boxes.
3. Contractor shall provide documentation that resistance tests for all spare common and hot wires and tracer wire has been performed and the results for ohms reading on each wire tested.
4. Confirm irrigation heads are at specified elevation and distance(s) from paved surfaces and curbs, plumb and soil compacted.
5. Inspect concrete size and elevation of pads for backflow assembly, booster pump, and controller enclosure pads. Confirm quality of concrete, finishes, access to the Irrigation Controller and spare conduit/sleeving as required for wiring.
6. Review trench and related excavation repair including backfill, compaction, fine grade, seed, and sod installation.
7. Review appropriate use of purple valve covers and other product as required for non-potable water applications.
8. Generate a punch list of items to be corrected, prior to Substantial Completion.
9. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.

Section 1126.00 Recreation Facilities

Recreation facility specifications will be guided by design and construction specifications of South Suburban Parks and Recreation

Section 1127.00 Trails and Paths

Section 1127.01 Maintenance Paths and Primary Walkways

All maintenance paths within the parks, open land areas, or greenbelts, which shall be utilized by the public and Littleton maintenance staff, shall be a minimum of ten (10) feet wide, and shall be constructed with a minimum of six (6) inch thick concrete. The concrete shall comply with Section 900 Concrete Mix Design And Construction of these Standards and Specifications. In Specific Areas, Primary walkways shall be required to be wider than eight (8) feet, and a three (3) foot wide crusher fines ("soft") shoulder may be required.

Section 1127.02 Soft Trails

Where applicable, soft trails shall be three (3) to eight (8) feet wide and constructed with a running slope less than 12.5:1 (horizontal:vertical). Short sections of trail may be constructed up to a maximum slope of 7:1, if approved by Littleton.

A. Soft Trail Materials

1. Soft trail aggregate shall be three-eighths (⅜) inch minus decomposed granite or crushed material. It shall be gray unless otherwise approved. On slopes greater than 12:1 (horizontal:vertical) or locations identified as potential wash out areas a binder material shall be used. Binder material shall be StaLok® brand stabilizer. Binder material shall be used according to manufacturer's specifications.
2. Timbers for cross members shall be eight (8) inch by eight (8) inch pressure-treated wood, recycled rubber or plastic. Each timber shall be anchored in place with three (3) twenty-four (24) inch #4 steel reinforcing bars (rebar).

Section 1127.03 Trails With Slope Less Than 12:1 (Horizontal:Vertical)

A. Soft trails with a slope of less than 12:1 (horizontal:vertical) shall be constructed with a minimum of four (4) to six (6) inches of compacted soft trail aggregate. Aggregate material shall be compacted in place to at least ninety-five (95) percent of the maximum standard proctor dry density as defined in ASTM D698.

Section 1127.04 Trails With Slope Equal To Or Greater Than 12:1 (Horizontal:Vertical) and Washout Areas

A. Soft trails with a slope equal to or greater than 12:1 (horizontal:vertical) shall be constructed with four (4) to six (6) inches of soft trail aggregate stabilized with a binder material. Aggregate and binder materials shall be compacted in place to ninety-five (95) minimum of the maximum standard modified Proctor dry density as defined in ASTM D698. Binder mixing and installation shall strictly comply with the binder manufacturer's recommendations.

B. Soft trails with a slope equal to or greater than 8:1 (horizontal: vertical) or identified as a washout potential area shall receive mitigation efforts. Wash out mitigation will use cross timbers as the preferred method but other mitigation systems such as, but not limited to: pipes, water bars, and culverts, may be used if approved by the City. Mitigation efforts shall be installed on the uphill part of the trail from the areas that have been identified as a potential wash out area so as to prevent water from running down the trail to the potential wash out area causing damage.

C. Cross Timbers: trail alignment. Timbers shall be installed at twenty (20) foot intervals along the Timbers shall be installed at fifteen (15) degrees from perpendicular to the trail centerline. The top of the timbers shall be at the same level as the trail surface, and the bottom of the timbers shall be keyed into the binder-stabilized subgrade. Each timber shall be anchored in place with three (3) – two (2) foot long #4 steel reinforcing bars (rebar). No part of the rebar shall protrude above the top of the timber.

Section 1127.05 Cross Slope

Soft trails shall be constructed with a uniform two (2) percent cross slope to encourage water to run-off to the side of the trail. If a slope cannot be constructed into the trail then a crown in the center of the trail with a slope not to exceed 20:1.

SECTION 1200 STRUCTURES

Section 1201.00 Reinforcing Steel - Epoxy Coated

Measurement: (Pounds) - Reinforcing steel will be measured by computing the unit weight of steel called for on the plans. Exceptions will be made for design revisions or proven error in excess of two (2) percent of the quantities specified in the Bid Schedule.

Payment: Reinforcing Steel - Epoxy Coated consists of furnishing and placing reinforcing steel per these specifications and in conformity with the plans. Materials and construction shall be in accordance with the requirements of Section 602 of the CDOT Standard Specifications for Road and Bridge Construction.

Section 1202.00 Drilled Caissons

Measurement: (Linear Foot) - Drilled caissons will be measured by the linear foot from ground line or elevation shown on the plans to the bottom of the hole as drilled.

Payment: Drilled Caissons consists of furnishing all materials, labor, tools, equipment, services and incidentals necessary to construct the drilled shafts (also referred to as drilled caissons, drilled piers, cast-in-place-drilled-holes, or cast-in-situ piles). Materials and construction shall be in accordance with the requirements of Section 503 of the CDOT Standard Specifications for Road and Bridge Construction.

Section 1203.00 Miscellaneous

Items: - Access cover and frame, embedded items, flared end sections, grate and frame, tied joints, manhole steps, reshape manhole inverts, trash guards, meter pits, meters, etc.

Measurement: (Each) - The quantity of miscellaneous items will be measured by the actual number of items installed as specified in the plans or Contract Documents

Payment: Accepted quantities of miscellaneous items will be paid for at the contract unit price bid for each of the various items that appear in the Bid Schedule. No separate measurement or payment will be made for subsidiary items essential to making the items functional as intended but shall be included in the work.

Section 1204.00 Crib or Bin Wall

Items: Steel, concrete, timber.

Measurement: (Square feet) - Crib walls of the various types and design specified in the Bid Schedule will be measured by the number of square feet of facial area which parallels the centerline of the roadway or channel.

Payment: Accepted quantities of the various types specified in the Bid Schedule will be paid for at the contract unit price bid. No separate measurement or payment will be made for excavation; furnishing and installing Class "B" concrete, reinforcing steel; furnishing placing and compacting backfill, etc., but shall be included in the work.

Section 1205.00 Fence and Gates

Measurement: (Lineal Feet) (Each) - Fence will be measured along the base of the fence between the end post of each continuous run of fence but excluding gate openings. Gates will be measured by the actual number of the various sizes or types installed.

Payment: Accepted quantities of fence and gates will be paid for at the contract unit price bid for the various types and sizes called for in the Bid Schedule. No separate measurement or payment will be made for clearing and grubbing, grading along the alignment; line, end, corner and line brace posts; braces, guyes, concrete, painting and cut surface treatment of wood posts cut in the field, but shall be included in the work.

Section 1206.00 Retaining Walls

Retaining walls shall be in such a location that the wall will not obstruct access to the utility infrastructure within easements of the public right-of-way, including fire hydrants and meter pits. Retaining walls that are over four (4’) feet in height measured, when measured from the grade level on the low side to the top of wall, or supporting a surcharge of earth; or a structure require a Building Permit. Retaining wall shall have a maximum height of four (4') feet with minimum space between tiers of four (4') feet.

Fences erected on top of retaining walls shall not exceed the height limitations specified in the City Code. The height of such fence shall be measured from the ground level on the high side of the retaining wall to the top of the fence. Retaining wall and fence combined cannot exceed 7’ from grade without engineering calculations.

Intersection sight distance criteria: Retaining walls erected within vehicular sight triangles or vehicular safe line of sight shall comply with these Standards and Specifications. No fence or retaining wall shall be erected or maintained that obstructs the vision of motorists, as determined by the City Engineer. Any fence or retaining wall that does obstruct the vision of the motorists may be abated as a nuisance as set forth in the City Code.

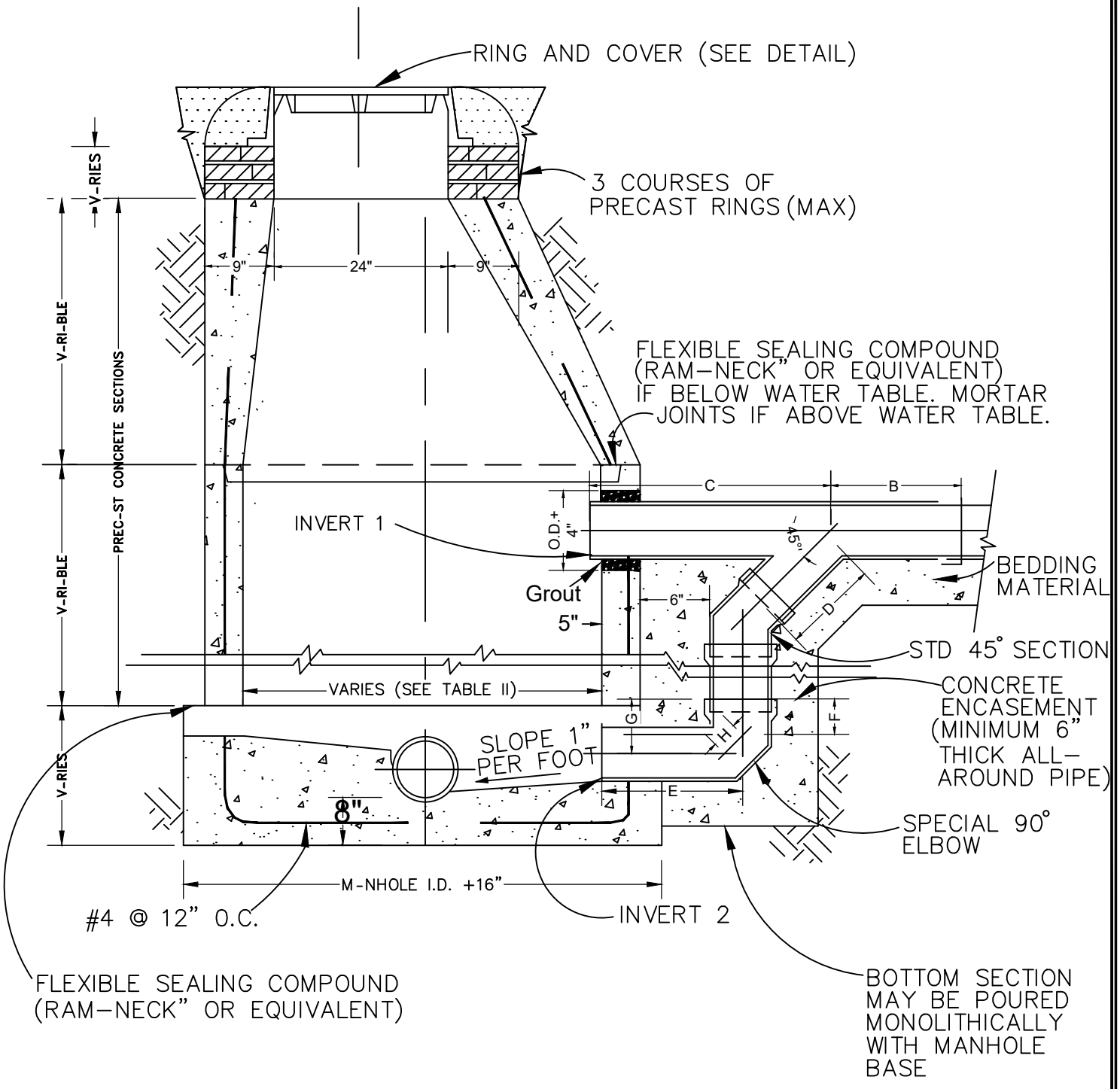
Measurement: (Liner Feet)(Square Feet) - The quantity of retaining walls will be measured by the actual linear feet or square feet of facial area as specified in the plans or Contract Documents.

Payment: Accepted quantities of miscellaneous items will be paid for at the contract unit price bid for each of the various items that appear in the Bid Schedule. No separate measurement or payment will be made for subsidiary items essential to making the items functional as intended but shall be included in the work.

SECTION 1300 APPENDIX

Sheet List Table	
Sheet Number	Sheet Title
I	TITLE SHEET
II	NOTES
III	INDEX
1A	OUTSIDE DROP MANHOLE (SANITARY SEWER)
1B	OUTSIDE DROP MANHOLE INVERT (SANITARY SEWER)
2	CONNECTION TO INTERCEPTOR MANHOLE
3	AUXILLARY MANHOLE TO SEWER INTERCEPTOR
4	STORM MANHOLE
5	INTERMEDIATE PLATFORM FOR DEEP MANHOLE
6	BEDDING DETAIL
7	TYPICAL SINGLE FAMILY EROSION CONTROL PLAN
8	MANHOLE RING AND COVER
9	MANHOLE MARKERS
10	MANHOLE ADJUSTMENT
11	SERVICE LINE CONNECTION TO MAIN
12	SEWER CLEANOUT
13	SEWER SERVICE LINE DOUBLE CLEANOUT
14	SEWER REPAIR
15	PIPE ENCASEMENTS
16	PIPE ENCASEMENTS (2)
17	TYPICAL SEWER TRENCH
18	SEWER STUBOUT MARKER
19	SIDEWALK CHASE
20	UNDERDRAIN
21	UNDERDRAIN (2)
22	CONCRETE COLLAR (STORM)
23	CONNECTIONS TO EXISTING STRUCTURE
24	INLET TYPE 16 COMBINATION
25	INLET TYPE 16 COMBINATION (2)
26	INLET TYPE 16 COMBINATION (3)
27	INLET TYPE 16 COMBINATION DOUBLE
28	INLET TYPE 16 COMBINATION TRIPLE
29	INLET TYPE 16 COMBINATION TRIPLE (2)
30	INLET TYPE 16 VALLEY
31	INLET TYPE 16 VALLEY TRIPLE
32	INLET TYPE 16 FRAME
33	INLET TYPE 16 GRATE AND CURB BOX
34	CLEANOUT - GENERAL
35	UTILITY PATCH DETAILS
36	LOCATE & POTHOLE STREET REPAIR
37	TRENCH ZONE REQUIREMENTS
38	DRIVEWAY RAMP
39	ALLEY PAVING
40	SUBGRADE PREPERATION
41	STANDARD LOCATIONS FOR UTILITIES
42	LOCAL STREET TYPE CROSS-SECTION
43	NEIGHBORHOOD CONNECTOR
44	DOWNTOWN CONNECTOR
45	MIXED USE CONNECTOR
46	MIXED USE DOWNTOWN CONNECTOR
47	SUBURBAN CONNECTOR
48	COMMERCIAL CORRIDORS
49	CUL-DE-SACS

NOT TO SCALE

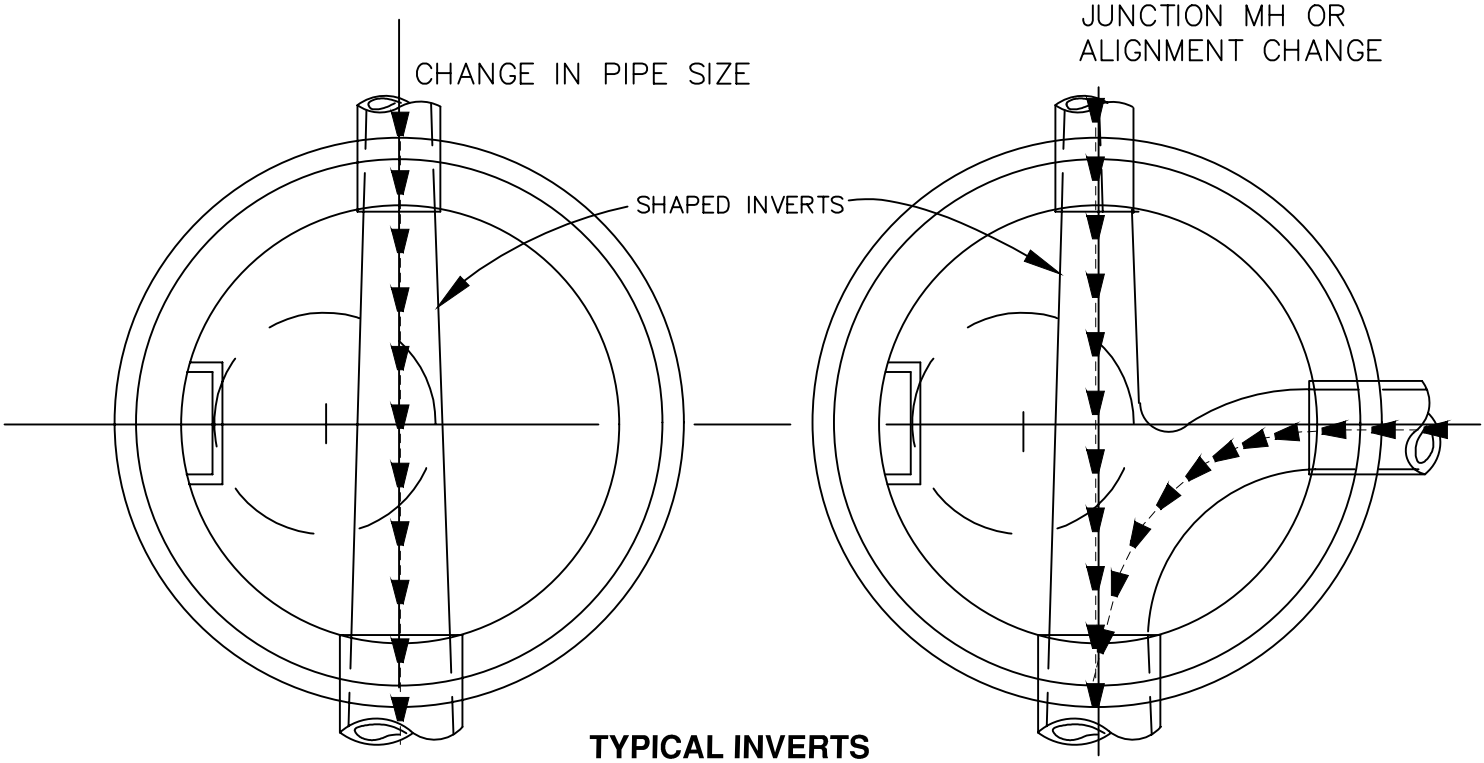


Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

OUTSIDE DROP MANHOLE (SANITARY SEWER)

SHEET
SD - 1A

DATE:
05/30/2025



TYPICAL INVERTS

NOT TO SCALE

TABLE II

PIPE I.D.	MANHOLE I.D.
18" & SMALLER	5'–0"
21" to 48"	5'–0"
54"	6'–0"
60" & LARGER	SPECIAL DESIGN

TABLE I

SIZE DATA FOR OUTSIDE DROP PIPE

PIPE I.D.	A (=B+C)	B	C	D	E	F	G	H
8"	60"	26"	34"	18"	21"	4 1/2"	8"	4 5/8"
10"	60"	20"	40"	21"	21"	5 1/8"	9"	5 1/2"
12"	60"	18"	42"	24"	21"	5 7/8"	10 3/4"	5 7/8"
15"	78"	28"	50"	30"	24"	7 7/8"	12 1/2"	7 3/4"

NOTES:

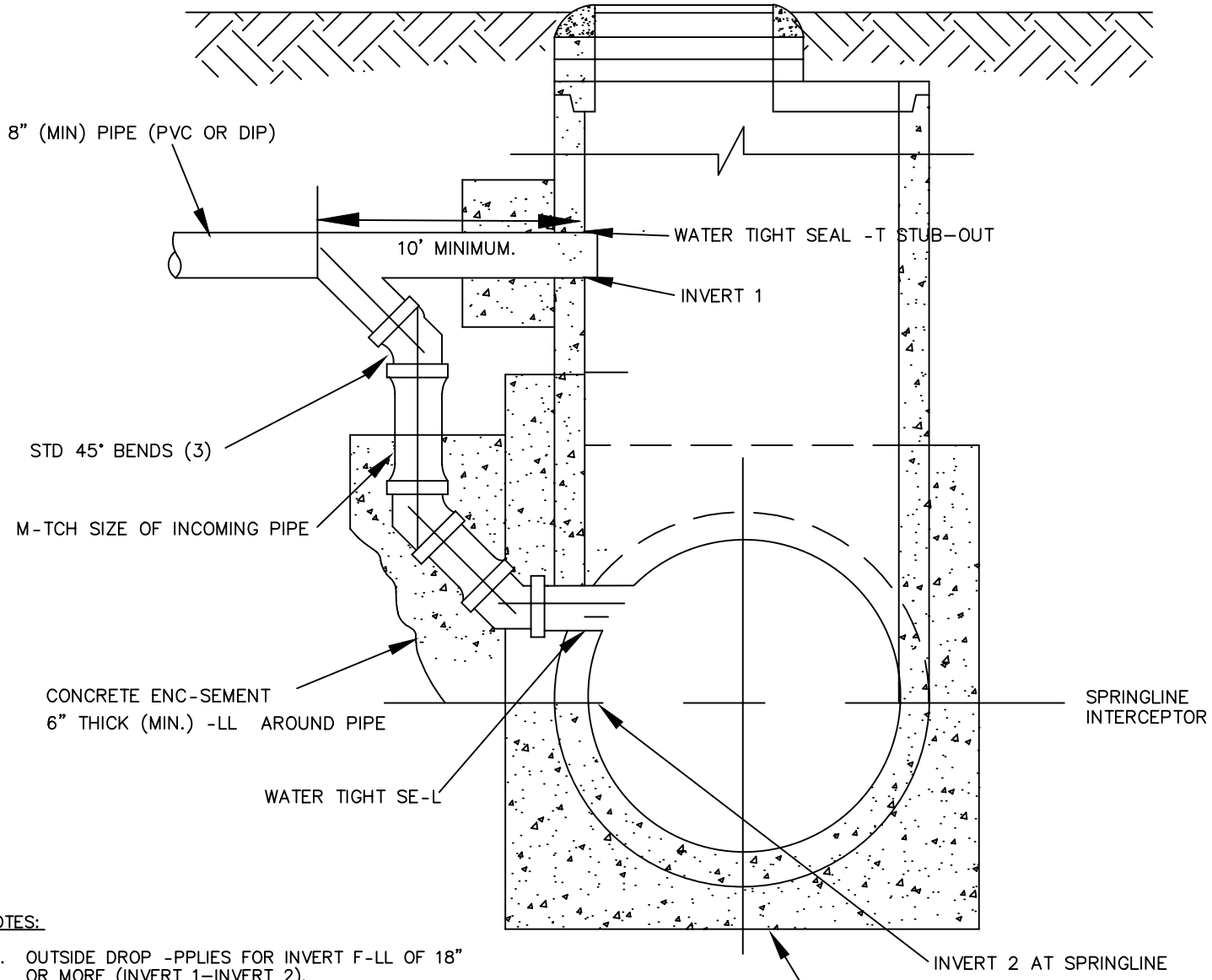
1. THIS DETAIL APPLIES TO VERTICAL INVERT DROPS IN EXCESS OF 18 INCHES. (INVERT 1–INVERT 2).
2. SEE CDOT M–604–20 FOR REINFORCEMENT AND CONCRETE REQUIREMENTS.
3. STEPS SHALL NOT BE INSTALLED IN SANITARY SEWER MANHOLES. ACCESS BY LADDER ONLY.
4. ENCASEMENT SHALL BE CLASS D CONCRETE.
5. A KOR–N–SEAL BOOT SHALL BE USED FOR THE CONNECTIONS IN A PRECAST MH A WATER STOP GASKET AROUND THE PIPE SHALL BE USED IN A CAST IN PLACE (CIP) BASE.
6. OUTSIDE DROP SHALL BE ALL OF ONE MATERIAL AND SIZE.
7. FOR CIP BASE MH WITH EXTENDED BASE, EXTEND #4 BAR PATTERN INTO EXTENSION.
8. FOR CIP EXTENSION TO PRESCAST MH BASE, USE #4 DOWELS X 22"LG (4" EMB) AND #4 AT 12 EW MAT, BASE THICKNESS TO MATCH THE PRECAST MH BASE THICKNESS, 8" MIN BASE DIMENSIONS TO SUPPORT ENCASEMENT.
9. ALL REQUIRED WALL OPENINGS SHALL BE PRECAST BLOCK–OUTS OR CORE DRILLED (JACK HAMMERING OF OPENINGS IS NOT ALLOWED.)
10. ALL DROP MANHOLES SHALL BE LINED.
11. ALL REBAR USED WILL BE EPOXY COATED INCLUDING THE TIES AND ANY CUT PORTION OF THE REBAR.

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

OUTSIDE DROP MANHOLE INVERT (SANITARY SEWER)

SHEET
SD - 1B

DATE: 05/30/2025



NOTES:

1. OUTSIDE DROP -PPLIES FOR INVERT F-LL OF 18" OR MORE (INVERT 1-INVERT 2).
2. THE MINIMUM PIPE SIZE TO T-P INTO -N INTERCEPTOR M-NHOLE SH-LL BE 8".
3. THE INTERCEPTOR LINE SH-LL BE CORE-DRILLED TO EX-CT PIPE SPECIFIC-TIONS FOR THE T-P. THE PIPE SH-LL BE SE-LED WITH - W-TERTIGHT G-SKET -ND THE JOINT ENC-SED IN CONCRETE (HIGH E-RLY).
4. PIPE SH-LL MEET -NSI/-STM--746 REQUIREMENTS.
5. WHERE THERE IS -N EXISTING STUB-OUT FROM THE M-NHOLE, THE TIE-IN SH-LL BE FOR - MINIMUM LENGTH OF 10 FEET FROM THE STUB-OUT CONNECTION, SH-LL INCLUDE W-TER TIGHT G-SKET, -ND ENC-SED IN CONCRETE.
6. SEE SD-1 FOR DIMENSIONS ON OUTSIDE DROP PIPE.
7. T-P CONNECTIONS WILL BE DONE -BOVE SPRINGLINE (-S SHOWN) TO PREVENT G-S/ODOR MIGR-TION.
8. ENC-SEMENT SH-LL BE CL-SS D CONCRETE
9. COORDIN-TION WITH OUTSIDE DISTRICTS M-Y BE -PPLIC-BLE

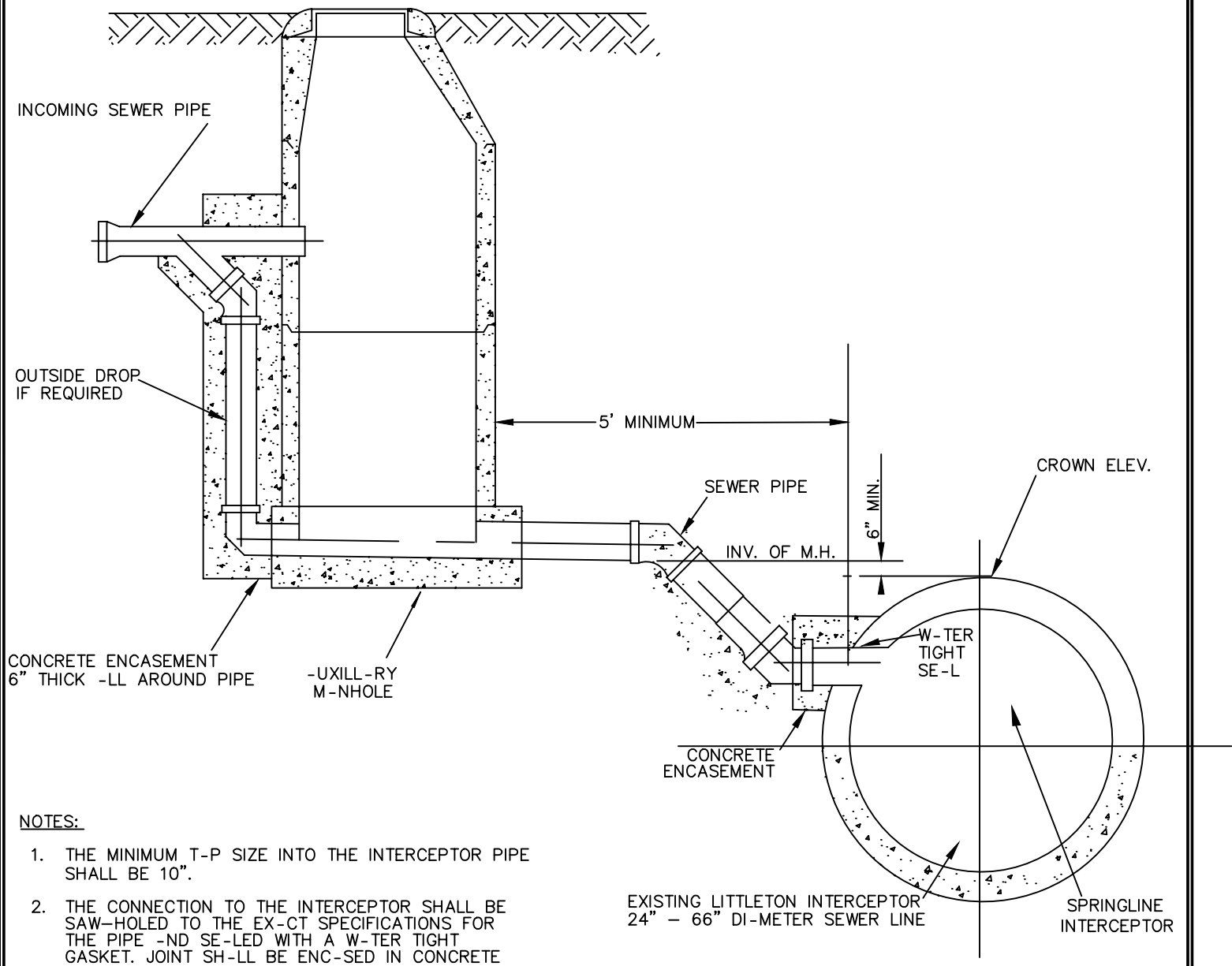
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

CONNECTION TO INTERCEPTOR MANHOLE

SHEET
SD - 2

DATE:
05/30/2025



NOTES:

1. THE MINIMUM T-P SIZE INTO THE INTERCEPTOR PIPE SHALL BE 10".
2. THE CONNECTION TO THE INTERCEPTOR SHALL BE SAW–HOLED TO THE EX-CT SPECIFICATIONS FOR THE PIPE -ND SE-LED WITH A W-TER TIGHT GASKET. JOINT SH-LL BE ENC-SED IN CONCRETE (HIGH EARLY).
3. PREC-ST M-NHOLE SECTIONS SHALL CONFORM TO -STM SPECIFIC-TIONS C–478 AND CDOT M–601–20.
4. THE INVERT OF E-CH M-NHOLE SHALL BE CONSTRUCTED TO ENSURE - SMOOTH -ND PROPER FLOW.
5. CONNECTION SHALL BE M-DE AT - POINT 2'+6" (MIN) HORIZONT-LLY FROM THE ADJ-CENT BELL JOINT OF INTERCEPTOR.
6. T-P CONNECTIONS WILL BE DONE -BOVE SPRINGLINE (AS SHOWN) TO PREVENT GAS/ODOR MIGRATION.
7. OUTSIDE DROP REQUIRED IF INVERT F-LL EXCEEDS 18", SEE SD–1.
8. ENCASEMENT SHALL BE CL-SS D CONCRETE.

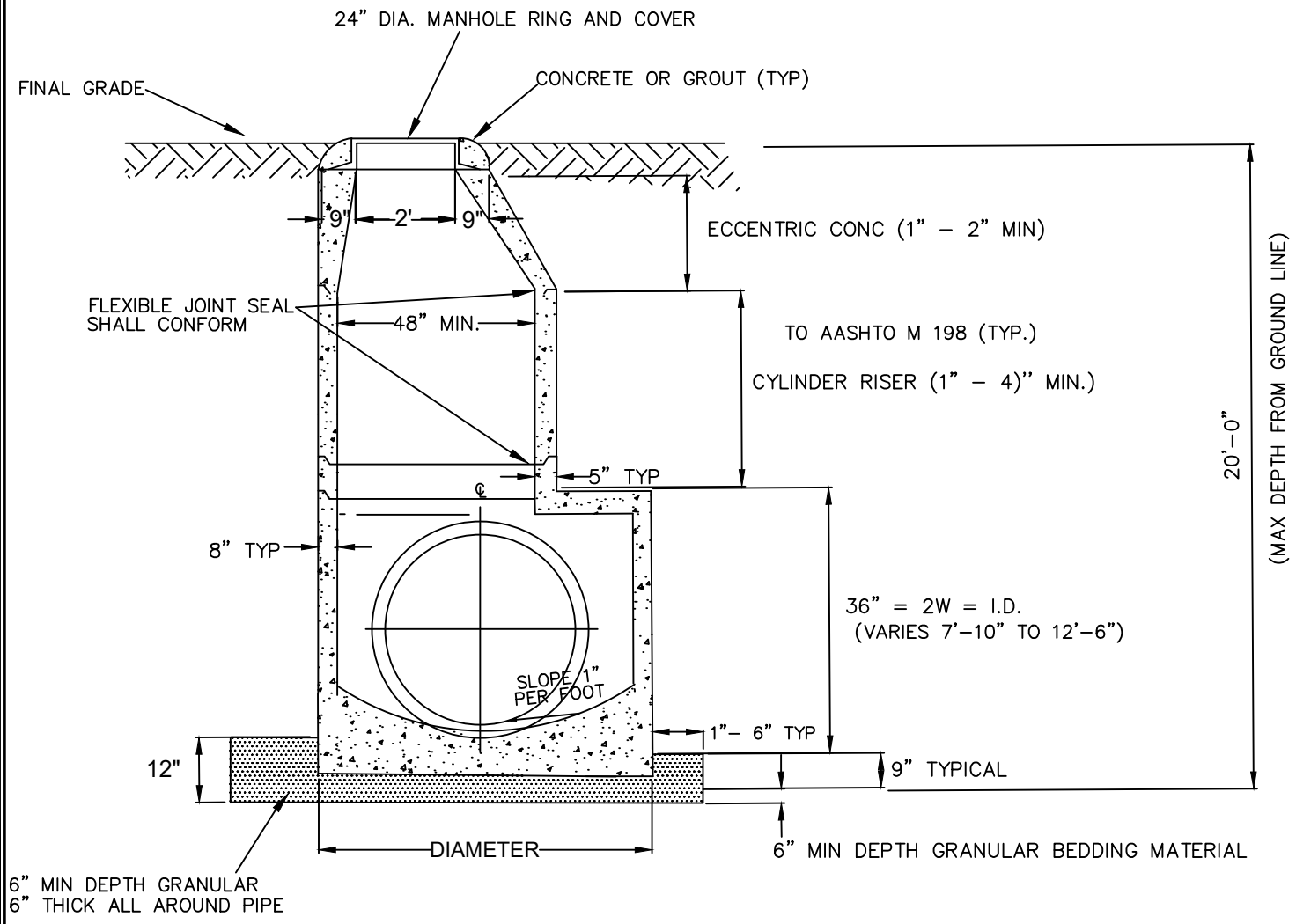
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

AUXILIARY MANHOLE TO SEWER INTERCEPTOR

SHEET
SD - 3

DATE:
05/30/2025



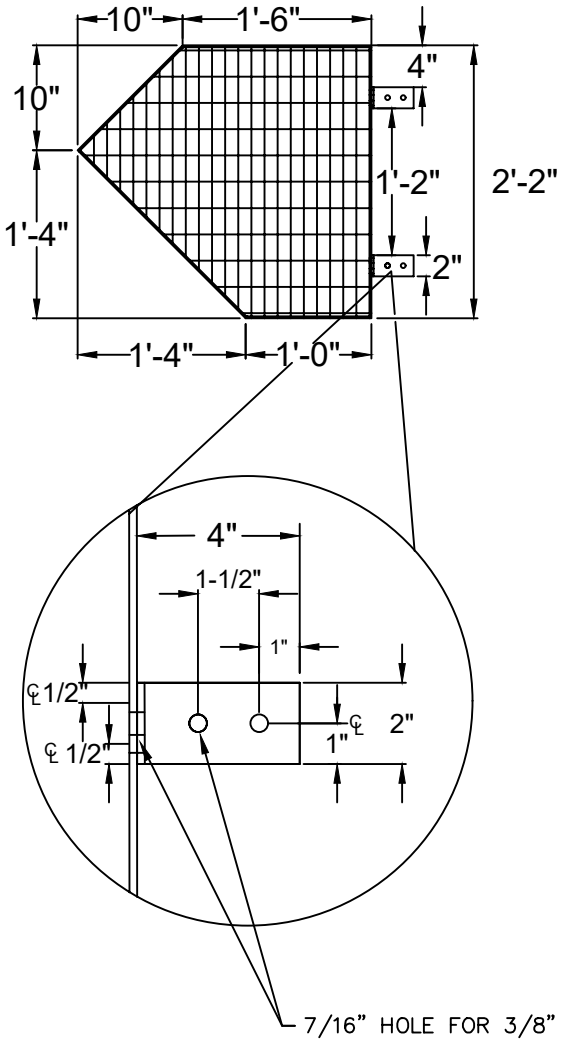
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

STORM MANHOLE

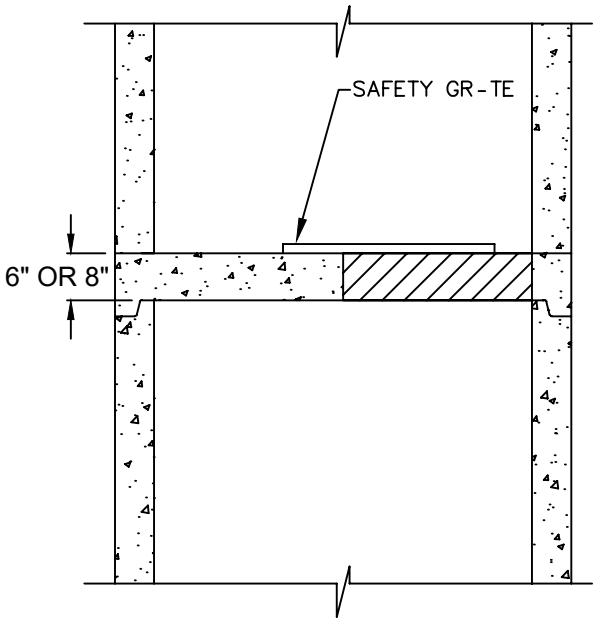
SHEET
SD - 4

DATE:
05/30/2025

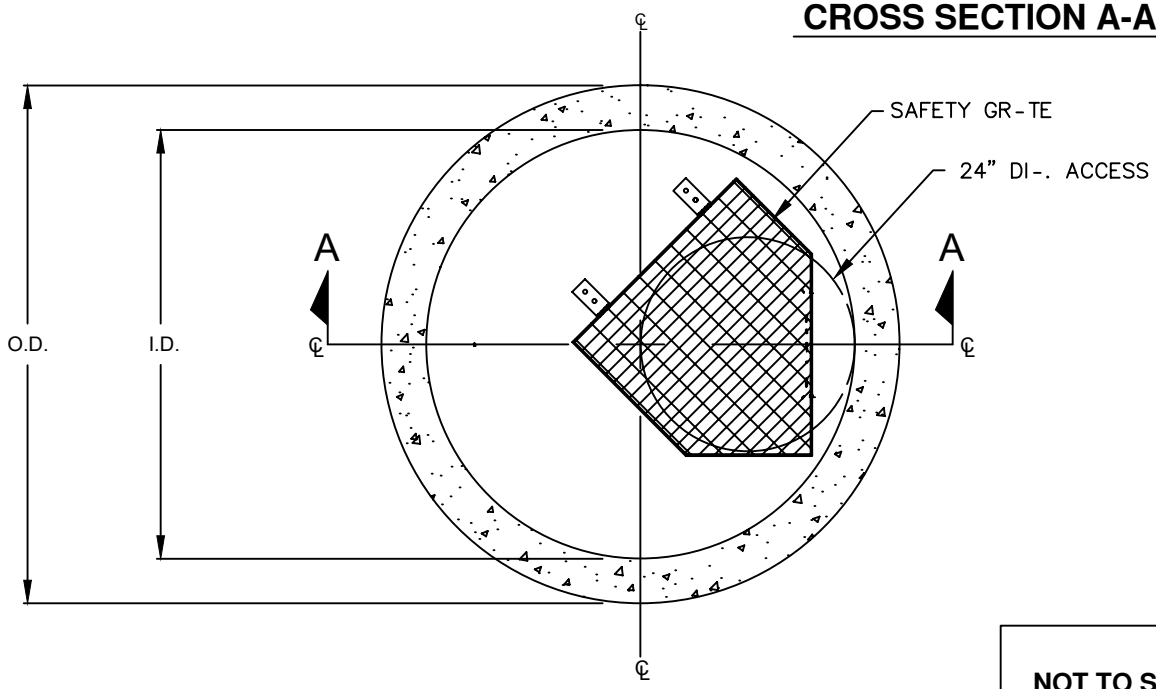


NOTE:

1. -TT-CH HINGE TO GR-TING WITH (2) $\frac{3}{8}$" DI-. BOLTS X 1" O.C WITH HEX NUTS. -TT-CH HINGE TO PL-TFORM WITH (2) $\frac{3}{8}$" LONG RED HEAD'S OR EQUAL.
2. S-FETY GRATING IS 1 $\frac{1}{4}$" X $\frac{3}{16}$" B-B 1$\frac{3}{16}$" O.C. HINGES -RE -LUMINUM $\frac{3}{16}$" THICK.
3. S-FETY GRATE TO BE A NON-CORROSIVE MATERI-L.



CROSS SECTION A-A



PLAN SECTION

NOT TO SCALE

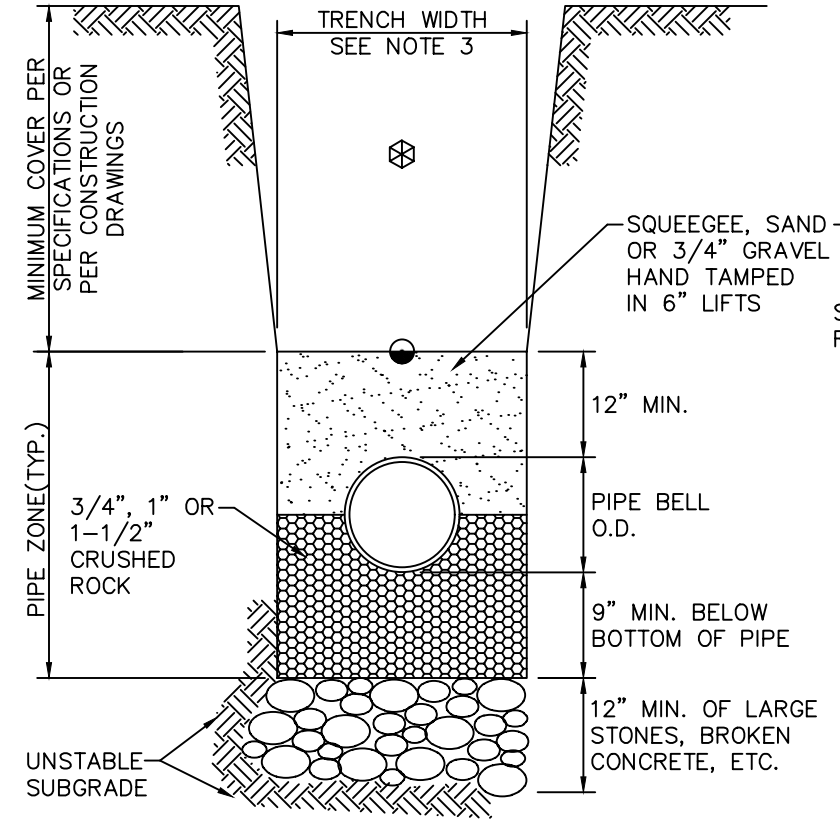
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INTERMEDIATE PLATFORM FOR DEEP MANHOLE

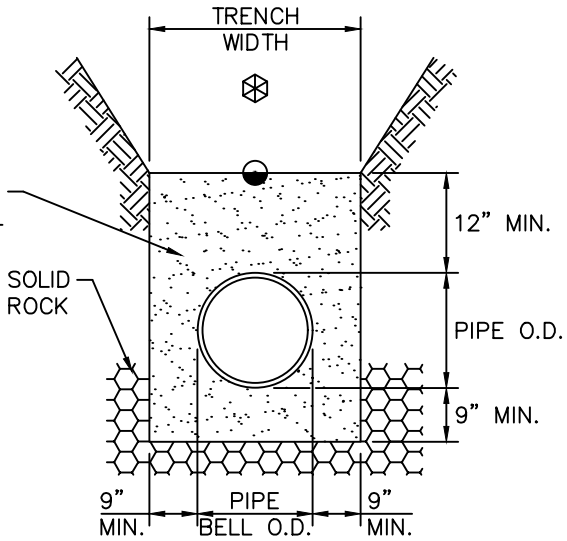
SHEET
SD - 5

DATE:
05/30/2025

NOT TO SCALE



UNSTABLE SUBGRADE



PIPE BEDDING IN ROCK

⊗ MACHINE COMPACTED TRENCH BACKFILL

◒ LIMITS 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 SAFETY OF THE WORKMEN AND PROTECTION OF OTHER UTILITIES IN ACCORDANCE WITH APPLICABLE LOCAL, STATE AND 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).
4. COMPACTION SHALL BE AS FOLLOWS: PIPE ZONE BEDDING 6 INCHES UNDER AND 12 INCHES OVER PIPE WILL REQUIRE 90% S.P.D., TRENCH ZONE ABOVE BEDDING MATERIALS, FULL TRENCH SECTION IN ROADWAY OR STREET R.O.W. LIMITS WILL REQUIRE 95% S.P.D. TRENCH ZONE ABOVE BEDDING MATERIALS, OUTSIDE OF STREET R.O.W. WILL REQUIRE 90% S.P.D.

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

BEDDING DETAIL

SHEET
SD - 6

DATE: 05/30/2025

1. THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE IS RESPONSIBLE FOR OBTAINING APPLICABLE PERMITS AND THE INSTALLATION AND MAINTENANCE OF ALL BEST MANAGEMENT PRACTICES (BMPS) FOR EROSION AND SEDIMENT CONTROL, EVEN IF SPECIFIC TASKS MAY BE DESIGNATED TO OTHERS.

2. FOR ALL SITES DISTURBING ONE (1) OR MORE ACRES, THE STATE OF COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT (CDPHE) REQUIRES A "STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITY" PERMIT. A COPY OF THAT ISSUED PERMIT SHALL BE SUBMITTED TO THE ENGINEERING DIVISION PRIOR TO ISSUANCE OF A LOCAL CITY PERMIT.

3. ALL BMPS SHOWN ON THE APPROVED STORMWATER MANAGEMENT PLAN (SWMP) PLAN SHALL BE INSTALLED PROPERLY AND INSPECTED BY A CITY REPRESENTATIVE PRIOR TO THE START OF ANY CONSTRUCTION ACTIVITY ON THE SITE THAT DISTURBS THE GROUND. BMPS SHALL BE INSPECTED CLEANED, AND MAINTAINED BY THE PROPERTY OWNER OR DESIGNEE AS NEEDED DURING CONSTRUCTION.

4. ISSUANCE OF A GRADING OR BUILDING PERMIT WITH AN APPROVED SWMP PROVIDES AUTHORIZATION FOR THE CITY TO ENTER THE PREMISES FOR PURPOSES OF INSPECTIONS AND COMPLIANCE WITH THE APPROVED PLANS, PROVISIONS OF MUNICIPAL CODE TITLE 7 CHAPTER 7, AND THE CITY'S STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA.

5. THE CITY MAY REQUIRE THAT THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE PROVIDE ADDITIONAL EROSION OR SEDIMENT CONTROL MEASURES, SHOULD WATER OR WIND EROSION PROBLEMS OCCUR OR SHOULD THE IMPLEMENTED STORMWATER MANAGEMENT PLAN (SWMP) AND BEST MANAGEMENT PRACTICES (BMPS) NOT FUNCTION ADEQUATELY OR AS INTENDED.

6. INSPECTIONS AND NEEDED MAINTENANCE OF BMPS ARE REQUIRED A MINIMUM OF EVERY 14 DAYS AND AFTER STORM EVENTS, OR ALTERNATELY EVERY 7 DAYS. THE CITY RESERVES THE RIGHT TO REQUIRE THE OPERATOR TO SUBMIT COPIES OF INSPECTION REPORTS OR OTHER STORMWATER MANAGEMENT DOCUMENTS AT ANY TIME.

7. SWMPS SHALL ACCOMMODATE CONSTRUCTION PHASING, INCLUDING CLEARING AND GRUBBING, UTILITIES, ROADS, VERTICAL CONSTRUCTION, FINAL GRADING, AND STABILIZATION, AND SHALL HAVE REDUNDANT DOWN SLOPE BMPS IN PLACE TO ENSURE ADEQUATE EROSION AND SEDIMENT CONTROL DURING ALL PHASES.

8. THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE IS RESPONSIBLE TO CLEAN ALL PUBLIC STREETS AND SIDEWALKS WHERE SEDIMENT OR MUD IS TRACKED ONTO THE PAVED SURFACE. THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE SHALL CLEAN THE PUBLIC WAY IMMEDIATELY OR WITHOUT DELAY UPON BEING NOTIFIED BY THE CITY. IT MAY ALSO BE NECESSARY TO PERIODICALLY CLEAN THE PUBLIC STORM SEWERS AND DOWN GRADIENT PROPERTIES DURING THE DEVELOPMENT OF THE SITE.

9. THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE SHALL BE RESPONSIBLE FOR IMPLEMENTATION AND FIELD UPDATES/CHANGES TO THE STORM WATER MANAGEMENT PLAN THAT INCLUDES THE PLAN VIEW LAYOUT AND INSTALLATION DETAILS OF APPROPRIATE CONTROL MEASURES, AND MAINTENANCE PROCEDURES.

10. IF THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE FAILS TO IMPLEMENT ANY OF THE PROVISIONS OF THE SWMP AND IGNORES THE CITY'S VERBAL OR WRITTEN REQUEST FOR IMMEDIATE REMEDY, THE CITY MAY MAKE ARRANGEMENTS OR HIRE A PRIVATE PROPERTY OWNER OR DESIGNEE TO PERFORM MAINTENANCE, INSTALLATION OR REPLACEMENT OF BMPS, OR CLEAN THE PUBLIC CHARGES FOR SERVICES WILL BE SENT TO THE OPERATOR, PROPERTY OWNER OR DESIGNEE FOR PAYMENT. ENFORCEMENT PROCEDURES ARE OUTLINED IN LITTLETON MUNICIPAL CODE 7-7-12.

11. THE CITY MAY ISSUE A "STOP WORK" ORDER TO STOP ANY PERMITTED SITE CONSTRUCTION WORK FROM PROCEEDING UNTIL THE BMPS PROVIDED ON THE SWMP AND APPROVED PLANS ARE INSTALLED, IMPLEMENTED AS INTENDED, MAINTAINED, OR UNTIL CORRECTIVE MEASURES ARE TAKEN AND ANY NECESSARY CLEANUP IS PERFORMED. THE OWNER BEARS ALL COSTS ASSOCIATED WITH ANY DELAYS IN THE PROJECT.

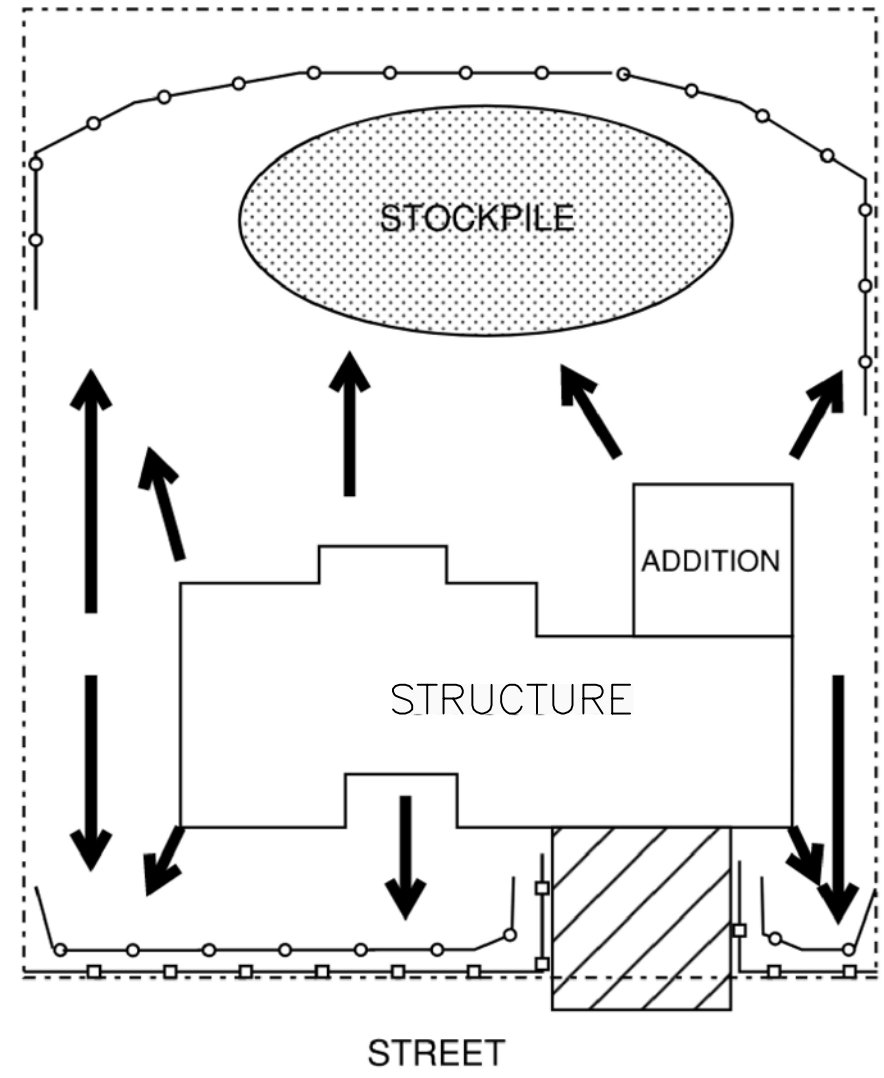
12. THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE SHALL NOT UTILIZE THE PUBLIC STREET AS A STAGING AREA FOR THE TEMPORARY STORAGE OF BUILDING MATERIALS, EXCAVATED MATERIALS, APPROVED BY THE CITY. USE OF OFFSITE PRIVATE PROPERTY FOR STAGING MAY BE SUBJECT TO REVIEW BY THE COMMUNITY DEVELOPMENT DEPARTMENT.

13. A CONSTRUCTION DE-WATERING DISCHARGE PERMIT SHALL BE OBTAINED FROM CDPHE PRIOR TO PUMPING OF ANY SURFACE OR SUB-SURFACE WATER INTO ANY CITY PUBLIC WAY OR STORM DRAINAGE SYSTEM. ADEQUATE SEDIMENT CONTROL BMPS SHALL BE REQUIRED AT THE PUMP'S INLET AND OUTLET

14. ALL SOIL AREAS DISTURBED SHALL BE GRADED, SEEDED, AND MULCHED OR OTHERWISE VEGETATED OR COVERED, TO STABILIZE THE GROUND SURFACE WITHIN 14 DAYS OF COMPLETION OF GRADING OPERATIONS. THE CITY SHALL APPROVE THE SEED MIX AND RATE OF APPLICATION PRIOR TO SEEDING THE AREA. IF DISTURBED SOIL AREAS ARE TO BE LEFT DORMANT FOR OVER 14 DAYS, A TEMPORARY STABILIZING COVER IS REQUIRED, THE METHOD TO BE APPROVED BY THE CITY. WEEDS ARE NOT AN ACCEPTABLE TEMPORARY OR PERMANENT STABILIZATION COVER.

15. BMPS SHALL REMAIN IN-PLACE AND OPERATIONAL UNTIL ALL SITE PAVING, PERMANENT LANDSCAPING, OR ADEQUATE VEGETATIVE COVER ESTABLISHMENT IS COMPLETED. ADEQUATE VEGETATION COVER IS DEFINED AS A UNIFORM VEGETATIVE COVER WITH A PLANT DENSITY (STEM OR OF AT LEAST 70% OF THE PRE-DISTURBANCE CONDITION. TEMPORARY IRRIGATION MAY BE NECESSARY TO ESTABLISH PLANT GROWTH. ADEQUATE VEGETATIVE COVER WILL BE DETERMINED BY CITY STAFF WITH AN ON-SITE INSPECTION PRIOR TO ANY PERMIT RELEASE, INCLUDING TERMINATION OF A CDPHE STORMWATER PERMIT.

16. AFTER THE SITE HAS BEEN STABILIZED AS DETERMINED BY CITY STAFF, THE OPERATOR, PROPERTY OWNER, OR THEIR DESIGNEE SHALL REMOVE ALL BMPS AND CLEAN ANY STORM SEWERS WHERE CONSTRUCTION SEDIMENT MAY HAVE DEPOSITED.



SILT FENCE

VEHICLE TRACKING CONTROL (VTC) - NEW CONSTRUCTION

DIRECTION OF SURFACE WATER RUNOFF

TEMPORARY CONSTRUCTION FENCE AS NECESSARY

PROPERTY LINE

NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

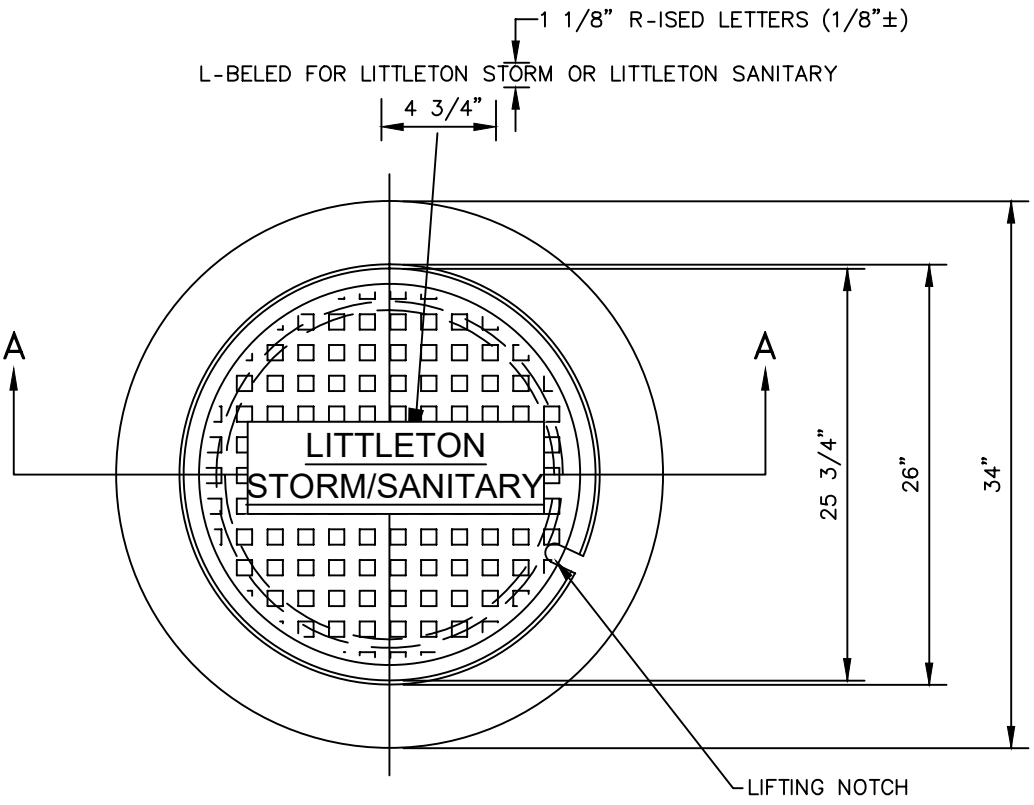
TYPICAL SINGLE FAMILY EROSION CONTROL PLAN

SHEET
SD - 7

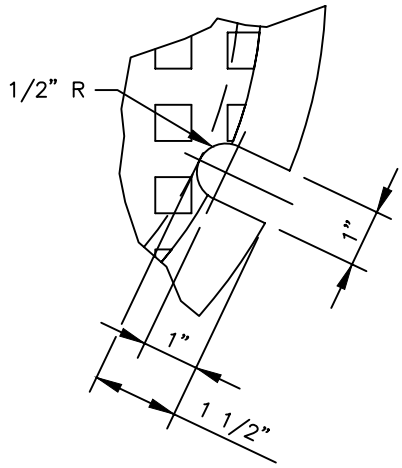
DATE: 05/30/2025

NOTE:

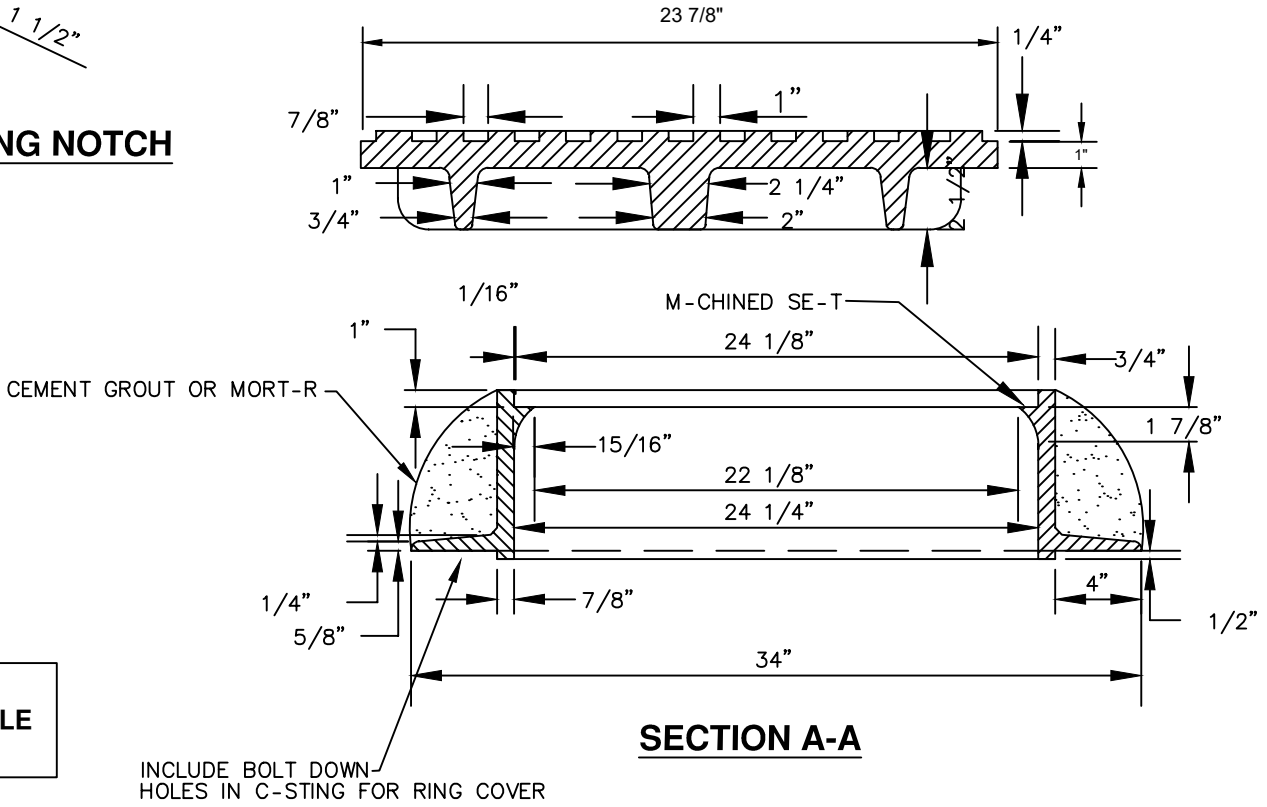
1. C-STING SPECIFIC-TIONS: -STM A-48 WITH A MINIMUM TENSILE STRENGTH OF 25 KSI(CL-SS 25)
2. PREFFERED DEPRESSION $\frac{3}{8}$" NO MORE TH-N $\frac{1}{4}$" DEPRESSED BELOW -DJ-CENT SURF-CE.
3. LOCKING LIDS REQUIRED ON -LL S-NIT-RY MAIN IN ARTERI-L ROADW-YS. NO BOLT-DOWN LIDS.
4. M-NHOLE LIDS TO BE LOC-TED OUTSIDE OF WHEEL P-TH AND BIKE P-TH L-NES.



PLAN



LIFTING NOTCH



SECTION A-A

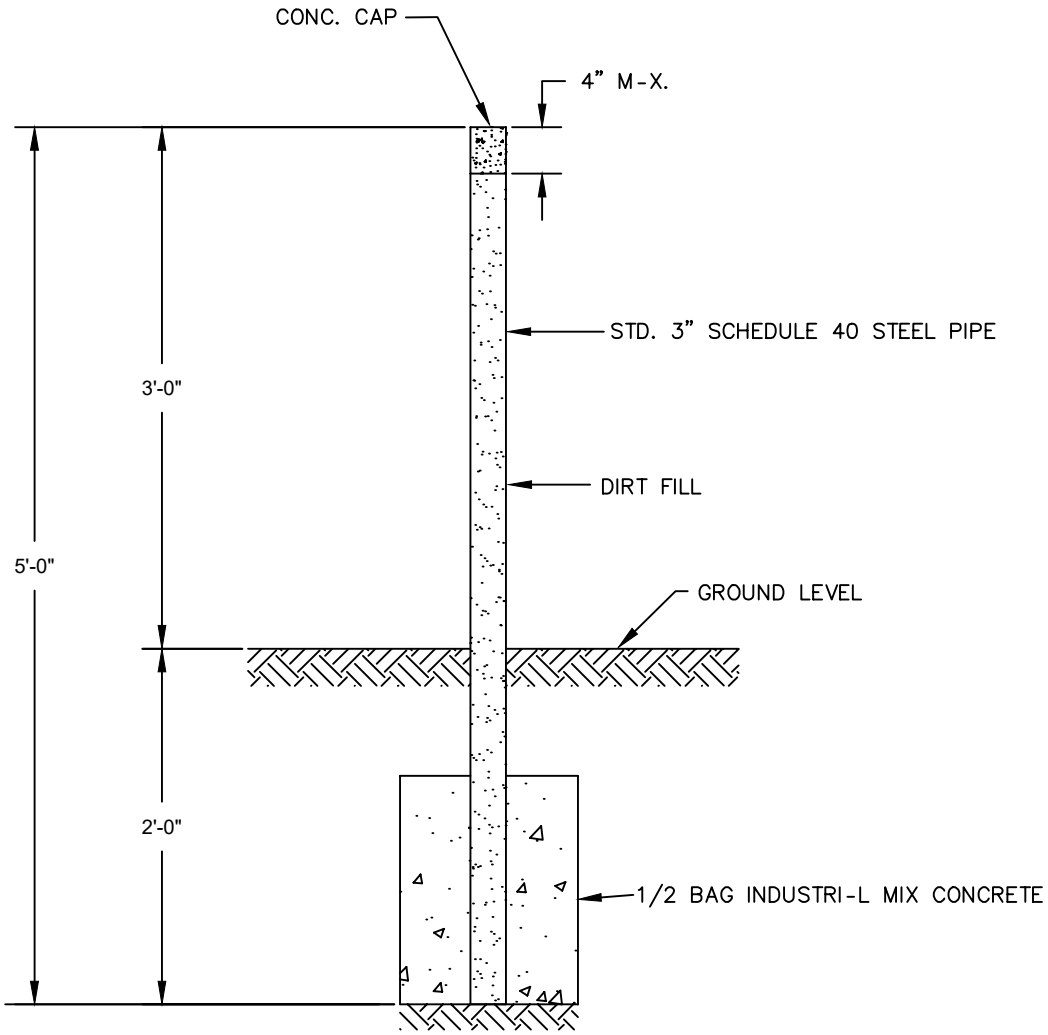
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

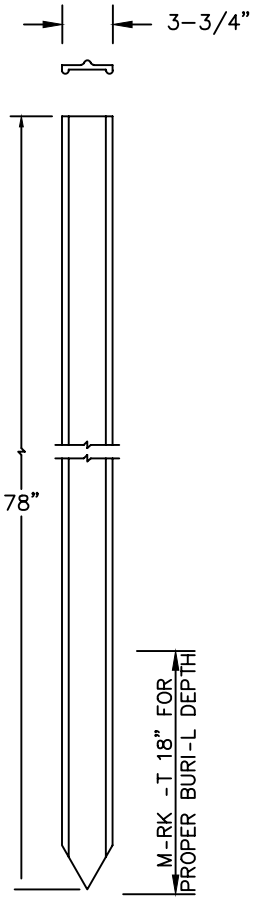
MANHOLE RING AND COVER

SHEET
SD - 8

DATE: 05/30/2025



STEEL PIPE POST



CARSONITE MARKER

NOTES:

1. IDENTIFIC-TION M-RKS ON POSTS SH-LL BE 3" DI-. CIRCLES BROKEN IN VERTIC-L CENTER () POINTING TO -PPURTEN-NCE WITH 1" STENCILS ON ON SIDE INDIC-TING TYPE OF -PPURTEN-NCE (MH, ETC.) -ND THE DIST-NCE IN FEET -ND INCHES FROM POST.
2. UTILITY M-RKER POST SH-LL BE C-RSONITE CUM-375 OR EQU-L WITH -NCHORS -ND -PPROPRI-TE DEC-LS FOR S-NIT-RY, STORM -ND W-TER.
3. M-NHOLE M-RKERS TO BE PL-CED IN -LL OPEN SP-CE -RE-S WHERE VEGET-TION H-S POTENTI-L FOR OVERGROWTH.

3. COLOR FOR S-NIT-RY SEWER – GREEN.
4. COLOR FOR STORM SEWER – YELLOW.
5. COLOR FOR W-TER – BLUE.

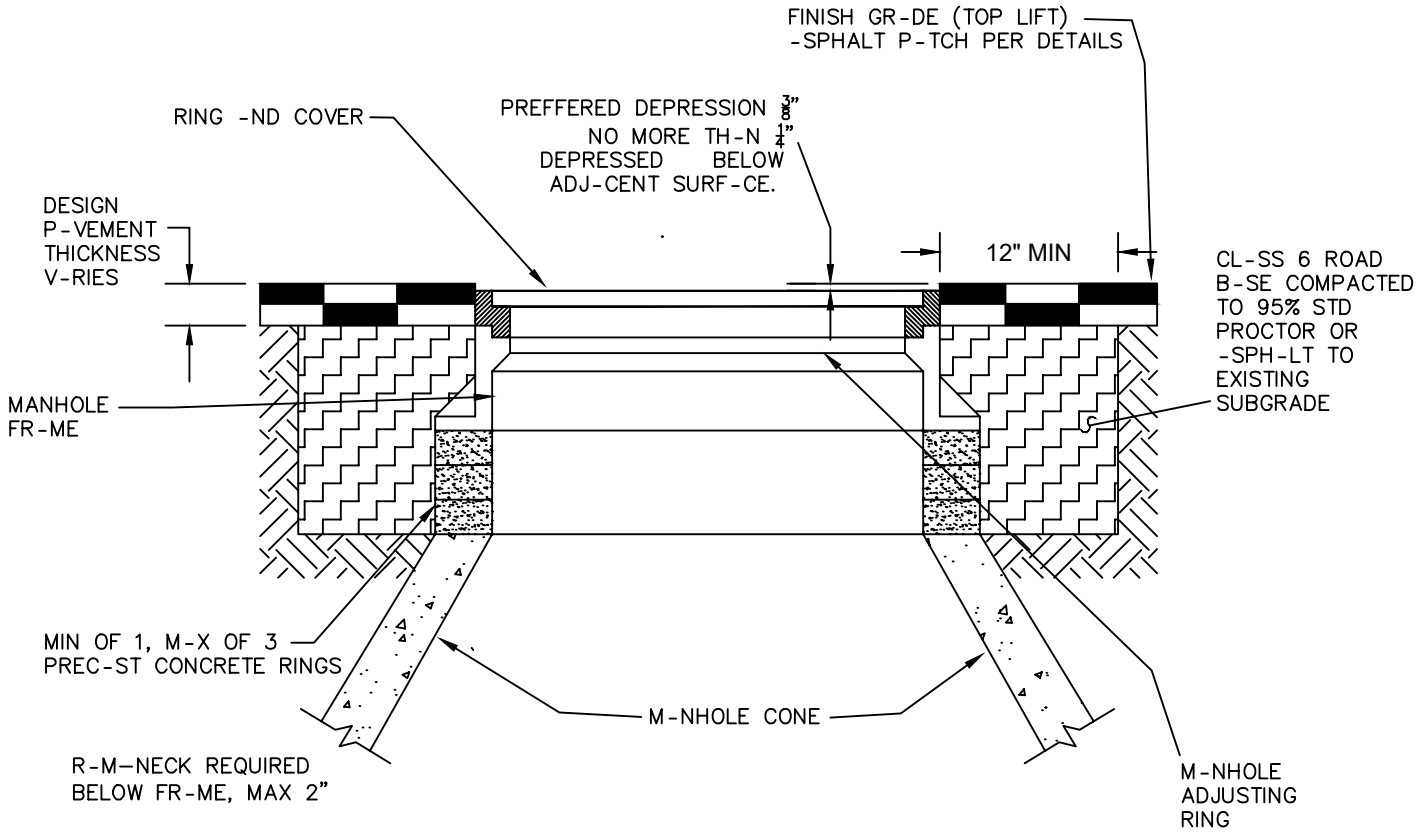
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

MANHOLE MARKERS

SHEET
SD - 9

DATE:
05/30/2025



MANHOLE ADJUSTMENT DETAIL

NOTE:

1. C-STING SPECIFICATIONS: ASTM --48 WITH - MINIMUM TENSILE STRENGTH OF 25 KSI(CL-SS 25)
2. PREFERRED DEPRESSION 3/8" NO MORE THAN 1/4" DEPRESSED BELOW -DJ-CENT SURFACE.
3. LOCKING LIDS REQUIRED ON ALL S-NITARY M-IN IN -RTERIAL RO-DWAYS. NO BOLT—DOWN LIDS.
4. M-NHOLE LIDS TO BE LOCATED OUTSIDE OF WHEEL PATH -ND BIKE PATH LANES.
5. M-NHOLE FRAME M-Y H-VE TO BE REMOVED AND GROUT R-MNECK OR PRECAST RISER TO BE USED BELOW IT TO OBT-IN PROPER SLOPE ON CERTAIN MANHOLES.

NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

MANHOLE ADJUSTMENT

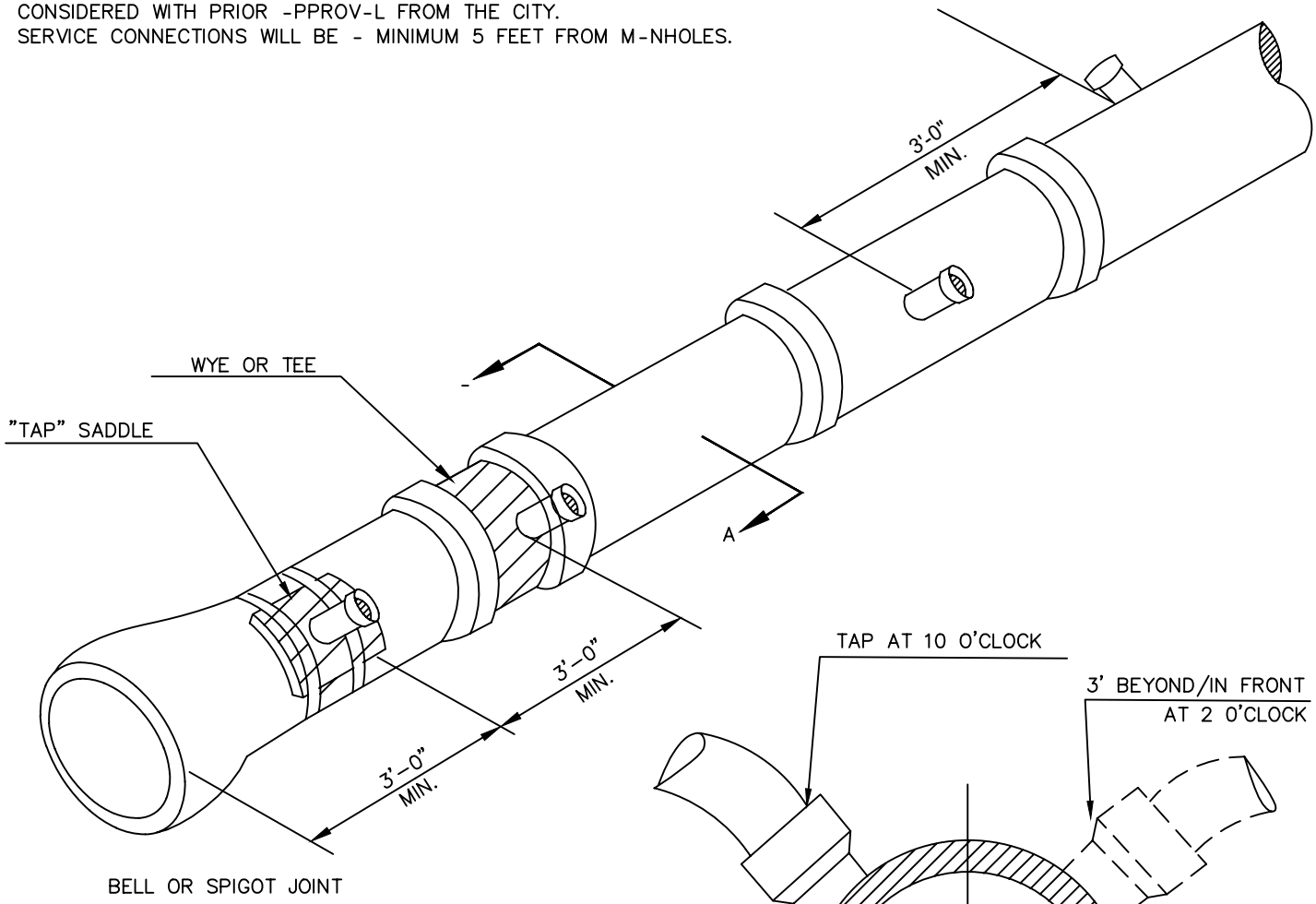
SHEET
SD - 10

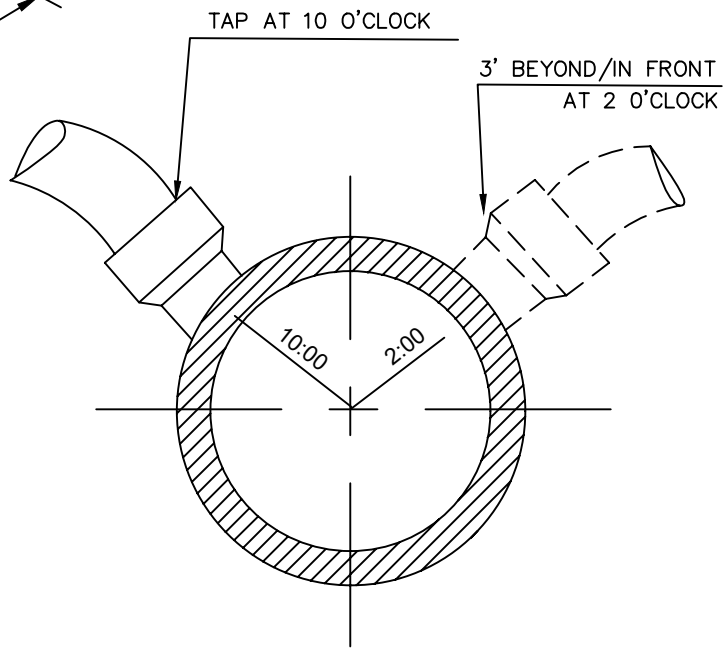
DATE:
05/30/2025

NOTES:

1) SERVICE CONNECTIONS ON E-CH SIDE OF THE SEWER MAIN SH-LL BE POSITIONED BETWEEN THE 2 O'CLOCK -ND 10 O'CLOCK POSITION -ND STAGGERED LONGITUDINALLY SO TH-T MULTIPLE CONNECTIONS DO NOT COME INTO THE M-IN -T THE SAME LOC-TION. ON NEW INST-LL-TIONS, EITHER WYE OR TEE FITTING SH-LL BE USED.
2) WHEN TAPPING INTO -N EXISTING SEWER M-IN, A S-DDLE CONNECTION WITH GLUED SURF-CE -ND ST-INLESS STEEL B-NDS, WITH -N -PPROVED CORING METHOD SHALL BE USED.
3) THE MINIMUM DIST-NCE BETWEEN SERVICE CONNECTIONS MADE -LONG THE PIPE SH-LL BE 3 FEET. (IF THE PIPE SEGMENT IS LESS THAN 3 FEET IN TOTAL LENGTH ENSURE THE CONNECTION IS CENTERED IN THE SEGMENT.)
4) THE MINIMUM DIST-NCE FROM EITHER THE BELL OR SPIGOT END OF PVC PIPE SH-LL BE 3 FEET.
5) -LL T-PS SHALL BE W-TERTIGHT. FOR T-PS TO REHABILIT-TED (LINED) MAIN LINES, THE W-TER TIGHT CONNECTION IS TO THE LINER.
6) TOP H-TS REQUIRED -T ALL LATER-L CONNECTIONS. -LTERN-TIVES MAY BE CONSIDERED WITH PRIOR -PPROV-L FROM THE CITY.
7) SERVICE CONNECTIONS WILL BE - MINIMUM 5 FEET FROM M-NHOLES.

NOT TO SCALE





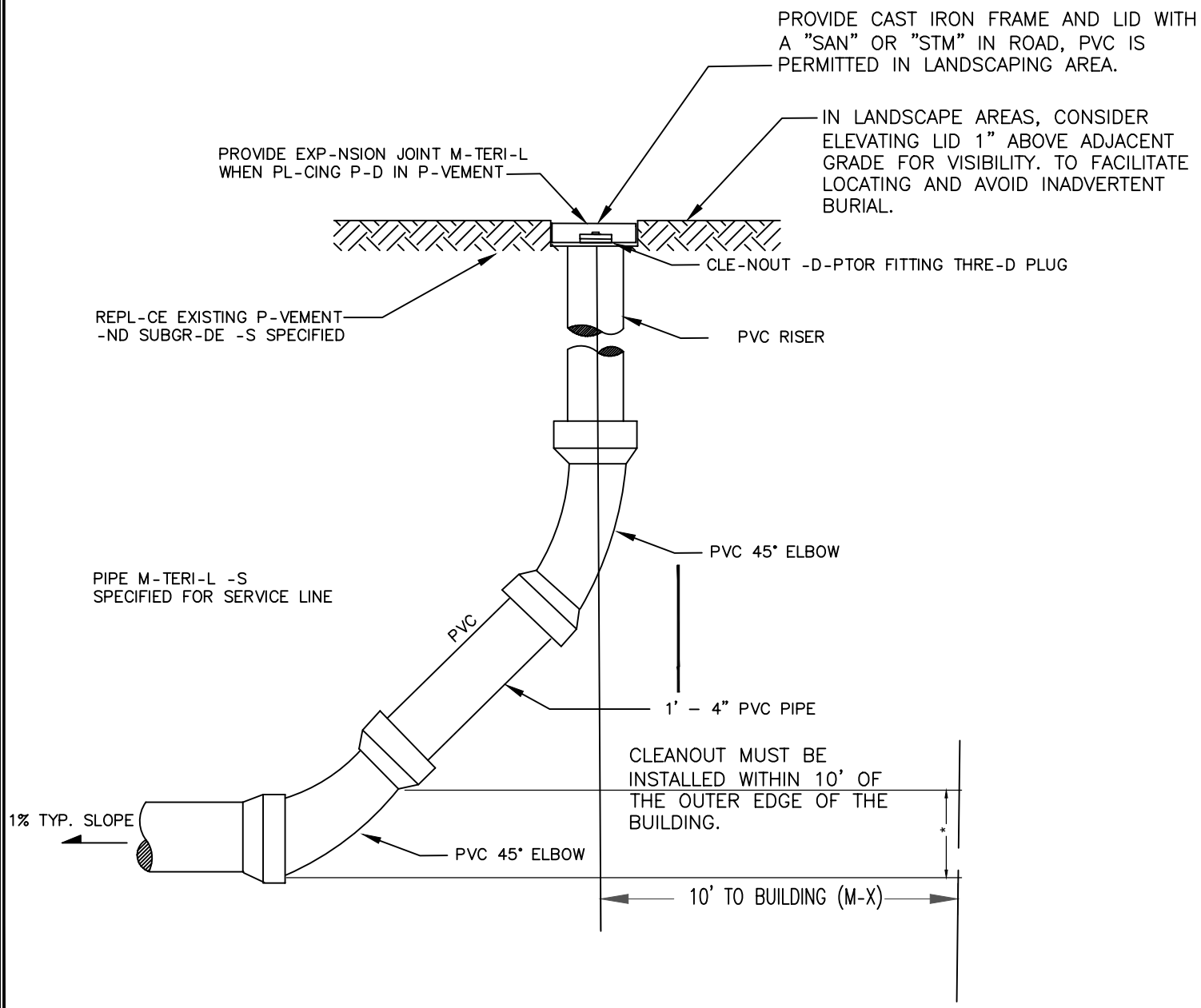
SECTION A-A

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

SERVICE LINE CONNECTION TO MAIN

SHEET
SD - 11

DATE: 05/30/2025



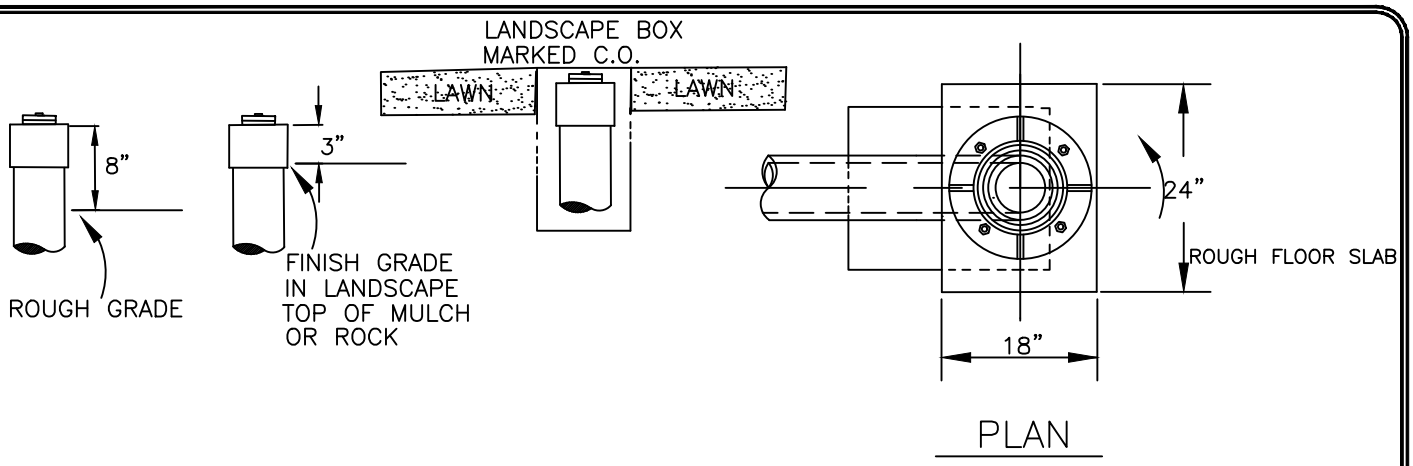
SEWER CLEAN–OUT

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

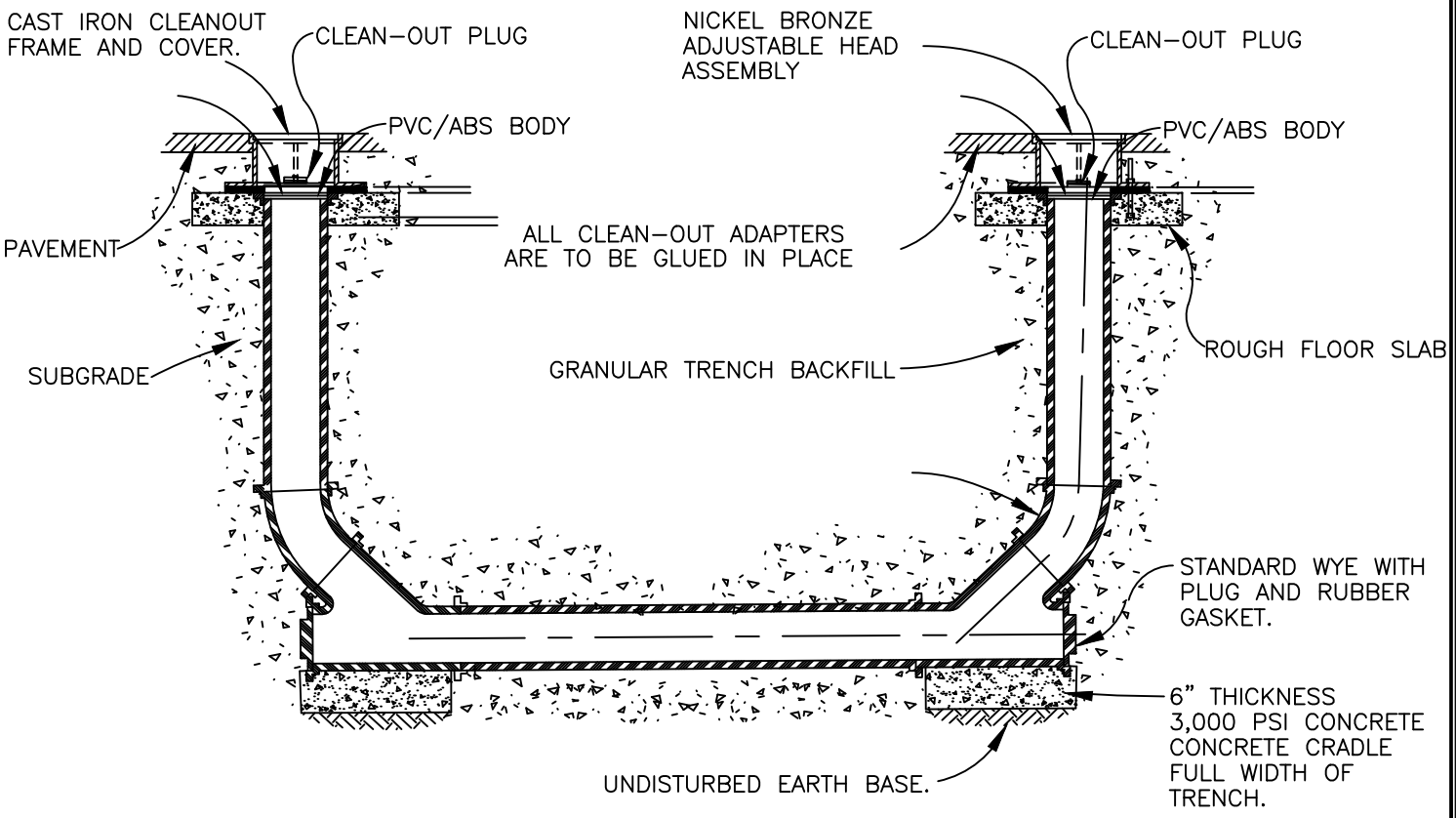
SEWER CLEANOUT

SHEET
SD - 12

DATE:
05/30/2025



PLAN



DOUBLE CLEANOUT REQUIRED IF LOCATED
MORE THAN 10' FROM THE BUILDING

NOTE:

1. DOUBLE COMBO WYE OR TEXAS TEE IS ALSO PERMITTED.
2. DOUBLE REQUIRED FOR ALL LOCATIONS EXCEPT AT END OF LINE.

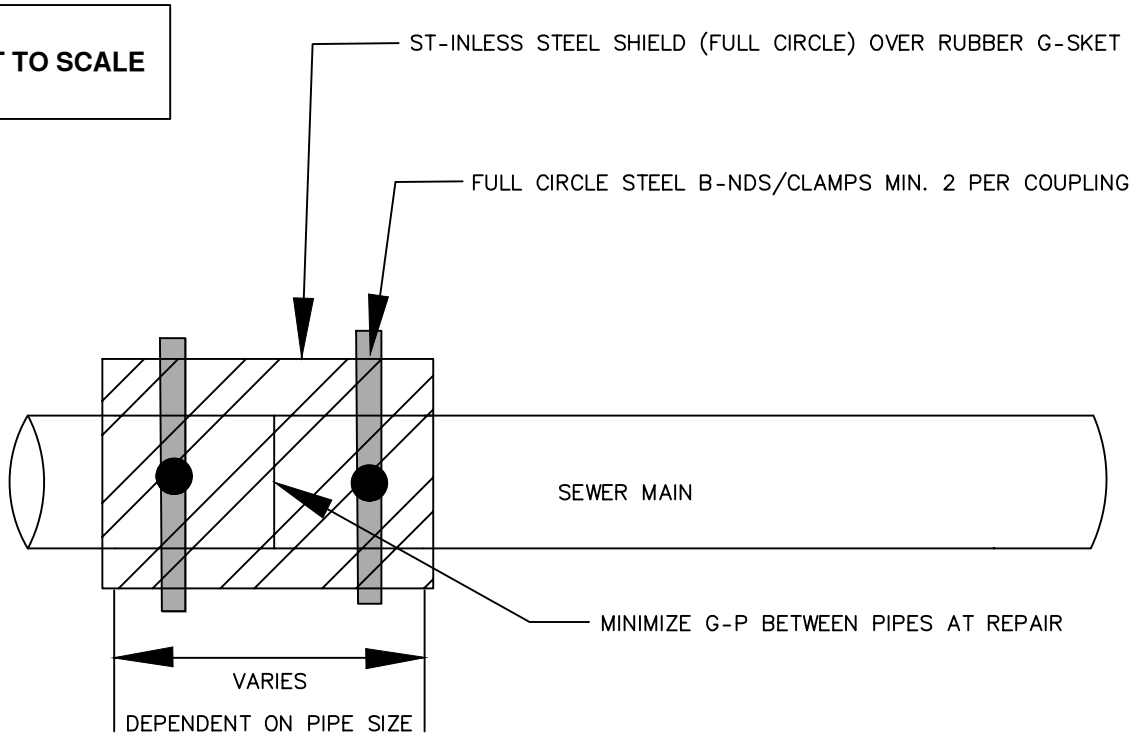
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

SEWER SERVICE LINE DOUBLE CLEANOUT

SHEET
SD - 13

DATE:
05/30/2025

NOT TO SCALE



NOTES:

1. -LL SEWER REP-IRS ON CITY MAINS SHALL UTILIZE PRE—F-BRICATED RIGID COUPLINGS. FLEXIBLE COUPLINGS ARE NOT PERMITTED.
2. FLEXIBLE GASKET UNDERNEATH THE SHE-R RING SHALL MEET -STM D5926 -ND -STM C 1173 STEEL.
4. SHEER RING/SHIELD TO BE A MINIMUM OF 0.12" THICK, 300 SERIES STEEL.
5. CLAMPS COMPRISED OF HOUSING, BAND AND SCREW, INSTALL TORQUE 60" LBS.
6. COUPLING TYPE SHALL BE ON THE LIST OF PRE--PPROVED MATERI-LS OR PRE—APPROVED BY THE CITY PRIOR TO INST-LL-TION.
7. CR-DLES REQUIRED FOR -NY REPAIRS TH-T INVOLVES - CH-NGE IN MATERI-L.
8. -LL STORM SEWERS SH-LL BE CONSTRUCTED SO TH-T THE MINIMUM COVER IS M-INT-INED TO WITHST-ND --SHTO HS—20 LO-DING ON THE PIPE.
9. THE MINIMUM COVER SH-LL NOT BE LESS TH-N 36—INCHES -T -NY POINT ALONG THE PIPE.
10. MINIMUM VERTIC-L CLEARANCE OF 18—INCHES BETWEEN THE STORM SEWER AND ANY OTHER UTILITY CROSSING, UNLESS OTHERWISE INSTRUCTED BY UTILITY PROVIDER AND APPROVED BY THE ENGINEER. IF 18—INCHES OF VERTICAL CLE-R-NCE CANNOT BE MAINTAINED, -DDITION-L MEASURES WILL BE REQUIRED. WHICH M-Y INCLUDE CONCRETE CRADLES, ENCASEMENTS, OR OTHER IMPROVEMENTS -S DIRECTED BY THE ENGINEER.
11. THE CONTR-CTOR SHALL W-LK THE SITE WITH THE ENGINEER AND CITY FORESTER TO IDENTIFY POTENTI-L TREE IMPACTS, TREES OF SPECI-L CONCERN FOR PRESERVATION, AND TREES TH-T -RE IN POOR/DE-D CONDITION TH-T WILL REQUIRE REMOV-L.
12. TREE PROTECTION ZONE (TPZ) SHALL BE IDENTIFIED DURING INITIAL FORESTER SITE VISIT. THE TPZ IS -PPROXIMATELY 1.5 FEET OR EVERY 1 FOOT OF TREE TRUNK DI-METER. (MEASURED -T 4.5 FEET ABOVE GR-DE)
13. NO VEHICLE OR M-TERIAL STORAGE, TRENCHING, GR-DING OR EXC-V-TION WITHIN TPZ.

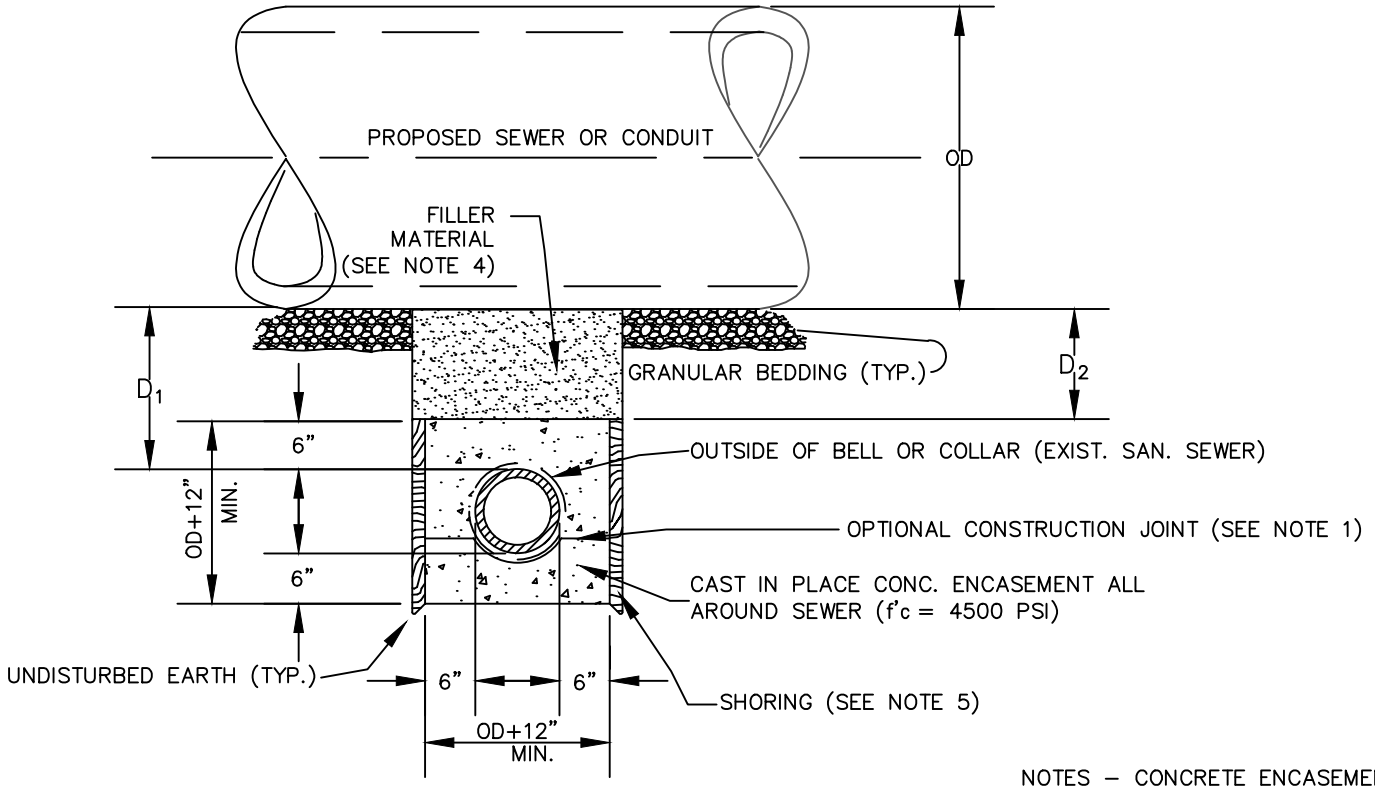
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

SEWER REPAIR

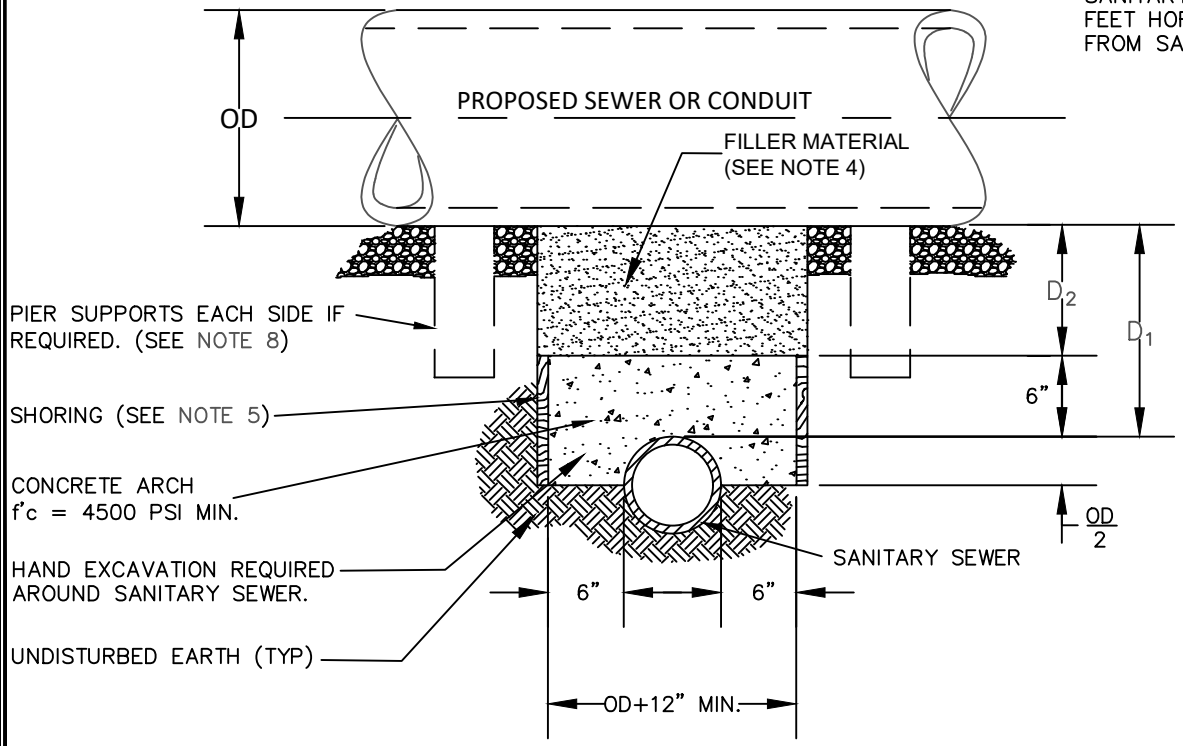
SHEET
SD - 14

DATE: 05/30/2025

PIPE ENCASEMENT TO BE 10 FEET MINIMUM OF OUTERWALL OF CROSSING PIPE



NOTES – CONCRETE ENCASEMENT REQUIRED OF WATER LINE WITH 12" OR LESS. MINIMUM 2 FEET VERTICAL SEPARATION FROM SANITARY AND STORM PIPE AND 5 FEET HORIZONTAL SEPARATION FROM SANITARY AND STORM.



FULL ENCASEMENT WILL BE REQUIRED FOR CLEARANCE LESS THAN 2 FEET AND APPROVAL FROM THE CITY OF LITTLETON. CONFIRM WITH SPECIFIC PROVIDER IF OTHER UTILITY TAKES PRECEDENT ON JOB SITE.

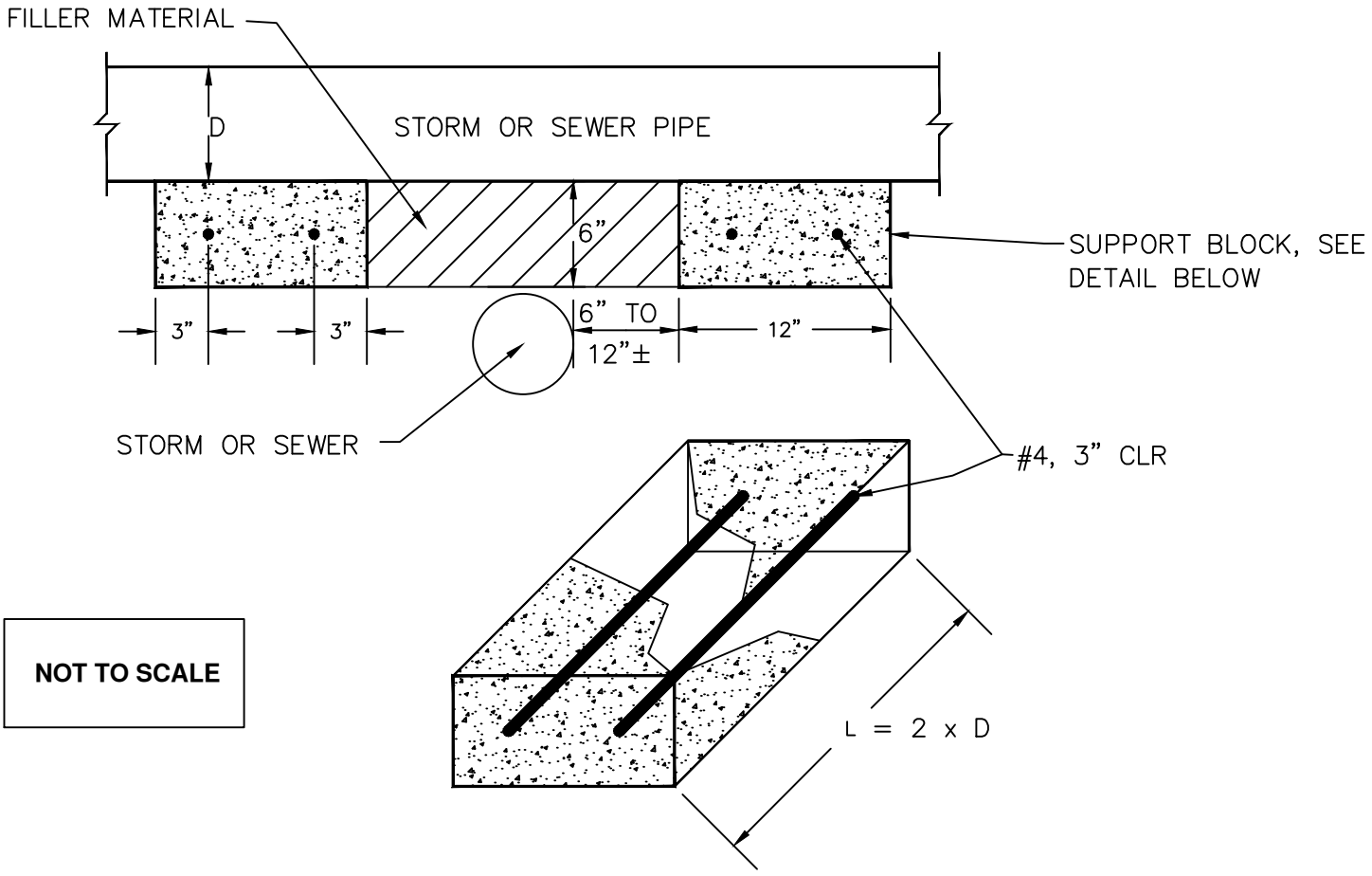
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

PIPE ENCASEMENTS

SHEET
SD - 15

DATE: 05/30/2025



NOT TO SCALE

PIPE SUPPORT ENCASEMENT TYPE

NOTES:

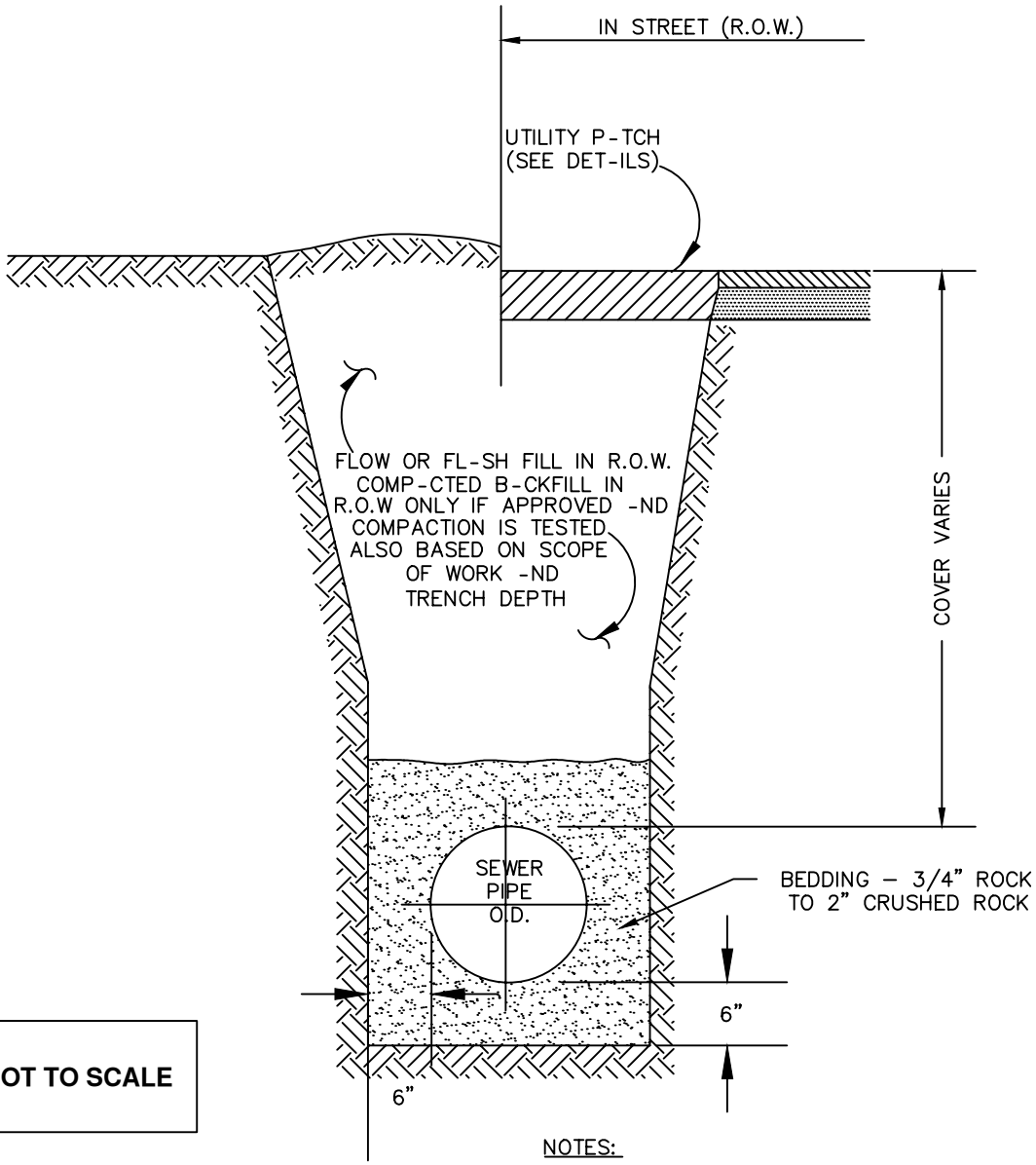
1. CONCRETE TO BE CAST AGAINST UNDISTURBED SOIL OR SHORING. IF OPTIONAL CONSTRUCTION JOINT IS USED AND BOTTOM HALF OF ENCASEMENT IS POURED SEPARATELY, A ONE INCH LAYER OF SAND OR MORTAR SHALL BE PLACED BETWEEN BOTTOM OF SANITARY SEWER AND TOP OF CONCRETE.
2. ENCASEMENT SHALL EXTEND FULL TRENCH WIDTH EXCAVATED FOR PROPOSED SEWER OR CONDUIT.
3. UNLESS OTHERWISE NOTED ON PLAN/PROFILE DRAWINGS, ENCASEMENTS NEED NOT BE REINFORCED. REINFORCEMENT, IF REQUIRED, TO BE SPECIFIED AND DETAILED SEPARATELY ON PLAN & PROFILE DRAWINGS.
4. FILLER MATERIAL BETWEEN OR ABOVE CONDUITS TO BE:
   (A) APPROVED COMPRESSIBLE MATERIAL SUCH AS STYROFOAM, ETC., IF $D_2 \leq 6"$.
   (B) COMPACTED GRANULAR BEDDING IF $D_2 > 6"$. (IF $D_2 > 6"$ FOR TYPE IIB ENCASEMENT POUR CONCRETE ON UNDISTURBED SOIL).
   (C) OR DICTATED BY UTILITY OWNER.
5. SHORING OR SHEETING, IF USED, TO BE CUT OFF AT TOP OF ENCASEMENT.
6. THESE ENCASEMENT DETAILS MAY ALSO BE APPLICABLE FOR CONDUITS OTHER THAN STORM OR SANITARY SEWER INSTALLATIONS. FOR SEWERS OR STORMS OVER OR UNDER WATER MAINS, SEE DENVER WATER DEPARTMENT STANDARD DETAILS.
7. IN CERTAIN SITUATIONS WHERE THE EXISTING CONDUIT DIAMETER IS EXTREMELY LARGE, PIER SUPPORTS ON EACH SIDE OF SANITARY SEWER MAY ALSO BE REQUIRED. IF REQUIRED, SUPPORTS TO BE SPECIFIED AND DETAILED SEPARATELY ON PLAN AND PROFILE DRAWINGS.
8. TYPE OF ENCASEMENT OR NEED FOR REINFORCEMENT SHALL BE PER ENGINEER RECOMMENDATIONS BASED ON PROJECT SPECIFIC CONDITIONS AND NEEDS.

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

PIPE ENCASEMENTS (2)

SHEET
SD - 16

DATE:
05/30/2025



NOT TO SCALE

BEDDING GRADATION	
SIEVE %	P-SSING WEIGHT
3/8"	100
NO. 200	0–5

NOTES:

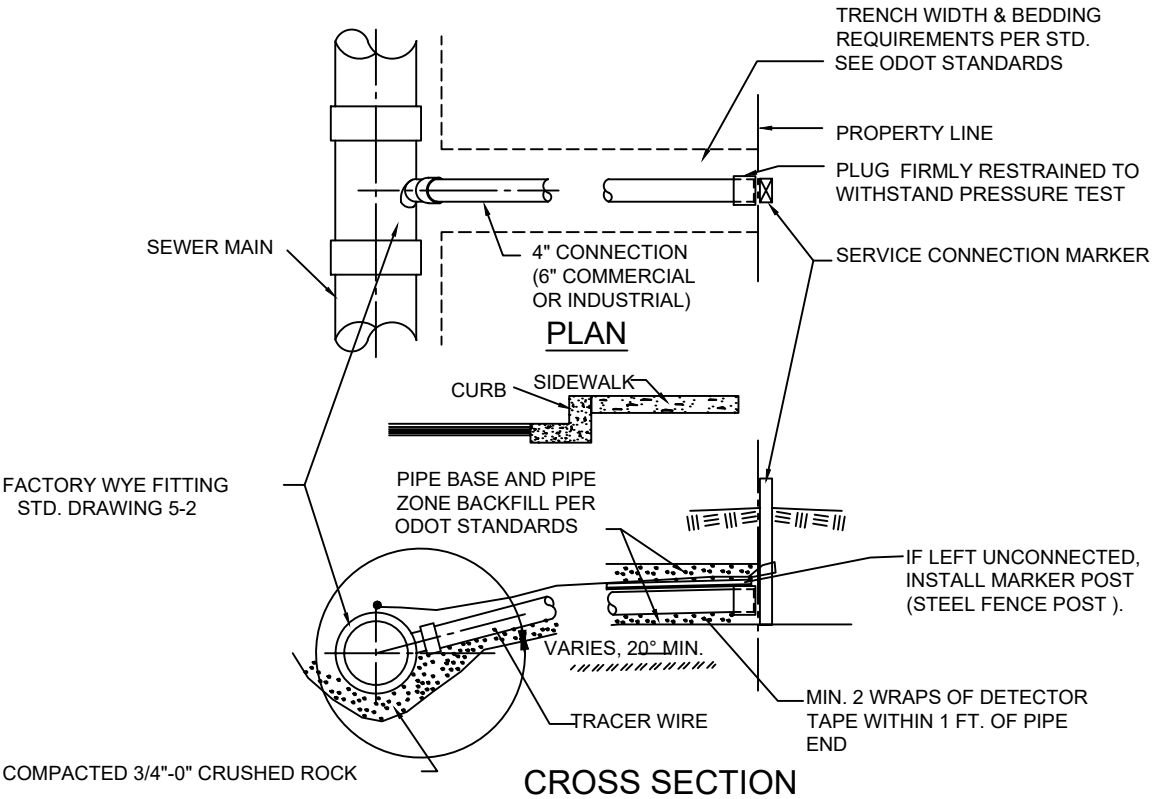
1. SEE SEP-R-TE DETAILS FOR UTILITY PATCHES IN ASPH-LT.
2. THE CITY REQUIRES COMP-CTION TESTS BE PROVIDED BY -N INDEPENDENT GEOTECHNIC-L ENGINEER UNLESS FLOW-BLE BACKFILL IS USED. FLOW FILL SH-LL BE SUBJECT TO CITY APPROVAL.
3. BEDDING SHALL BE FROM 6" BELOW THE PIPE TO SPRING LINE FOR CONCRETE PIPE ONLY. FOR ALL OTHER PIPE TYPES, BEDDING SH-LL EXTEND TO 12"ABOVE THE PIPE (SEE CH-RT FOR MATERI-L TYPE -ND SIZE..
4. TRENCH TO BE BR-CED OR SHEETED -S NECESSARY FOR THE SAFETY OF THE WORKMEN -ND THE PROTECTION OF OTHER UTILITIES PER OSHA REQUIREMENTS.
5. IF GROUND W-TER IS PRESENT AND SUIT-BLE/ST-BLE SOIL IS ENCOUNTERED. SUB–BEDDING -ND GEO–TEXTILE FABRIC IS REQUIRED. IF GROUND WATER AND ST-BLE SOIL IS PRESENT, INCREASE DEPTH -S SHOWN USING NO.67 BEDDING PER ENGINEERING EVALUATION -ND -PPROV-L.
6. TAPE TRACER WIRE (TW) TO TOP OF PIPE.

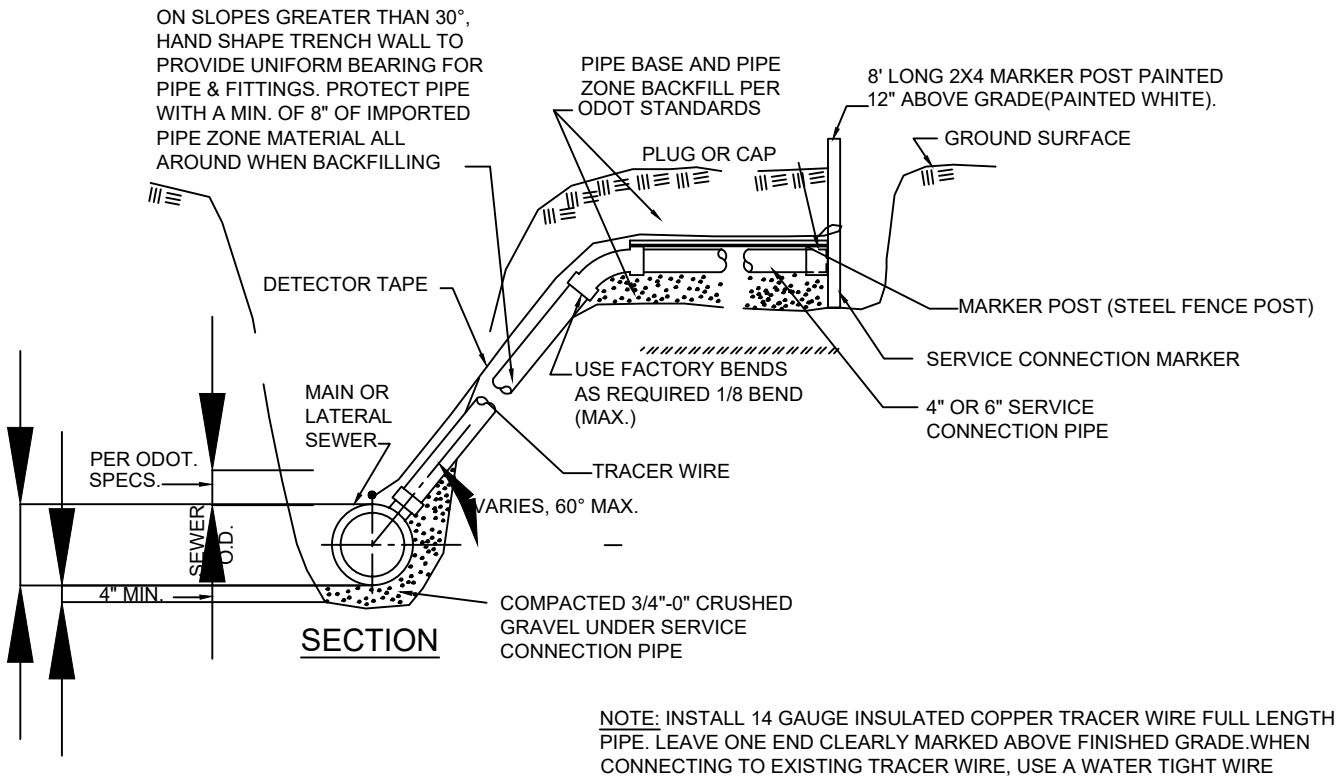
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

TYPICAL SEWER TRENCH

SHEET
SD - 17

DATE: 05/30/2025





STANDARD SERVICE CONNECTION DETAIL FOR DEEP TRENCHES AT DISCRETION OF DISTRICT ENGINEER

NOTE: INSTALL 14 GAUGE INSULATED COPPER TRACER WIRE FULL LENGTH OF PIPE. LEAVE ONE END CLEARLY MARKED ABOVE FINISHED GRADE.WHEN CONNECTING TO EXISTING TRACER WIRE, USE A WATER TIGHT WIRE CONNECTOR OR INSTALL C.O WITH BOTH ENDS OF TRACER WIRE CLEARLY EXPOSED ABOVE FINISHED GRADE.

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

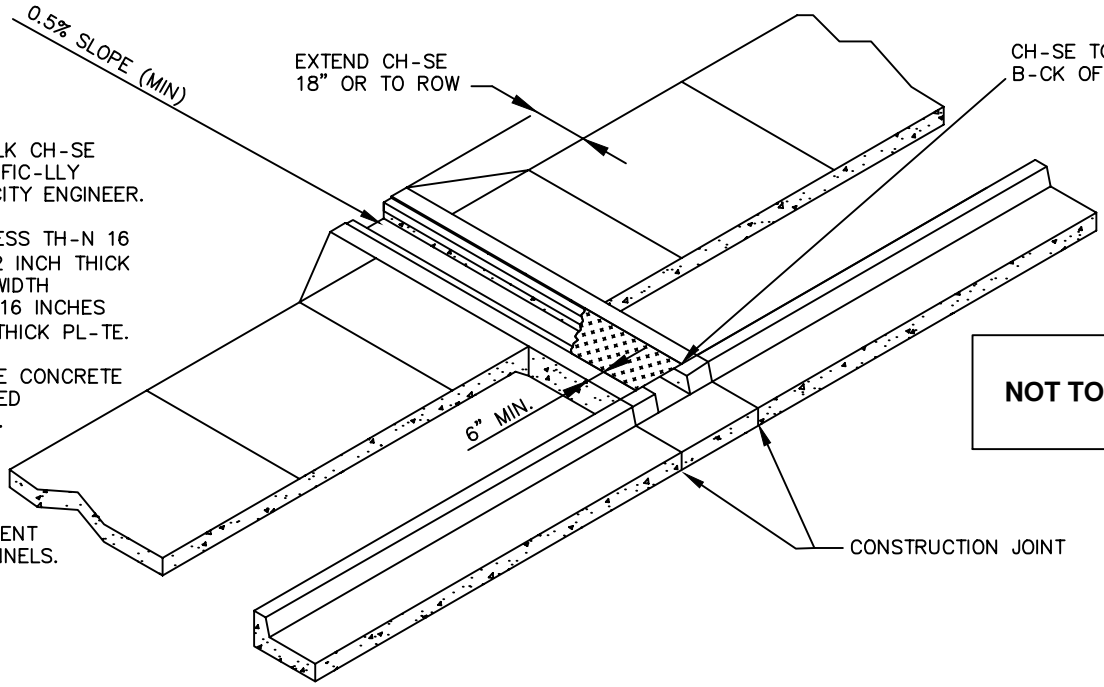
SEWER STUBOUT MARKER

SHEET
SD - 18

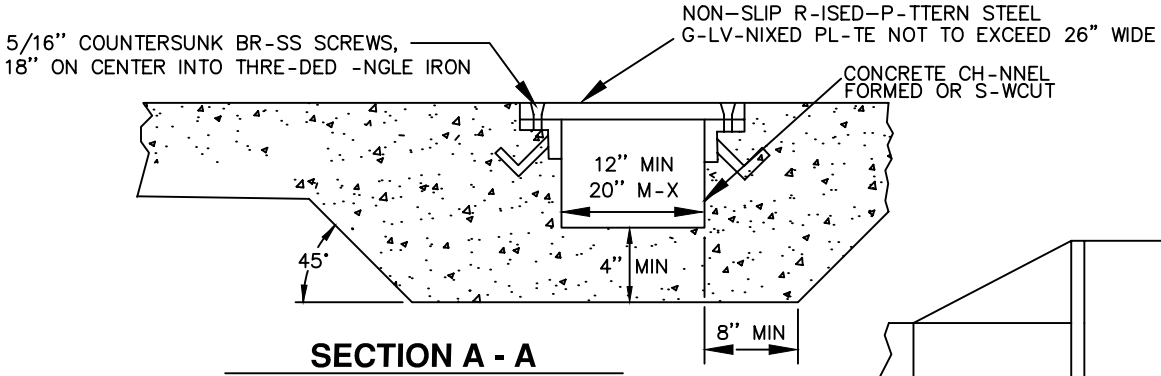
DATE: 05/30/2025

NOTE:

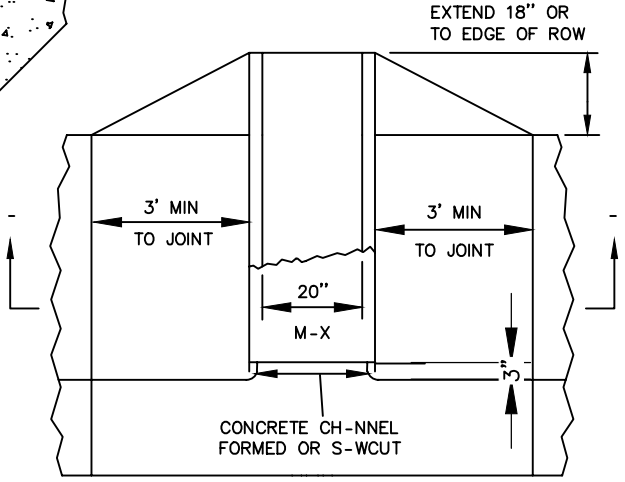
1. USE OF SIDEW-LK CH-SE SH-LL BE SPECIFIC-LLY -PPROVED BY CITY ENGINEER.
2. CH-SE WIDTH LESS TH-N 16 INCHES USE 1/2 INCH THICK PL-TE. CH-SE WIDTH GRE-TER TH-N 16 INCHES USE 5/8 INCH THICK PL-TE.
3. SIDEW-LK CH-SE CONCRETE SH-LL BE PL-CED MONOLITHIC-LLY.
4. FOR MULTIPLE OPENINGS, 12" (MIN) BETWEEN -DJ-CENT CONCRETE CH-NNELS.

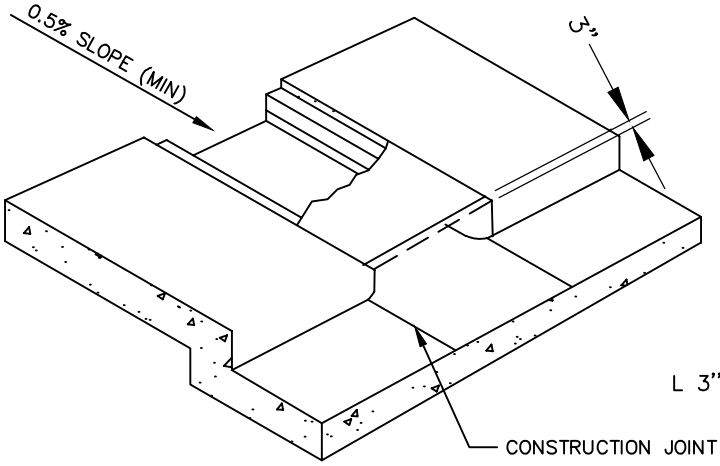


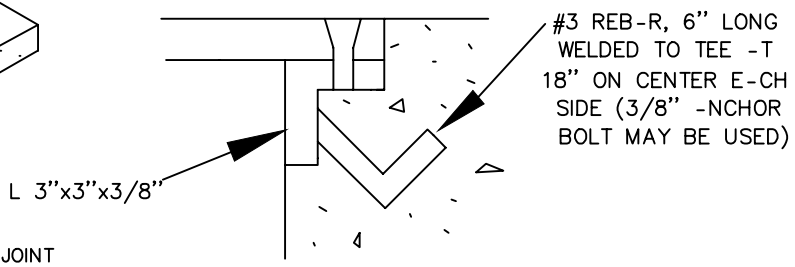
NOT TO SCALE



SECTION A - A





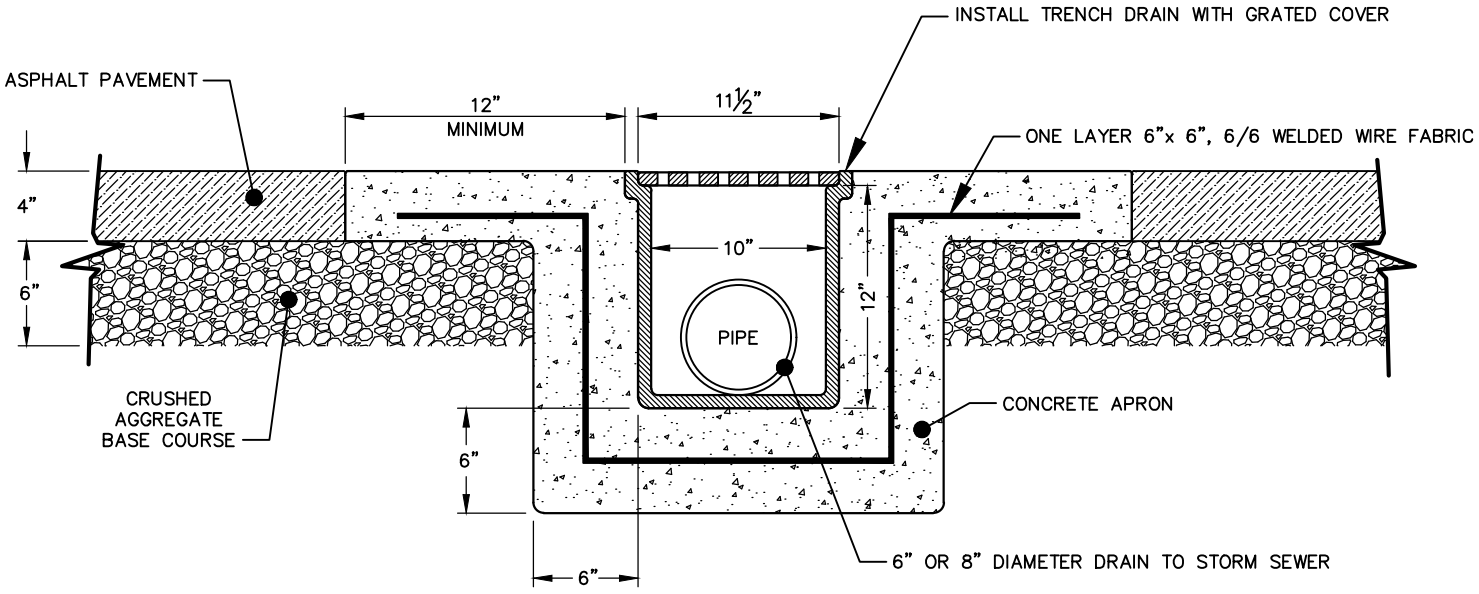


Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

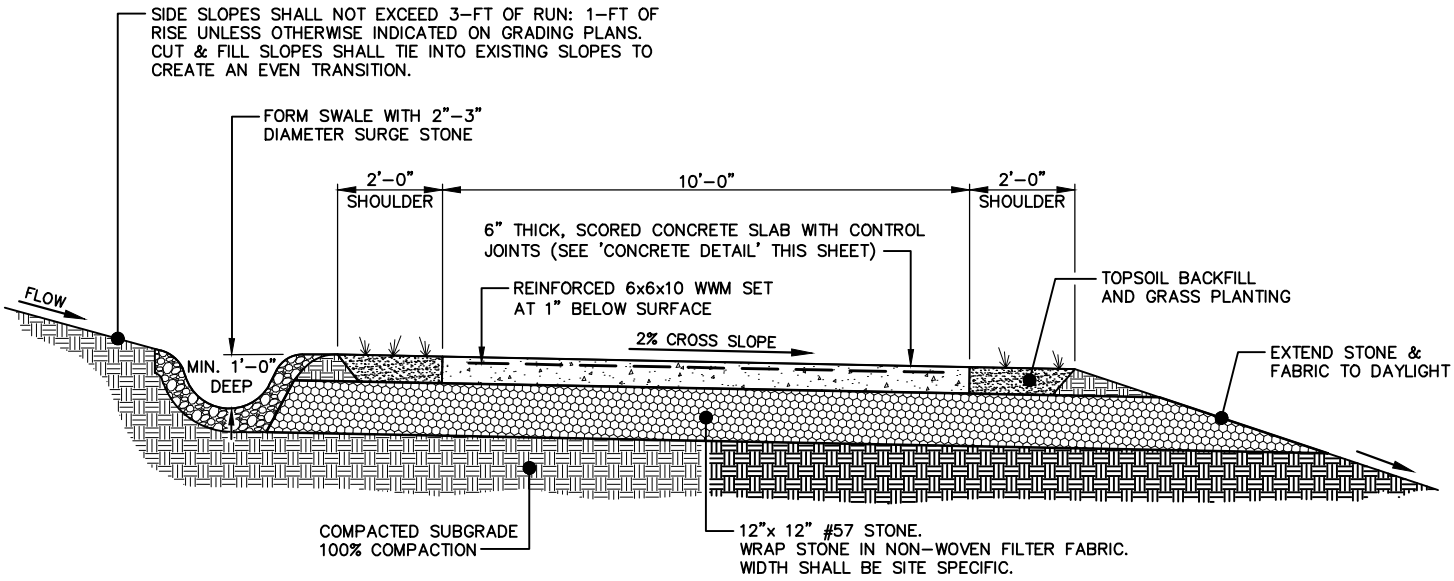
SIDEWALK CHASE

SHEET
SD - 19

DATE: 05/30/2025



SECTION VIEW



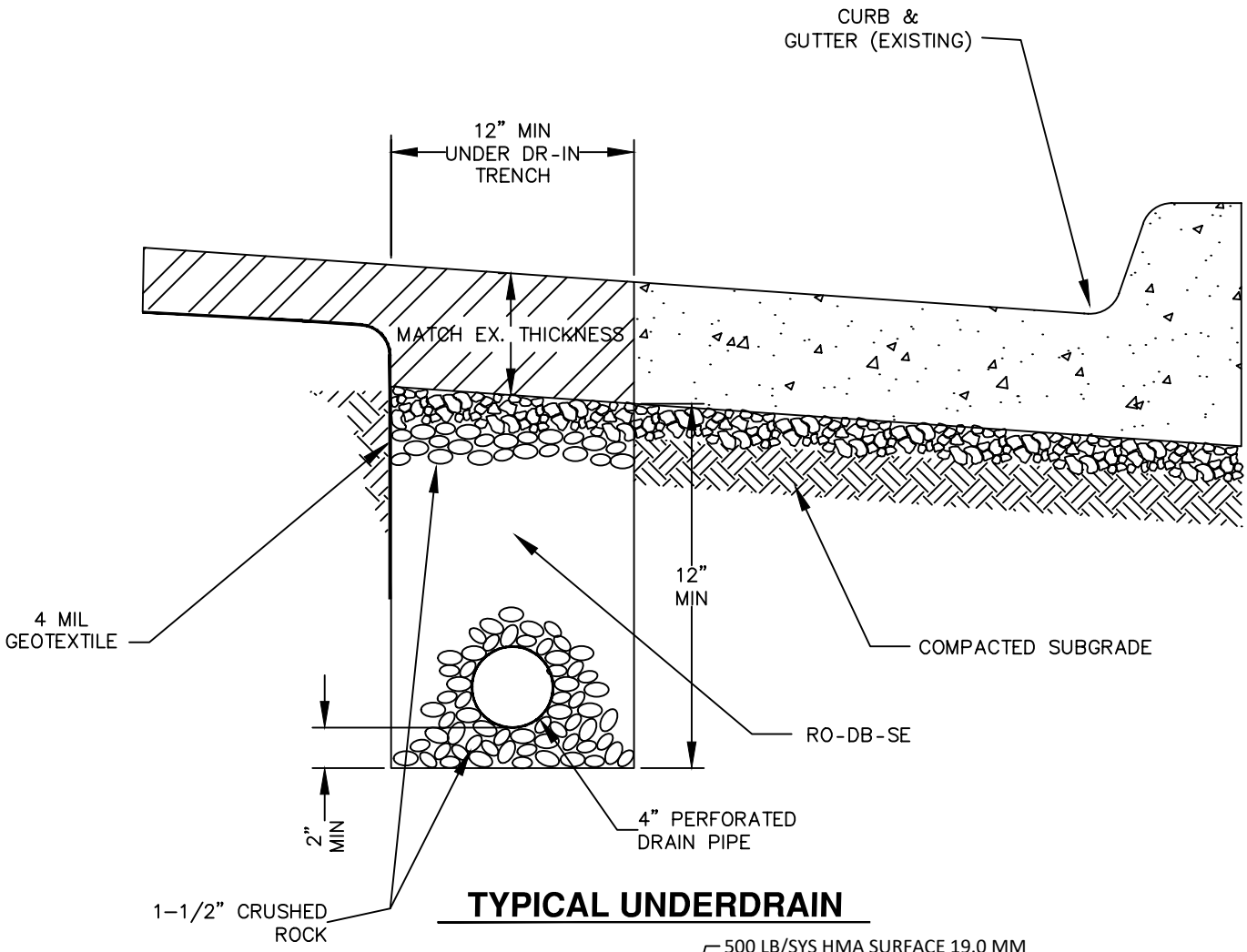
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

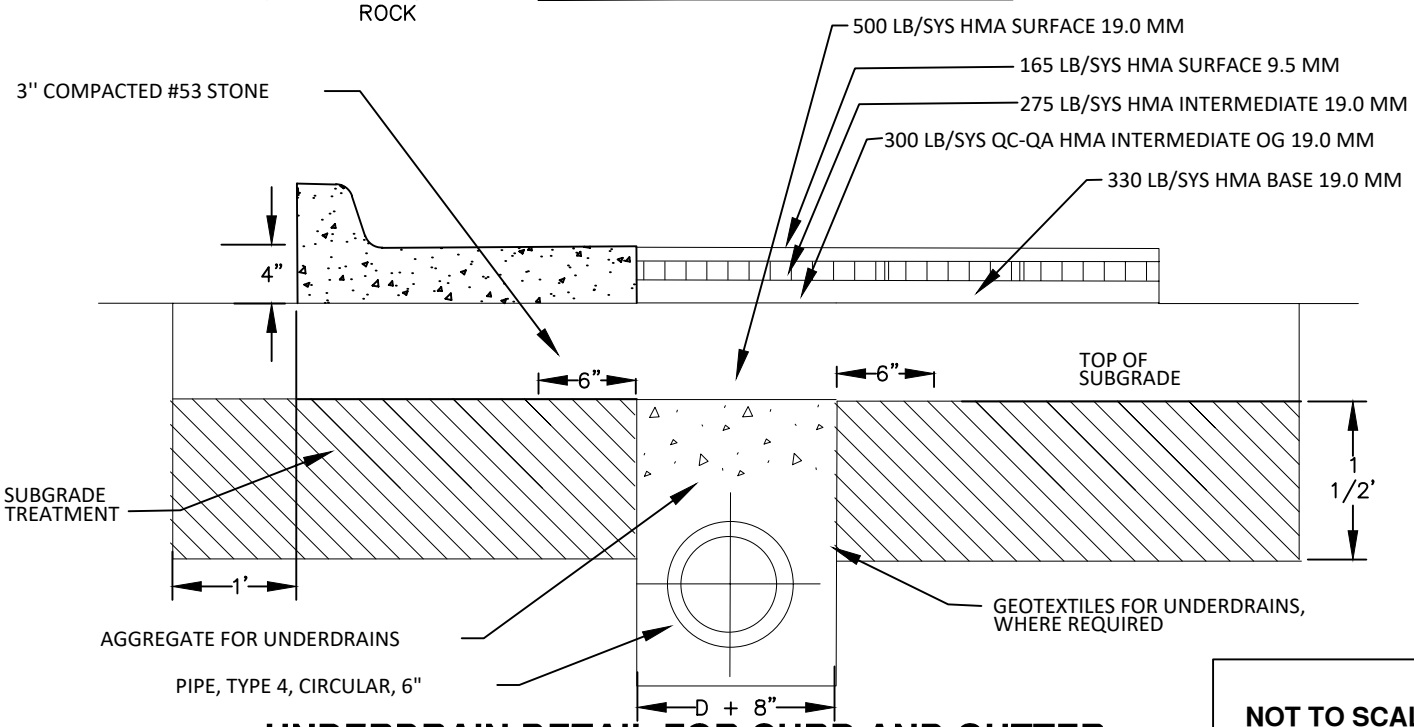
UNDERDRAIN

SHEET
SD - 20

DATE:
05/30/2025



TYPICAL UNDERDRAIN



UNDERDRAIN DETAIL FOR CURB AND GUTTER

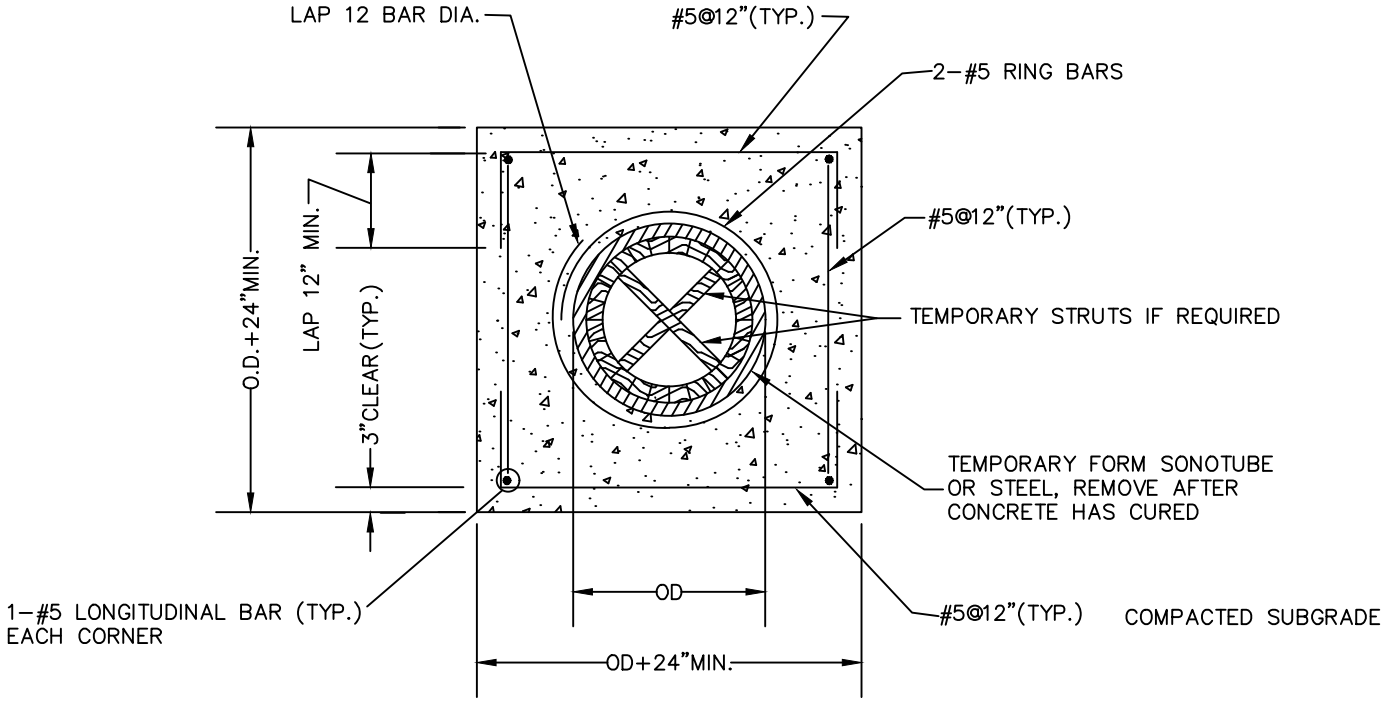
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

UNDERDRAIN (2)

SHEET
SD - 21

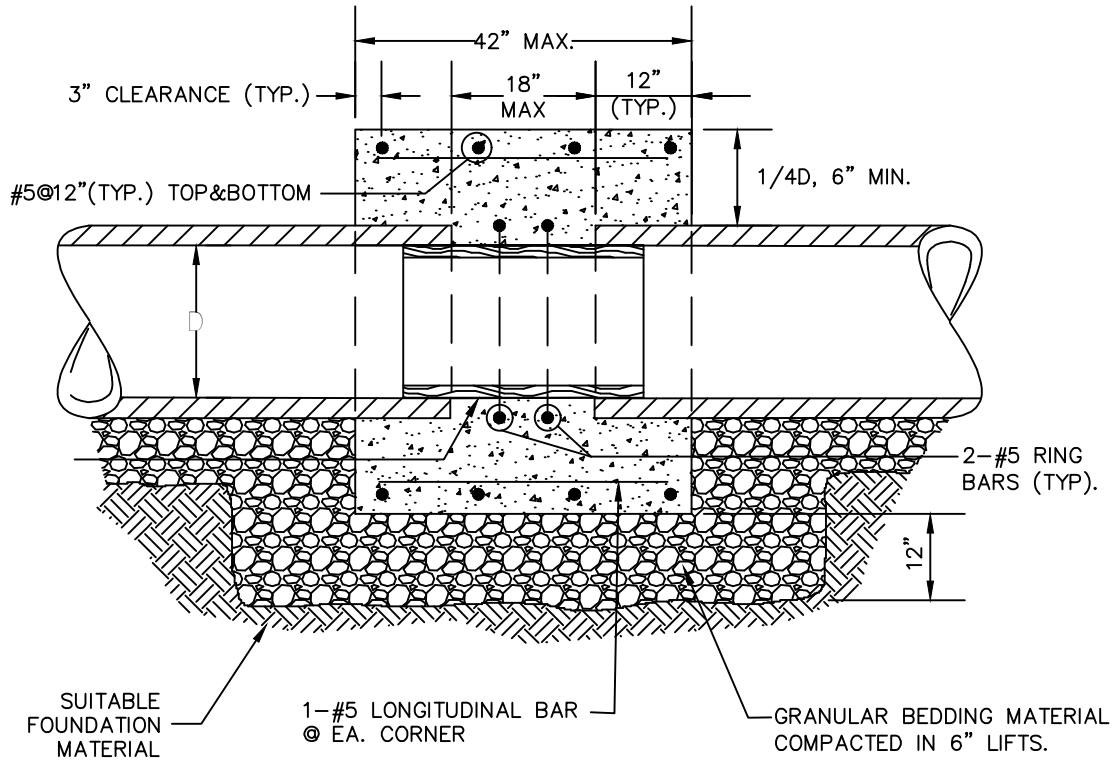
DATE:
05/30/2025



PLAN

NOT TO SCALE

**ALL REBAR WITH BE COATED WITH EPOXY COATING INCLUDING TIES AND CUT REBAR



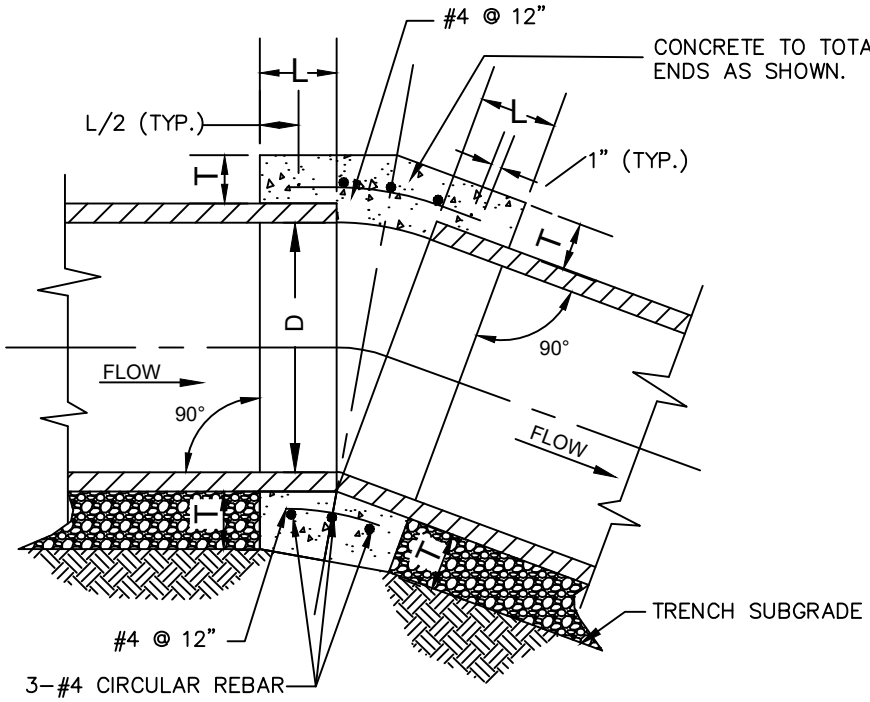
SECTION

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

CONCRETE COLLAR (STORM)

SHEET
SD - 22

DATE: 05/30/2025

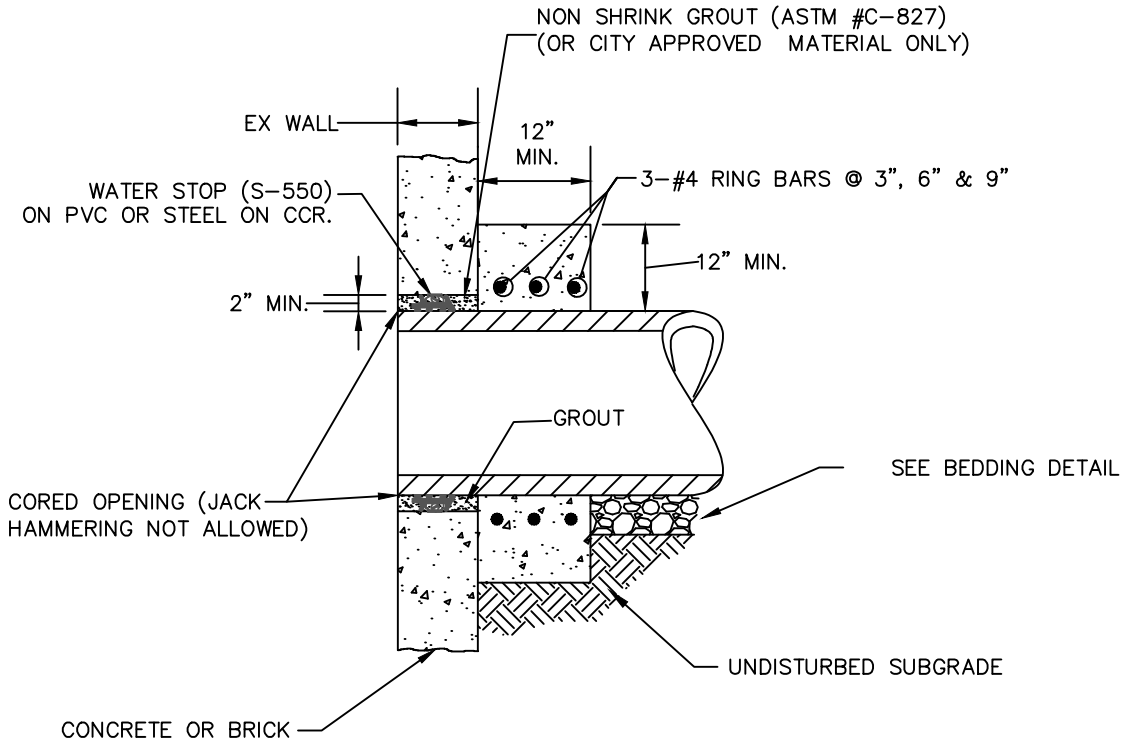


MIN. PIPE COLLAR DIMENSIONS		
D	L	T
15"	18"	12"
18"	18"	12"
21"	18"	12"

COLLAR - VERTICAL DEFLECTION

NOT TO SCALE

**ALL REBAR WITH BE COATED WITH EPOXY COATING INCLUDING TIES AND CUT REBAR



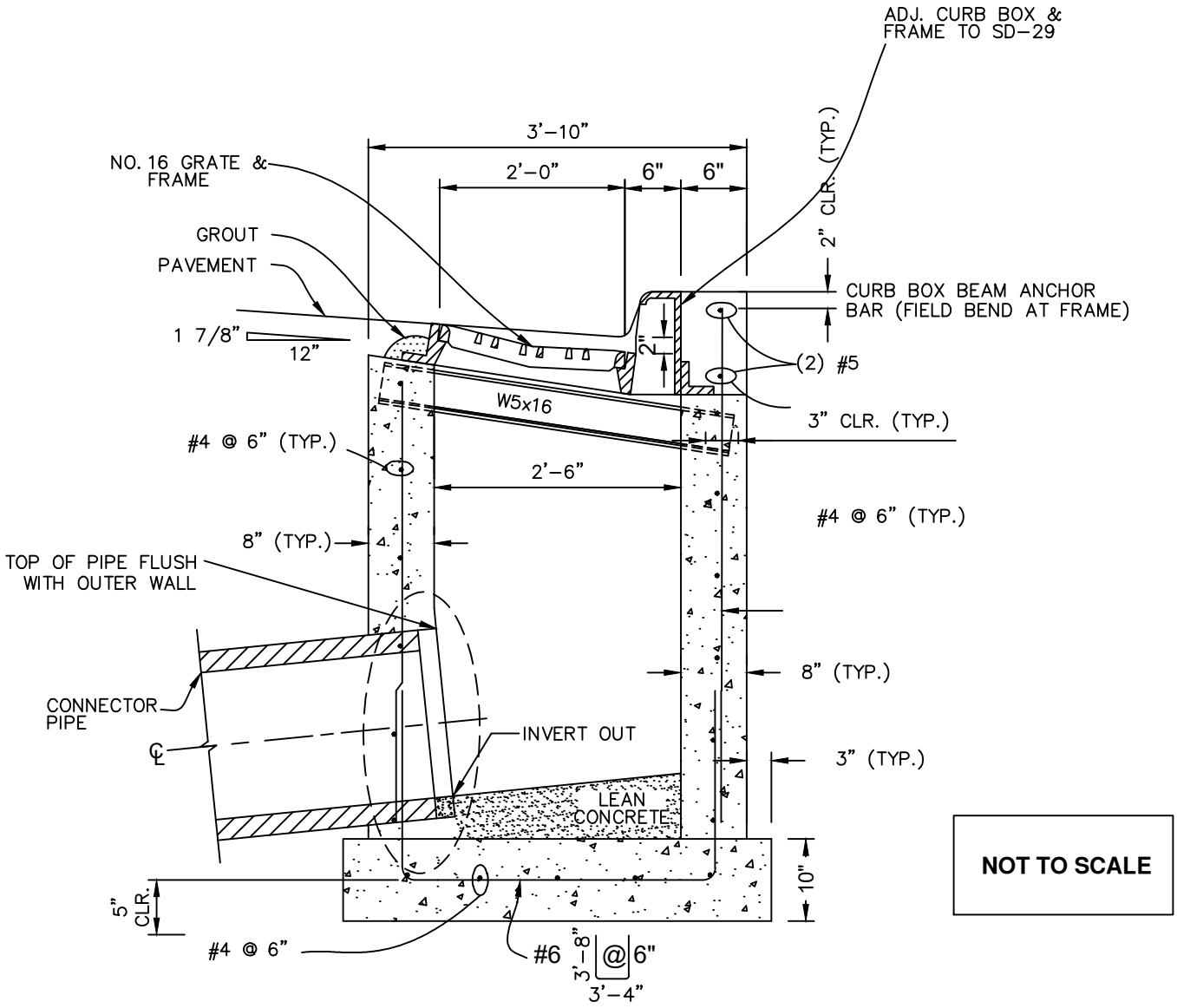
CONNECTION TO EXISTING INLET OR STRUCTURE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

CONNECTIONS TO EXISTING STRUCTURE

SHEET
SD - 23

DATE: 05/30/2025



NOT TO SCALE

INLET TYPE COMBINATION (ALL) NOTES:

1 INLET STRUCTURES SHALL ALSO INCLUDE 2'-0" CURB & GUTTER TRANSITION SECTION AT EACH END OF INLET PLUS SIDEWALK SECTIONS WHERE REQUIRED BEHIND INLET STRUCTURE AND TRANSITION SECTIONS.

2 FLOOR SLOPE MAY BE POURED MONOLITHIC WITH BASE.

3 Sc = SLOPE OF CONNECTOR = 2% MIN.

4 UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS OR OTHERWISE APPROVED, ALL NO. 16 INLETS SHALL BE CONSTRUCTED WITH AN ADJUSTABLE CAST IRON CURB BOX.

5 DESIGN CONDITIONS FOR INLET ALLOWS DEPTHS OF 12'-0" (MAX.). FOR INLETS MORE THAN 12'-0" FEET IN DEPTH, SHOP DRAWINGS AND DESIGN ANALYSIS SHALL BE SUBMITTED FOR APPROVAL.

6 ALL REINFORCING STEEL SHALL BE ASTM, A-615, GRADE 60 DEFORMED BARS. DIAMETER OF BEND MEASURED ON THE INSIDE OF THE BAR SHALL BE A MINIMUM OF 6 BAR DIAMETER.

7 ALL SHALL CONFORM TO AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 8TH EDITION, 2017.

8 NO FORMWORK SHALL WORK REMAIN INSIDE STRUCTURE WHEN COMPLETE.

9 CONCRETE MIX FOR GUTTER AND ANY ADDED STREET PANELS SHALL MEET CLASS 2 REQUIREMENTS FOR SULFATE RESISTANCE IN ACCORDANCE WITH CDOT STANDARD 601.04 ON STREETS WHERE MAGNESIUM CHLORIDE CHEMICAL DEICERS ARE APPLIED. REFER TO WCPM STANDARD CONSTRUCTION SPECIFICATIONS SECTION 11 FOR REQUIREMENTS FOR SULFATE RESISTANCE IN CONCRETE EXPOSED TO EARTH.

10 SPLICING OF REINFORCING STEEL SHALL BE PERMITTED ONLY WHERE DETAILED IN DRAWINGS.

11 INLET WALLS SHALL BE FORMED BOTH INSIDE AND OUTSIDE. CASTING OF SIDEWALLS AGAINST EARTH IS NOT PERMITTED.

12 LEAN CONCRETE FILL TO BE F'C = 2000 PSI. INLET STRUCTURE, LID, STREET CURB AND GUTTER, AND PAVEMENT TO BE F'C = 4,500 PSI, MAX W/CM = 0.45 AND AIR ENTRAINED 5% TO 8%. F'C = 28 DAY COMPRESSIVE STRENGTH REQUIREMENT FOR MIX DESIGN, FIELD ACCEPTANCE.

13 NO CORNER PENETRATIONS ON STRUCTURE.

14 SEE DETAIL SD-20, DETAIL FOR REBAR PLACEMENT AT WALL PENETRATION DETAIL

15. EXPANSION JOINT MATERIAL SHALL BE PLACED FULL DEPTH OF THE CURB GUTTER, SIDEWALK, PAVEMENT, AS APPLICABLE. THE TOP PORTION OF JOINT SHALL BE SEALED WITH SILICONE SEALANT.

16. MAXIMUM LENGTH OF AN INLET SHALL NOT EXCEED THE LENGTH OF A TRIPLE UNIT UNLESS APPROVED FROM CITY ENGINEER.

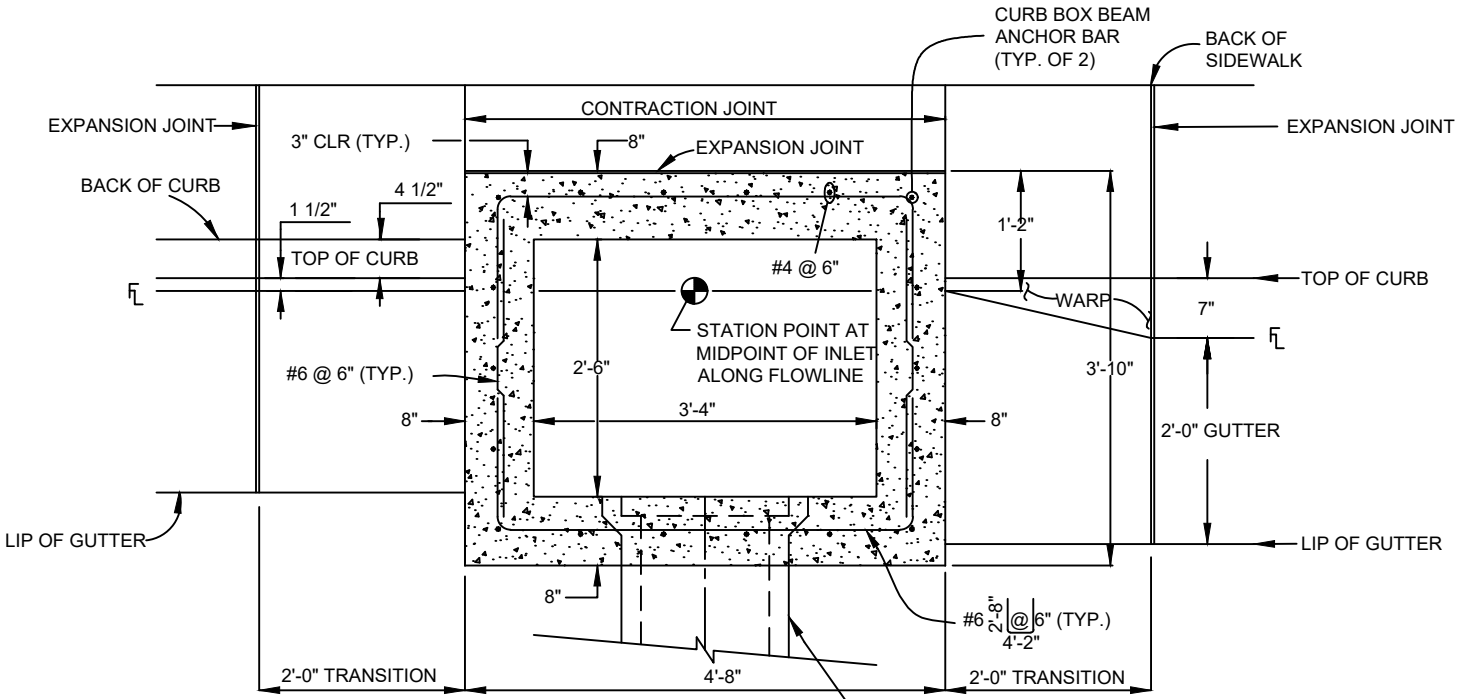
17. INLET SHALL NOT BE PLACED IN CURB RADII

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

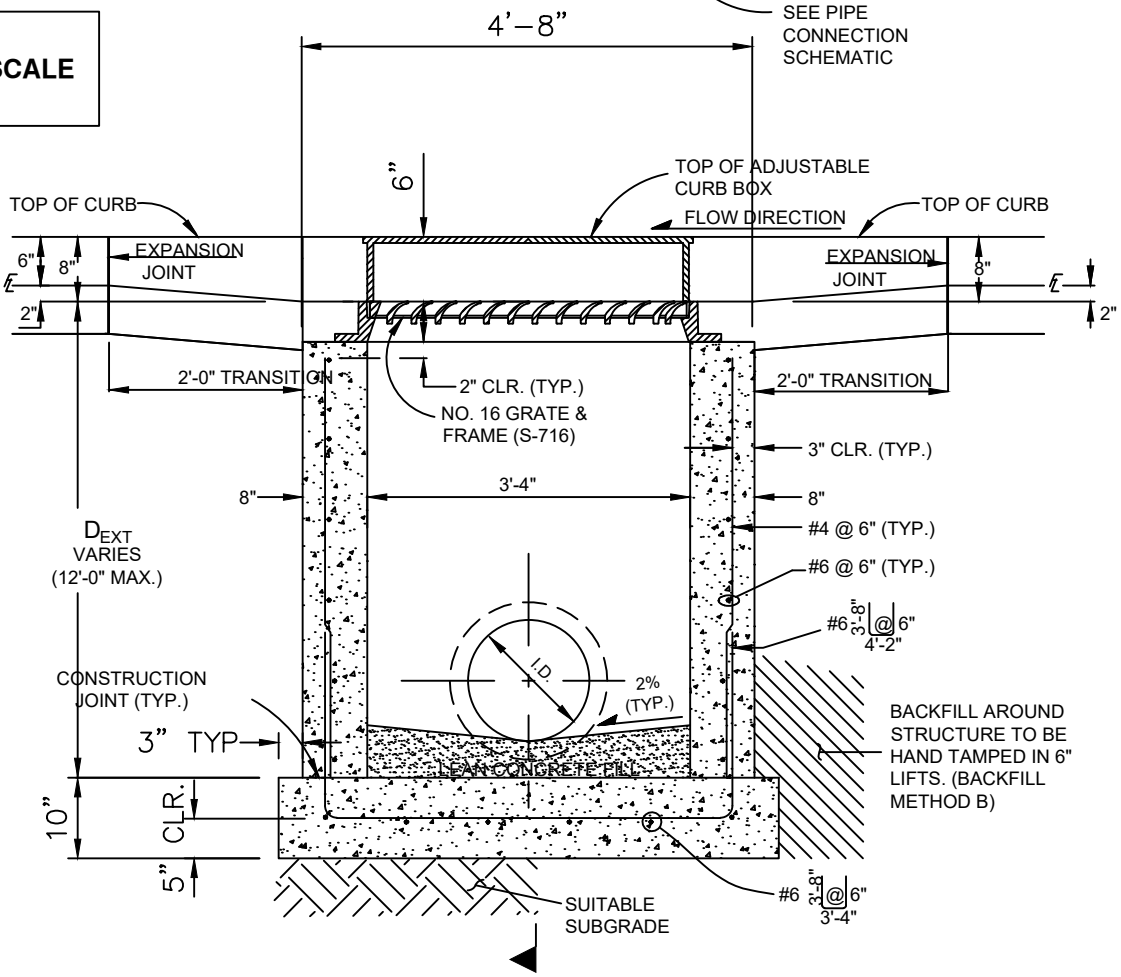
INLET TYPE 16 COMBINATION

SHEET
SD - 24

DATE:
05/30/2025



NOT TO SCALE

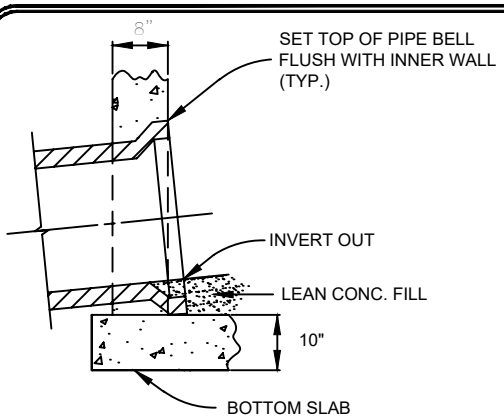


Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

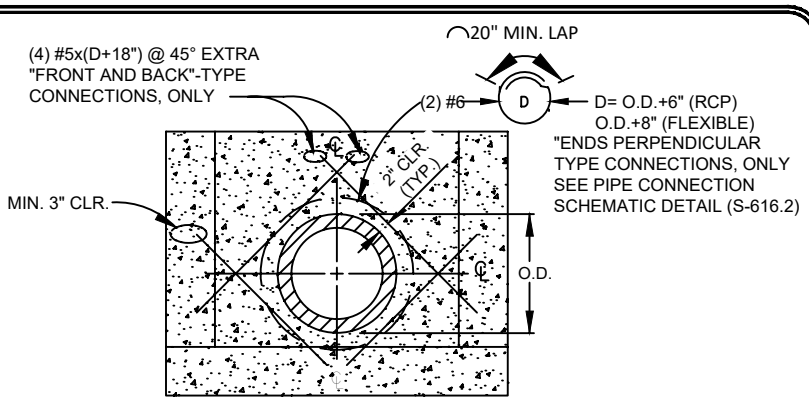
INLET TYPE 16 COMBINATION (2)

SHEET
SD - 25

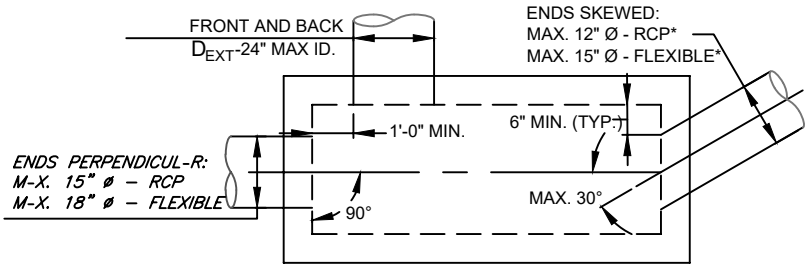
DATE: 05/30/2025



DETAIL - CONNECTOR OUTLET
NO SCALE



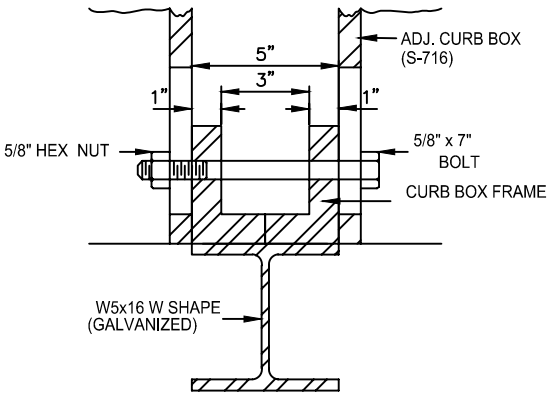
DETAIL - REBAR PLACEMENT AROUND CONNECTOR PIPE
NO SCALE



*ANGLED CONNECTIONS
REQUIRE CITY APPROVAL.

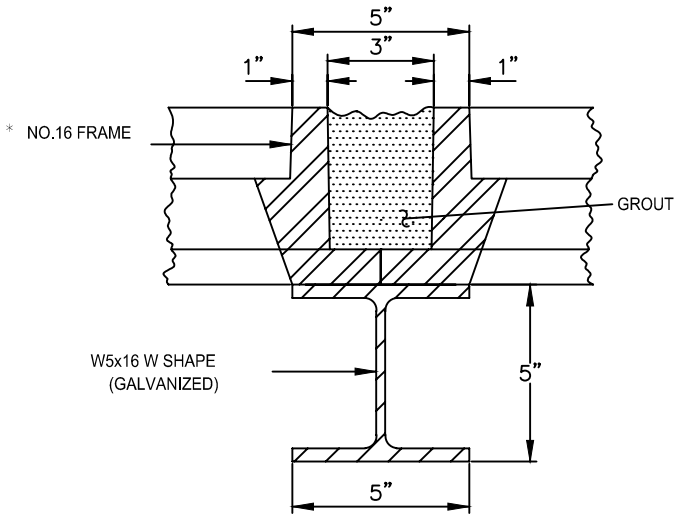
C / 17

PIPE CONNECTION SCHEMATIC (NO. 16 INLET)
THIS DIAGRAM IS PROVIDED FOR GENERAL GUIDANCE ONLY. THE DESIGNER IS RESPONSIBLE FOR VERIFYING PROJECT SPECIFIC GEOMETRY.



DETAIL - PLACEMENT OF ADJ. CURB BOX ON SUPPORT RAIL (TYP.)
NO SCALE

D,E / 16



DETAIL - FRAME PLACEMENT ON SUPPORT RAIL (TYP.)
NO SCALE

"Details adapted from the City of County of Denver Wastewater Standard Details, June 2020"

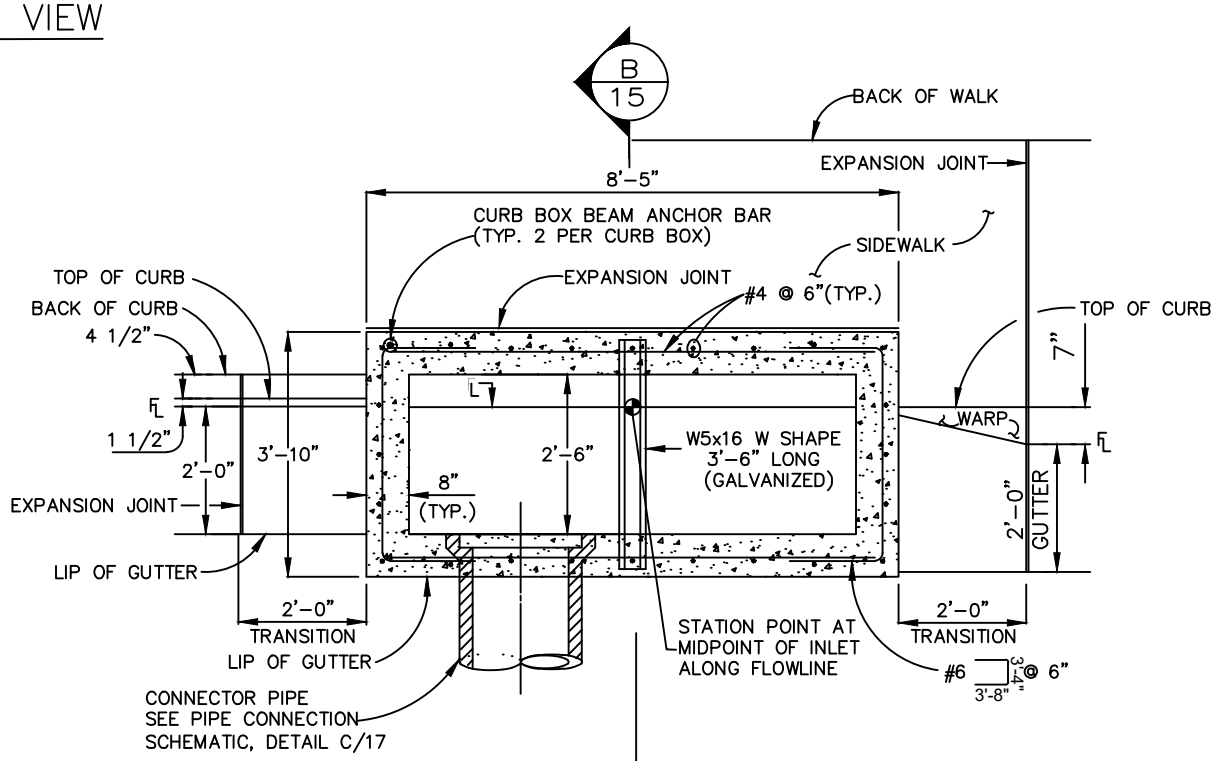
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INLET TYPE 16 COMBINATION (3)

SHEET
SD - 26

DATE:
05/30/2025

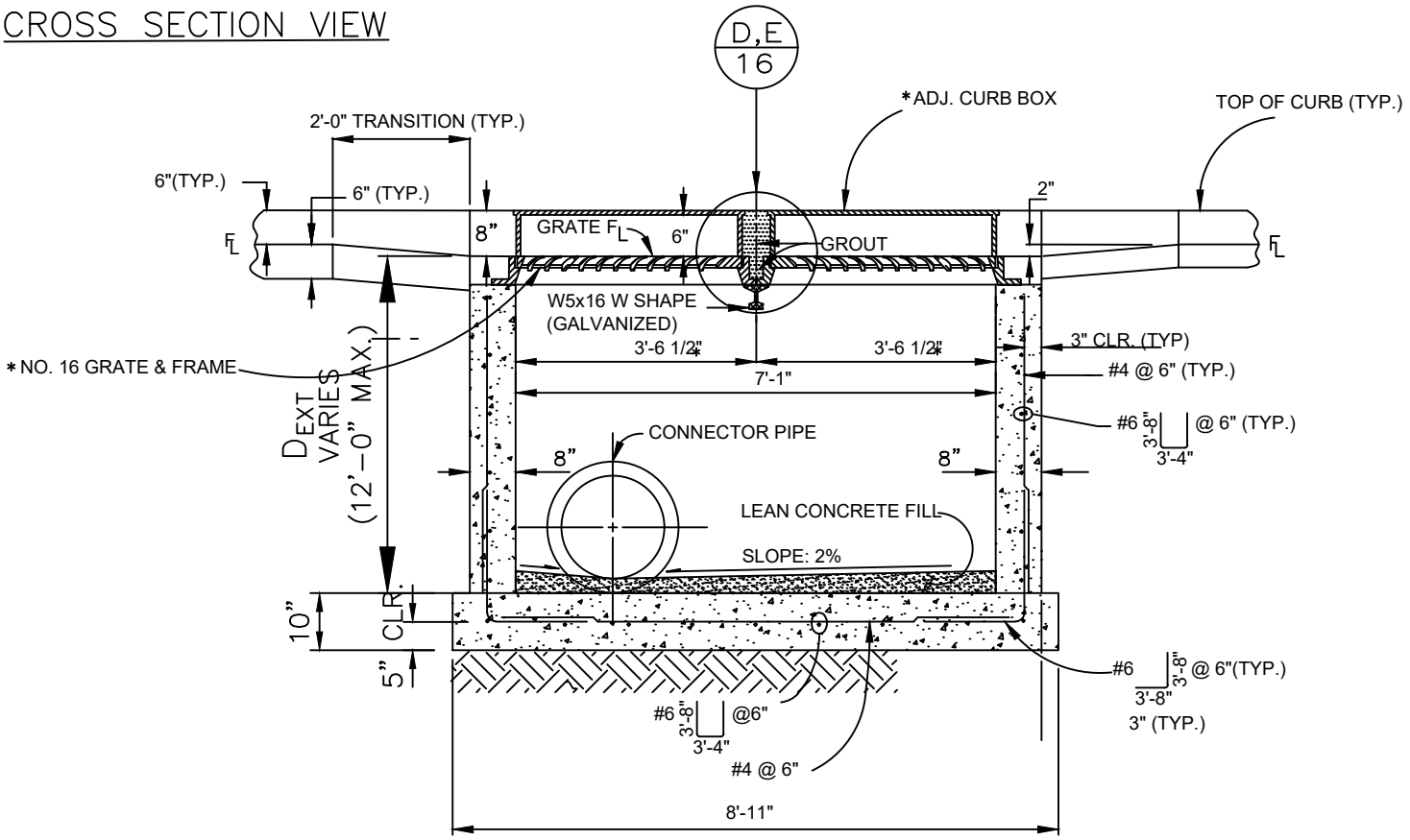
PLAN VIEW



6" VERTICAL CURB AND GUTTER

COMBINATION CURB GUTTER AND SIDEWALK

CROSS SECTION VIEW



"Details adapted from the City of County of Denver Wastewater Standard Details, June 2020"

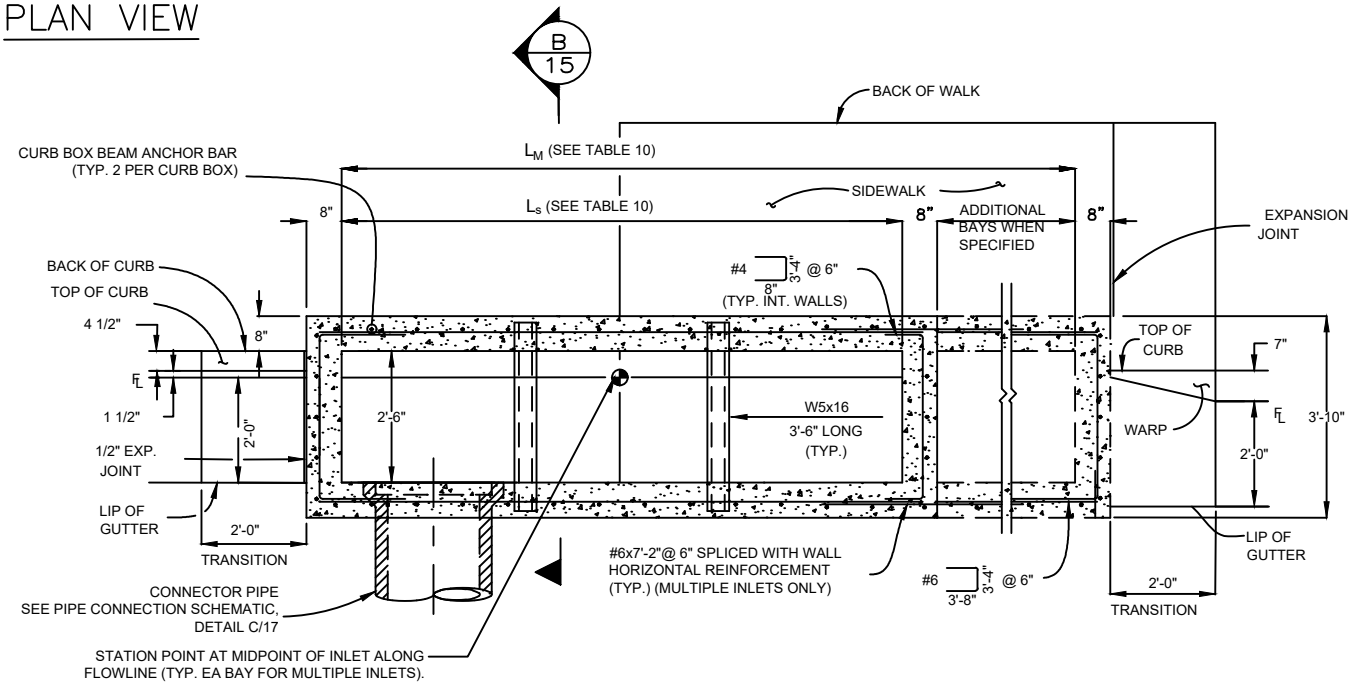
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INLET TYPE 16 COMBINATION DOUBLE

SHEET
SD - 27

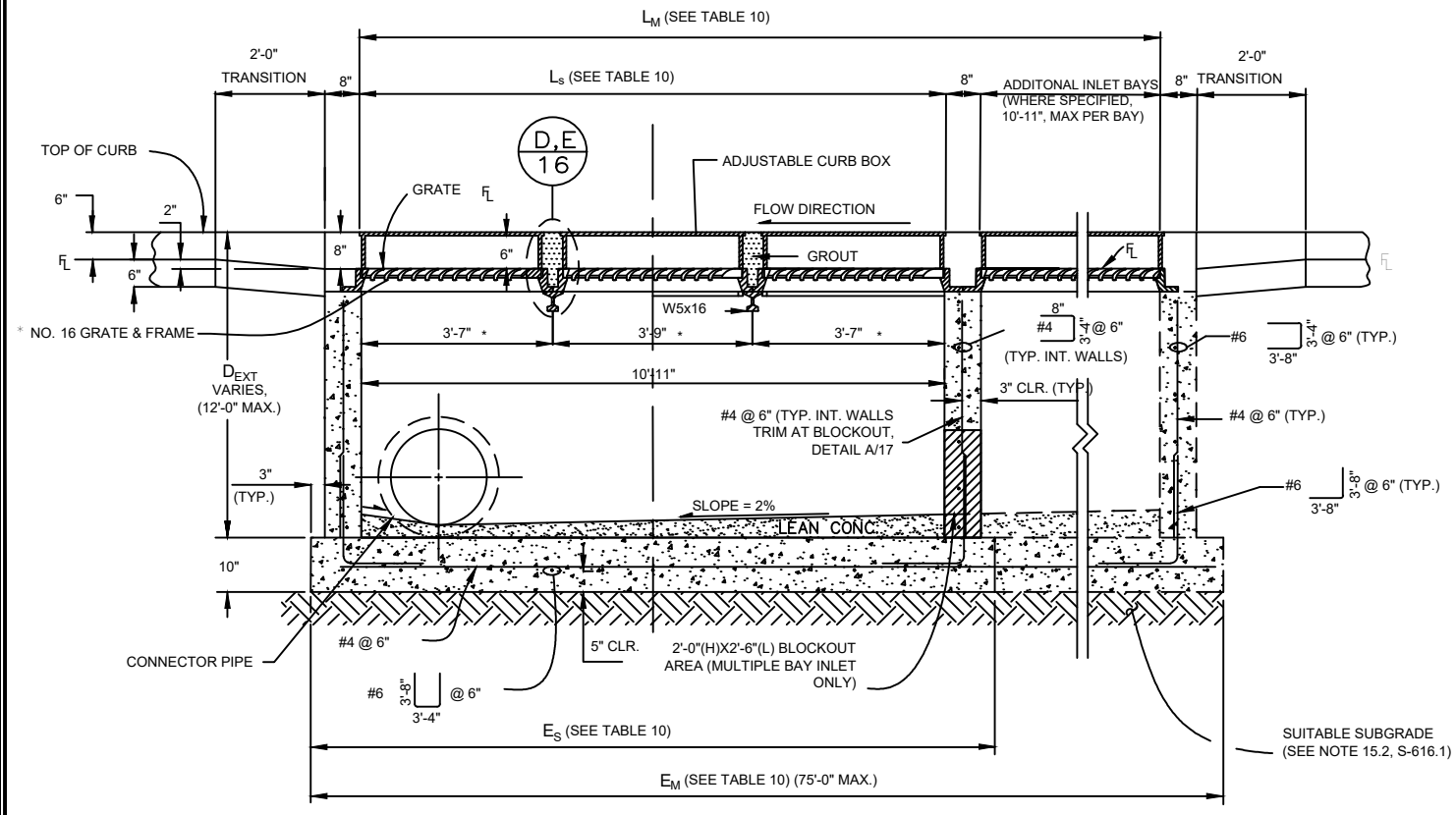
DATE:
05/30/2025

PLAN VIEW



6" VERTICAL CURB AND GUTTER **COMBINATION CURB GUTTER AND SIDEWALK**

CROSS SECTION VIEW



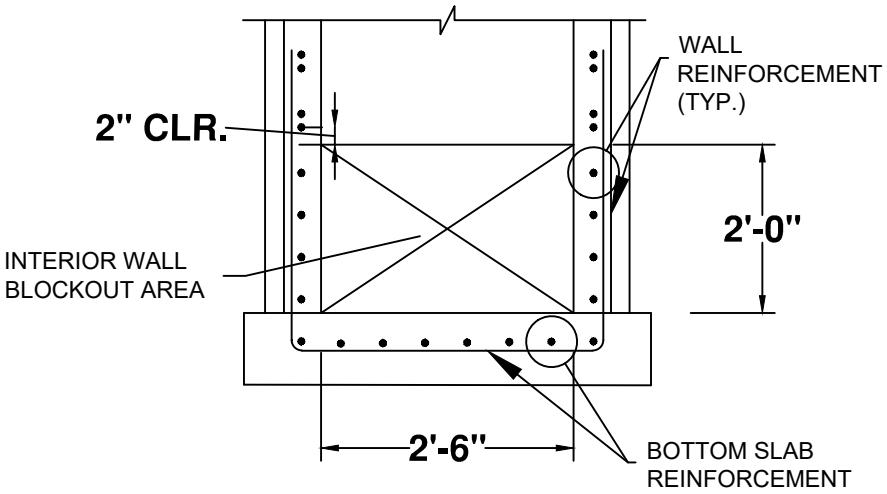
"Details adapted from the City of County of Denver Wastewater Standard Details, June 2020"

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INLET TYPE 16 COMBINATION TRIPLE

SHEET
SD - 28

DATE:
05/30/2025



DETAIL - TYPICAL INTERIOR WALL BLOCK-OUT

NO SCALE

TRIPLE NUMBER 16 INLET NOTES:

1. STANDARD GRATE AND FRAME DETAILS APPLY TO THE TRIPLE NUMBER 16 INLET EXCEPT FOR THE FRAME LENGTH. FRAME LENGTH SHOULD BE MANUFACTURED FOR THE DIMENSIONS CALLED OUT ON THIS SHEET.

TYPE 16 COMBO- TRIPLE, TOTAL INLET LENGTH

INLET CONFIGURATION	L_S OR L_M INLET LENGTH	■E_S OR E_M TOTAL BOTTOM SLAB LENGTH
TRIPLE NO. 16	10'–11"	12'–9"
NO. 16 3–3–2 (EXAMPLE CONFIGURATION)	10'–11", 10'–11", 7'–1"	32'–1"
NO. 16 ___–___–___ (CONFIGURATION TEMPLATE)	L_S , L_S , L_S	=3"+8"+L_S+8"+L_S+8"+L_S+8"+3"

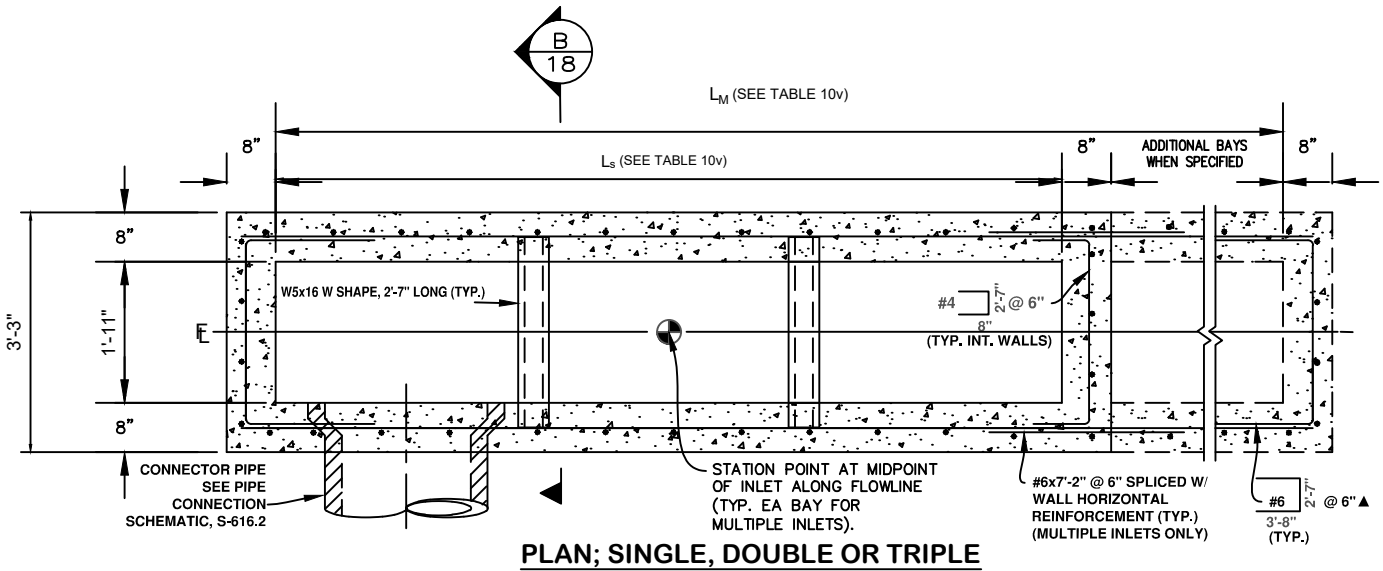
■ MAX. BOTTOM SLAB LENGTH = 17'–0"

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INLET TYPE 16 COMBINATION TRIPLE (2)

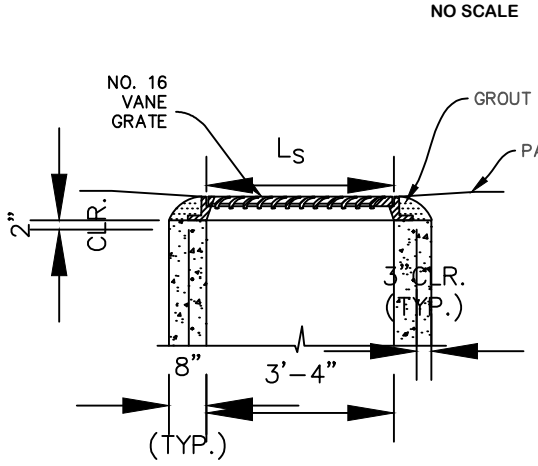
SHEET
SD - 29

DATE:
05/30/2025



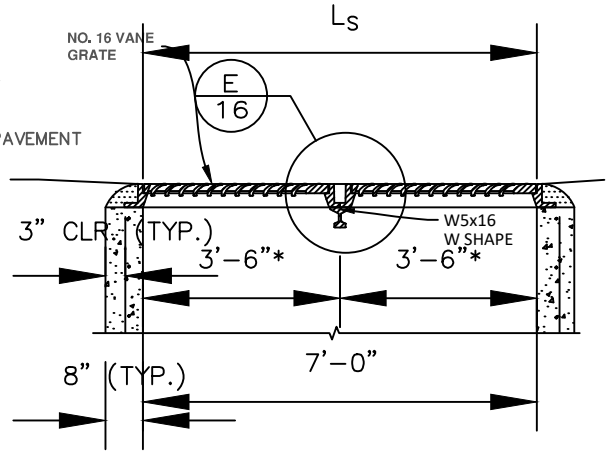
PLAN; SINGLE, DOUBLE OR TRIPLE

NO SCALE



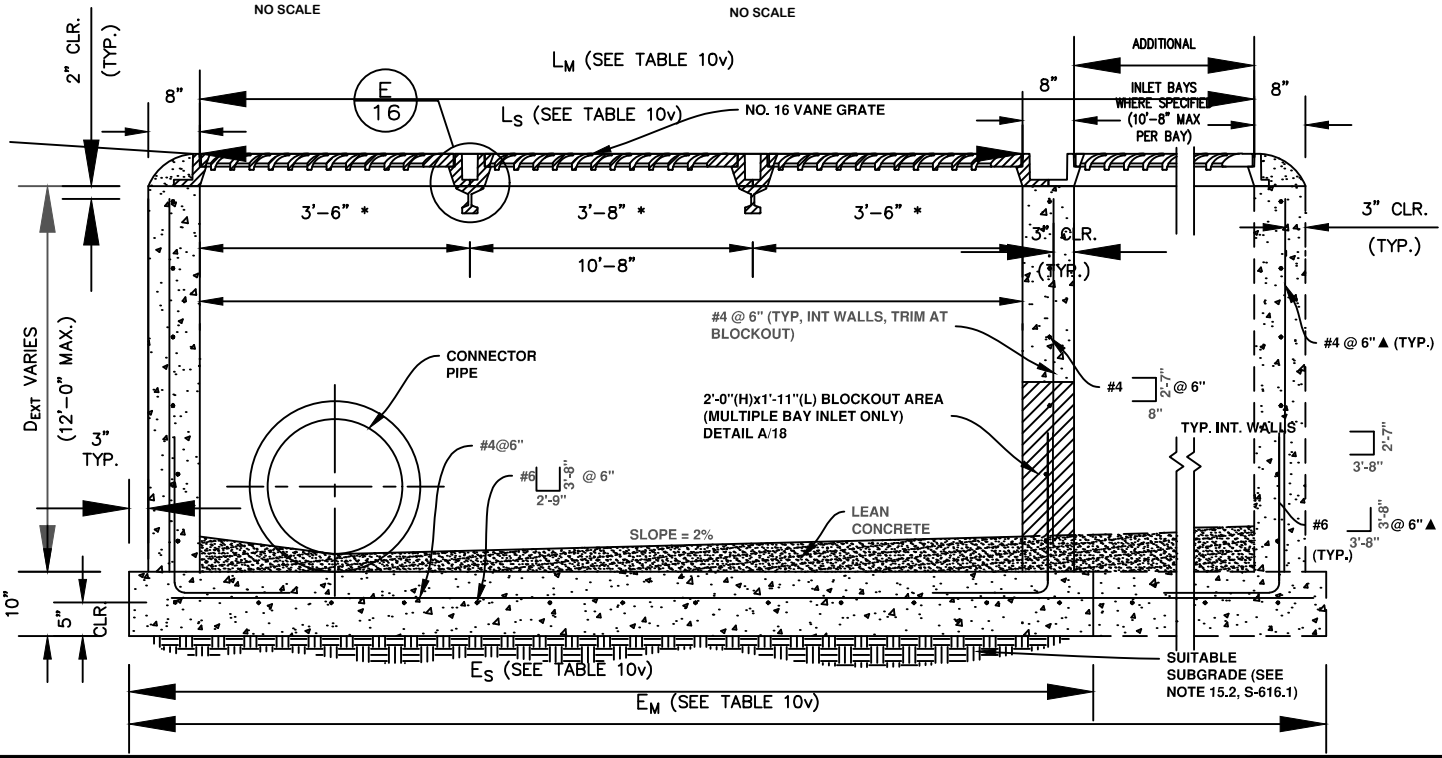
SINGLE NO. 16 VALLEY INLET

NO SCALE



DOUBLE NO. 16 VALLEY INLET

NO SCALE

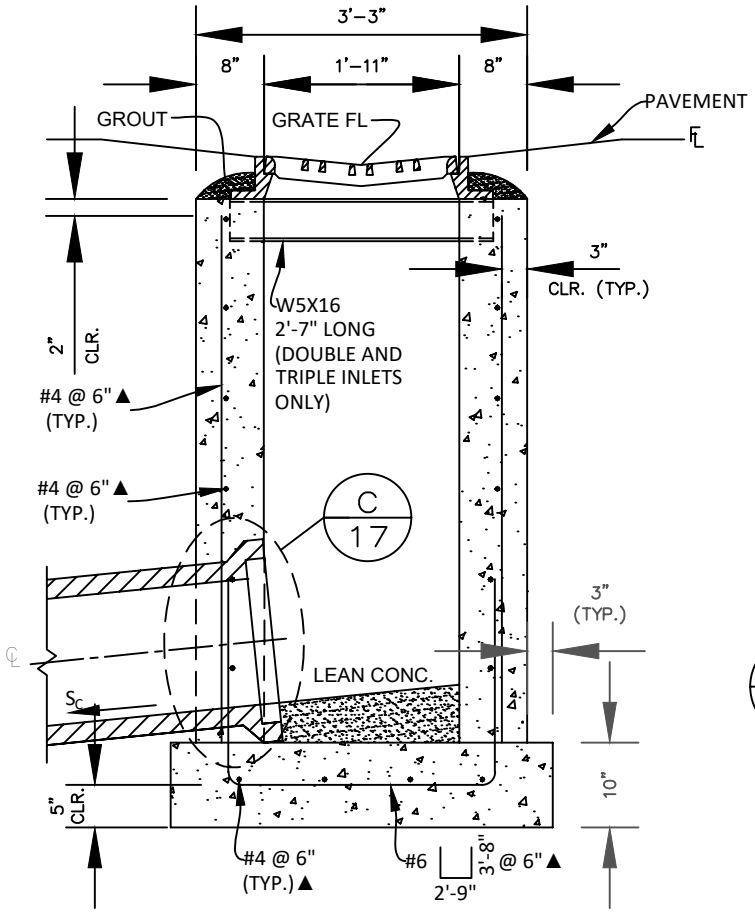


Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INLET TYPE 16 VALLEY

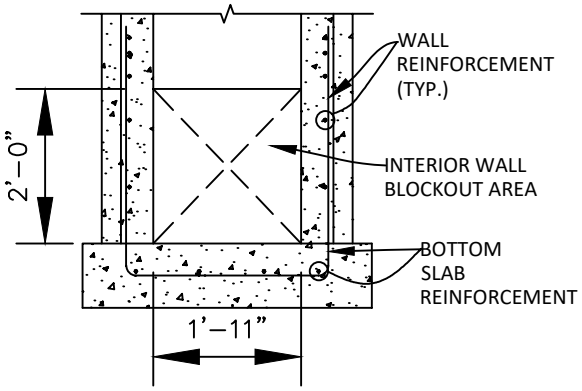
SHEET
SD - 30

DATE:
05/30/2025



B
18

SECTION
NO SCALE



A
18

DETAIL-TYPICAL INTERIOR WALL BLOCK-OUT
NO SCALE

"Details adapted from the City of County of Denver Wastewater Standard Details, June 2020"

TYPE 16 VALLEY TRIPLE, TOTAL INLET LENGTH

INLET CONFIGURATION	L_S OR L_M INLET LENGTH	■ E_S OR E_M TOTAL BOTTOM SLAB LENGTH
TRIPLE TYPE 16 VALLEY	10'–8"	12'–6"
TYPE 16 VALLEY 3–3–2 (EXAMPLE CONFIGURATION)	10'–8", 10'–8", 7'–0"	31'–6"
TYPE 16 VALLEY__–__–__ (CONFIGURATION TEMPLATE)	L_s , L_s , L_s	=3"+8"+L_s+8"+L_s+8"+L_s+8"+3"

■ MAX. BOTTOM SLAB LENGTH = 75'–0"

TYPE 16 VALLEY INLET NOTES:

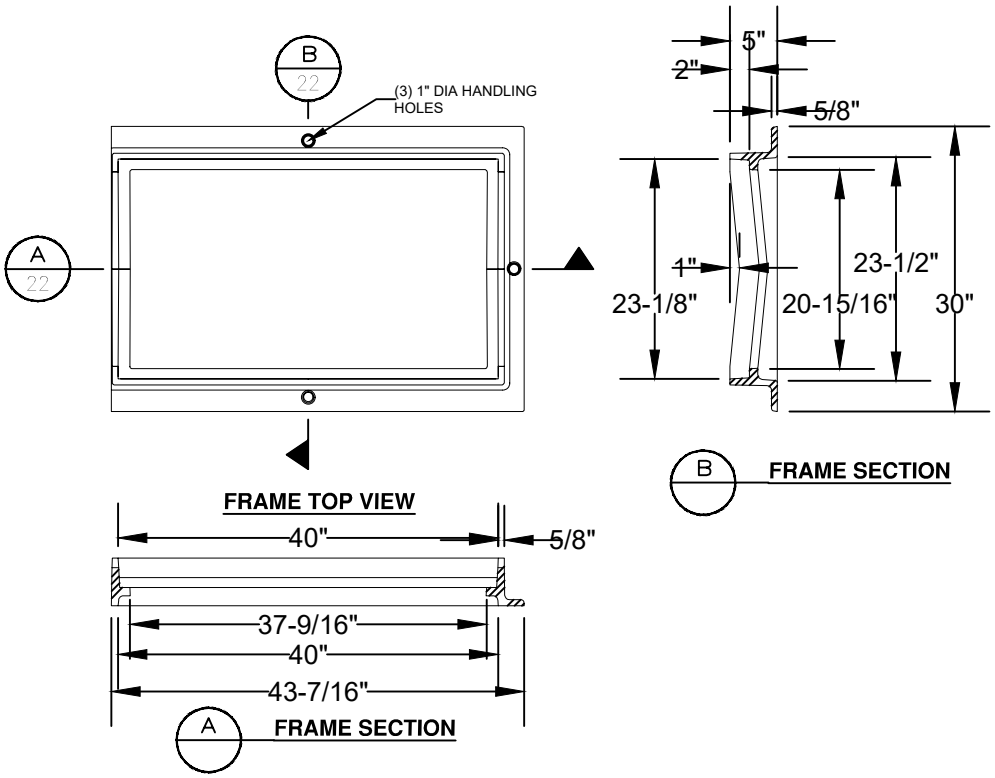
1. FRAME AND GRATE DETAILS -PPLY TO TRIPLE V-LLEY INLET EXCEPT FOR FR-ME LENGTH. FR-ME LENGTH SHOULD BE M-NUF-CTURED FOR DIMENSIONS C-LLED OUT ON THIS SHEET.
2. SEE NOTES FOR TYPE 16 INLET COMBINATION (SD–22).

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

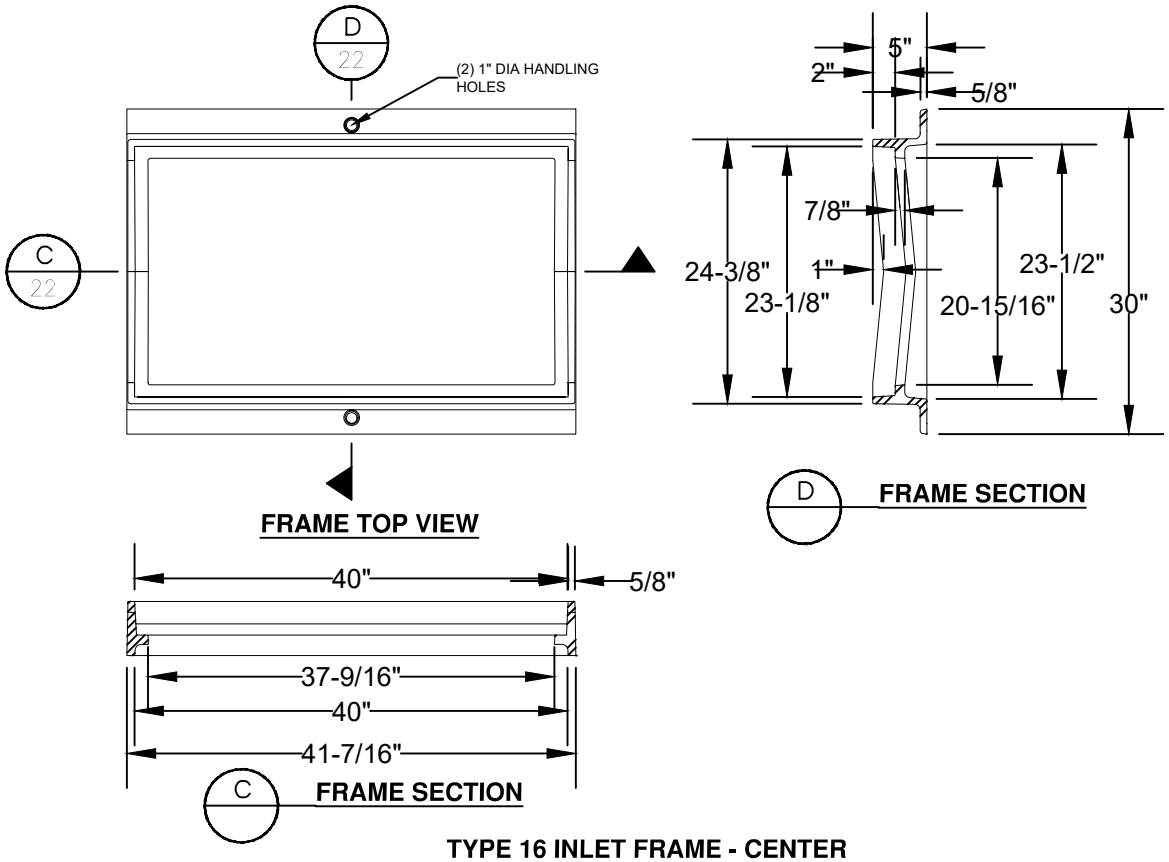
INLET TYPE 16 VALLEY TRIPLE

SHEET
SD - 31

DATE:
05/30/2025



TYPE 16 INLET FRAME - RIGHT OR LEFT
NO SCALE



TYPE 16 INLET FRAME - CENTER
NO SCALE

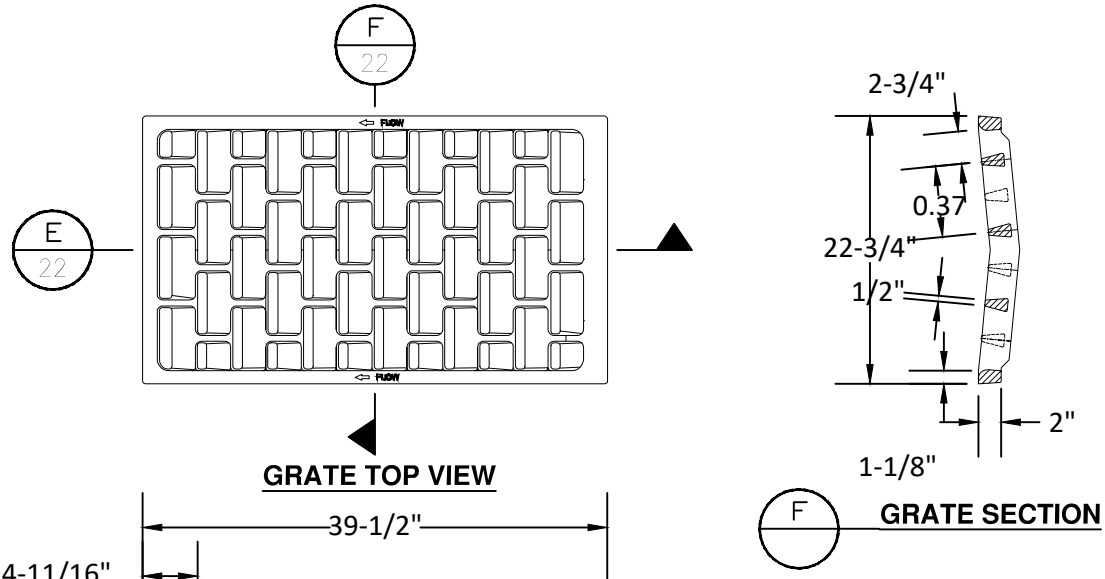
"Details adapted from the City of County of Denver Wastewater Standard Details, June 2020"

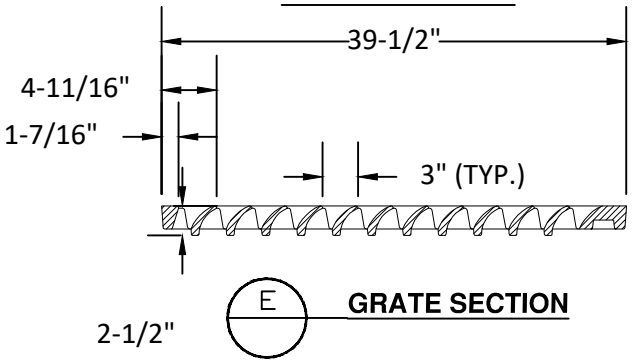
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INLET TYPE 16 FRAME

SHEET
SD - 32

DATE:
05/30/2025

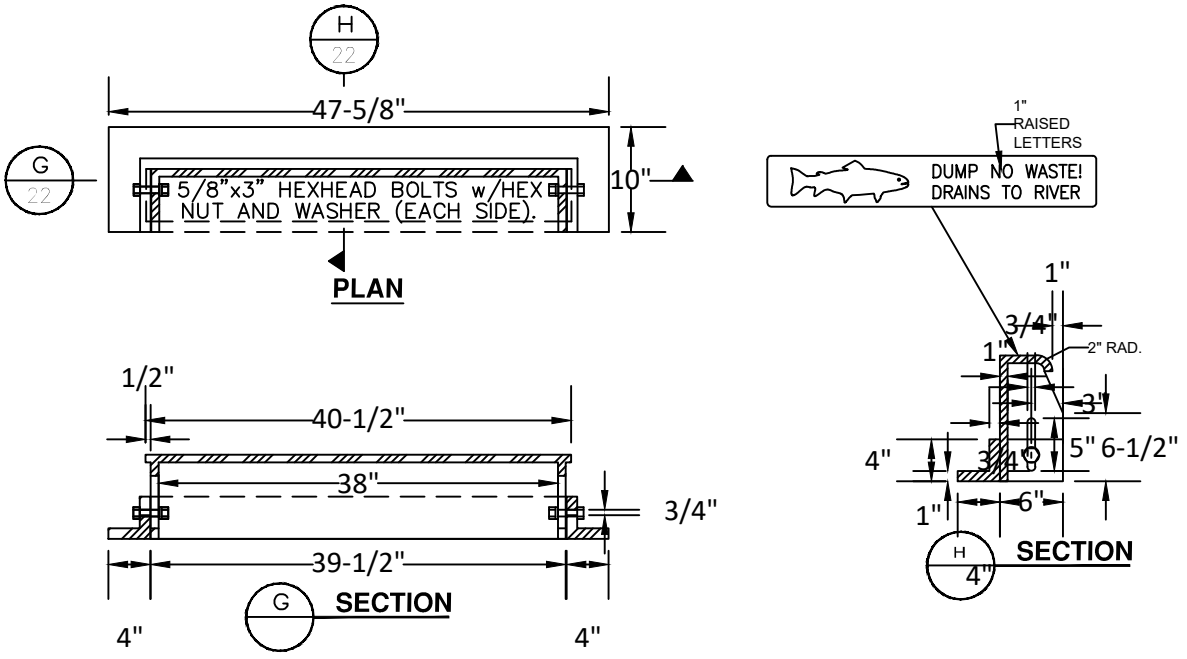




NO. 16 INLET GRATE
NO SCALE

GRATE & FRAME NOTES:

22.1 CAST IRON SHALL CONFORM TO ASTM A48. (CLASS 35B, MINIMUM)
22.2 CASTINGS SHALL COMPLY WITH FEDERAL SPECIFICATION RR-F-621D FOR CASTING PROOF LOADING (HEAVY DUTY).
22.3 ALL CASTINGS REQUIRE INDIVIDUAL APPROVAL/CERTIFICATION FROM THIS DIVISION.
22.4 CASTINGS SHALL NOT BE DIPPED OR PAINTED PRIOR TO FINAL INSPECTION, ONCE INDIVIDUAL CASTINGS ARE CHECKED, AND APPROVED BY THE DIVISION FOR PROJECT USAGE, THEY SHALL BE COATED WITH AN APPROVED MATERIAL.



ADJUSTABLE CURB BOX
(MINIMUM CURB OPENING AREA = 150 in^2)
NO SCALE

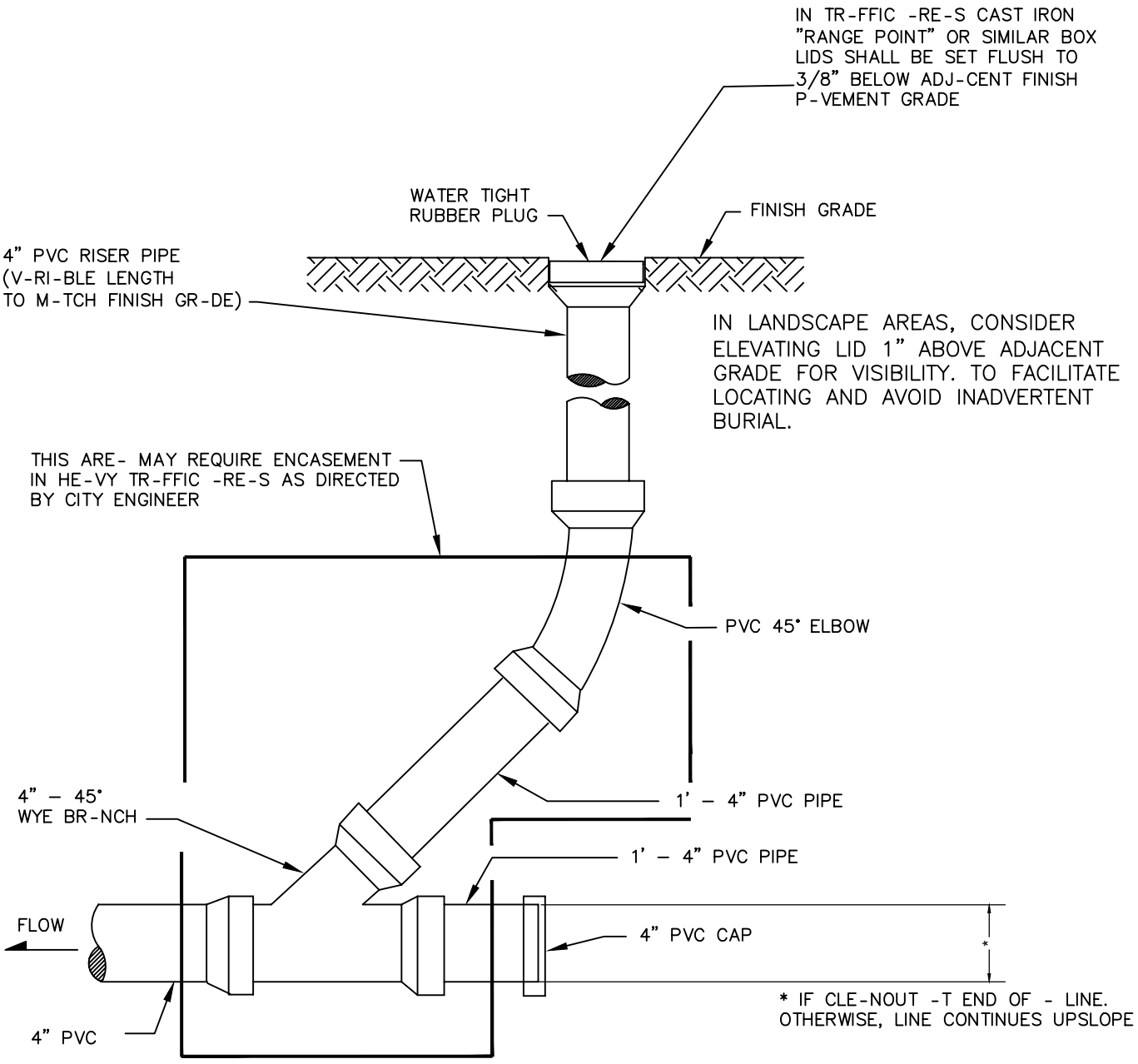
"Details adapted from the City of County of Denver Wastewater Standard Details, June 2020"

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

INLET TYPE 16 GRATE AND CURB BOX

SHEET
SD - 33

DATE: 05/30/2025



NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

CLEANOUT - GENERAL

SHEET
SD - 34

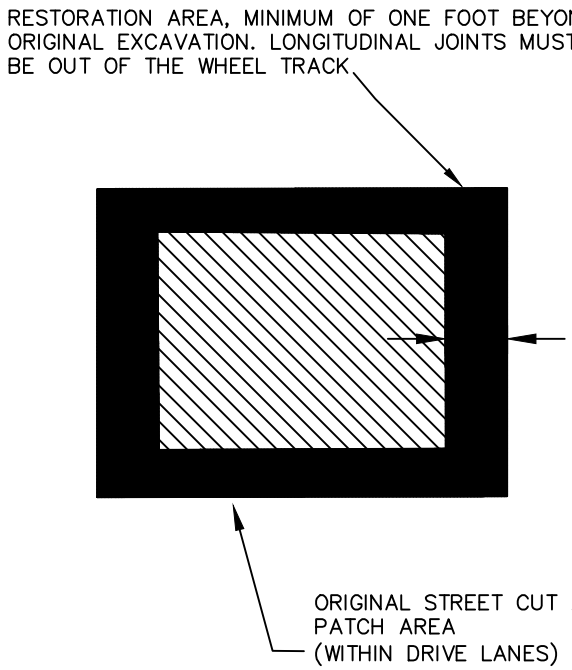
DATE:
05/30/2025

NOTE:

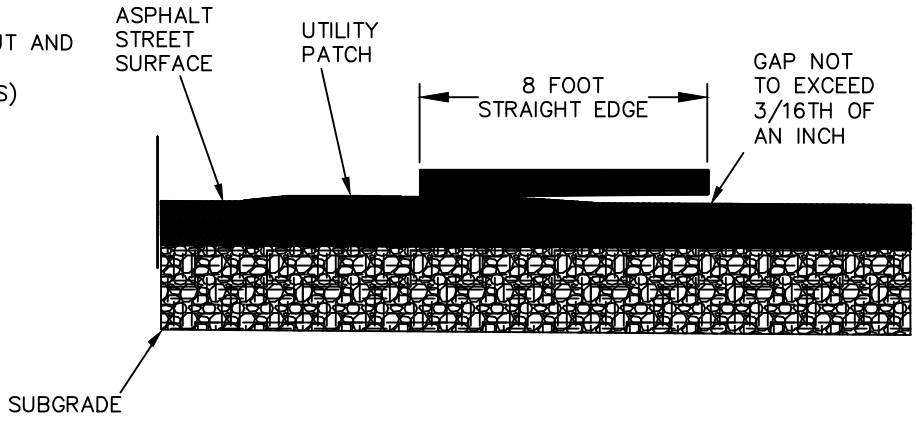
1. SURFACE TREATMENT AREAS – ASPHALT PATCHES SHALL BE FOUR 90– DEGREE ANGLES WITH STRAIGHT EDGES AD MATCH EXISTING PAVEMENT THICKNESS OR HAVE A MINIMUM DEPTH OF SIX INCHES, WHICHEVER IS GREATER. ASPHALT PATCH BACK MUST BE INSPECTED BY THE ENGINEERING INSPECTOR. ASPHALT PATCH SHALL BE TACKED ON THE EDGES AFTER COMPLETION.

2. RESURFACED AREAS – ASPHALT PATCHES SHALL BE FOUR 90–DEGREE ANGLES WITH STRAIGHT EDGES AND MATCH THE EXISTING PAVEMENT THICKNESS OR HAVE A MINIMUM DEPTH OF SIX INCHES, WHICHEVER IS GREATER. AN INFRARED/SEAMLESS PATCH SHALL BE COMPLETED AFTER ASPHALT PATCH BACK IS COMPLETED DUE TO RESURFACING PROJECT THAT WAS JUST COMPLETED. ALL MARKING PAINT SHALL BE REMOVED BY MEANS OF SODA BLASTING.

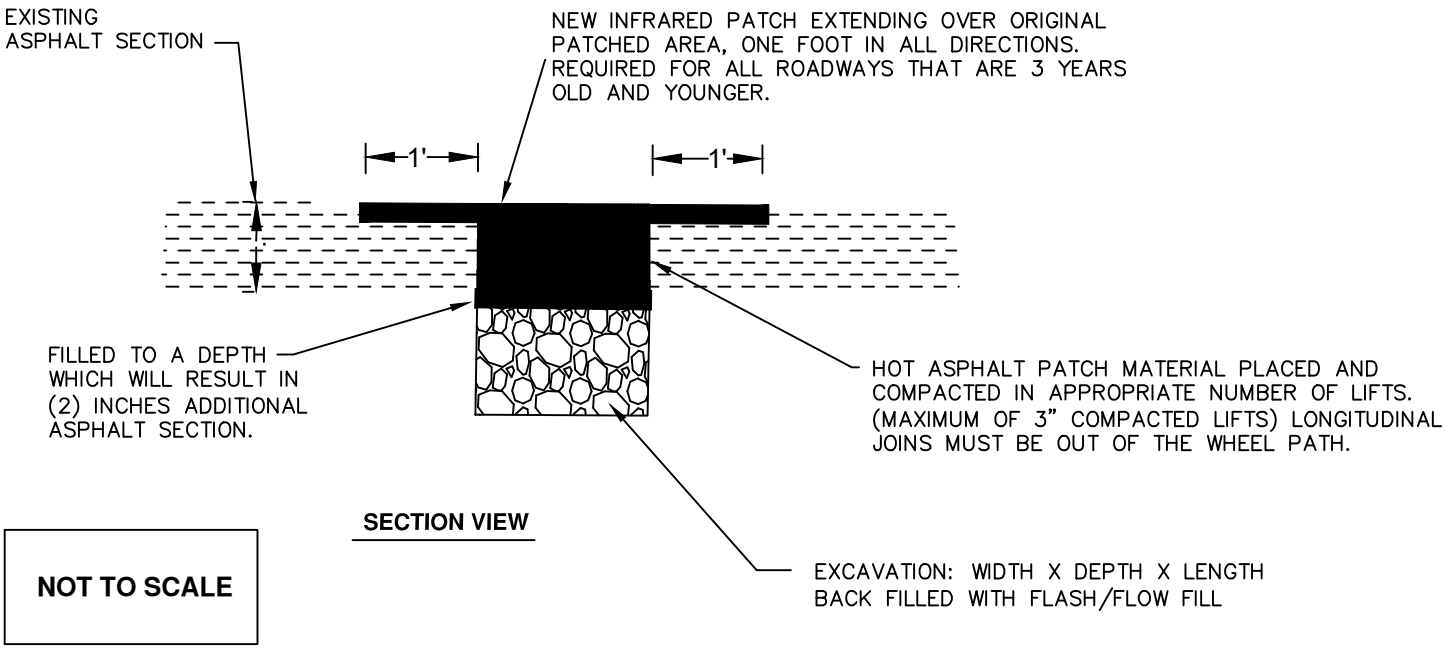
3. ASPHALT PATCHES SHALL BE FOUR 90–DEGREE ANGLES WITH STRAIGHT EDGES AND MATCH EXISTING PAVEMENT THICKNESS OR HAVE A MINIMUM DEPTH OF SIX INCHES, WHICHEVER IS GREATER. ASPHALT PATCH BACK MUST BE INSPECTED BY THE ENGINEERING INSPECTOR. ASPHALT PATCH SHALL BE TACKED ON THE EDGES AFTER COMPLETION. PAVEMENT CORING'S SHALL BE RETAINED BY THE CONTRACTOR FOR RESTORATION AND POTHOLES SHALL BE BACKFILLED WITH FLASH OR FLOW FILL TO THE BOTTOM OF THE PAVEMENT. THE TOP 3' OF THE RETAINED CORE WILL THEN BE SECURED INTO THE POTHOLE WITH VERSA SPEED AND SHALL BE ADJUSTED TO WITHIN 1/8" OF THE STREET SURFACE. NO POTHOLES WILL BE ALLOWED IN THE WHEELPATH. IF THERE ARE TWO OR MORE UTILITY POTHOLES WITHIN A CONCRETE PANEL THE ENTIRE PANEL SHALL BE REMOVED AND REPLACED BY THE PERMITTEE. CONCRETE MIX TO BE USED BY PERMITTEE SHALL BE PRE–APPROVED BY CITY OF LITTLETON.



PLAN VIEW



RIDE QUALITY CRITERIA, SECTION VIEW



SECTION VIEW

NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

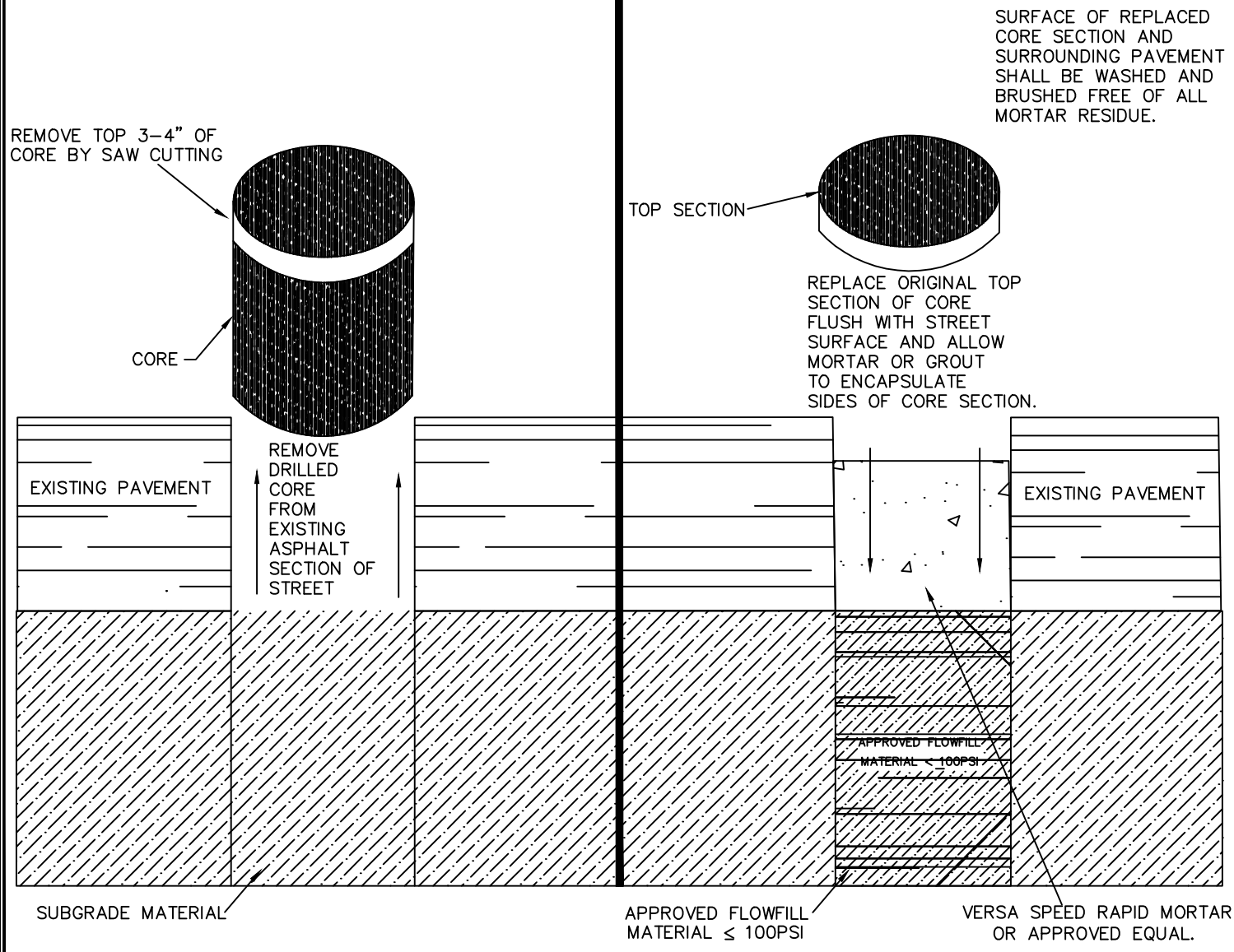
UTILITY PATCH DETAILS

SHEET
SD - 35

DATE: 05/30/2025

CORE REMOVAL

CORE REPLACEMENT



NOT TO SCALE

NOTES:

1. 2' X 2' PATCH WILL BE REQUIRED WHEN ORIGINAL CORES ARE NOT REPLACED IN ORIGINAL CORE LOCATION.
2. IF CORE IS DAMAGED PLEASE CONSULT WITH THE ENGINEERING INSPECTOR.

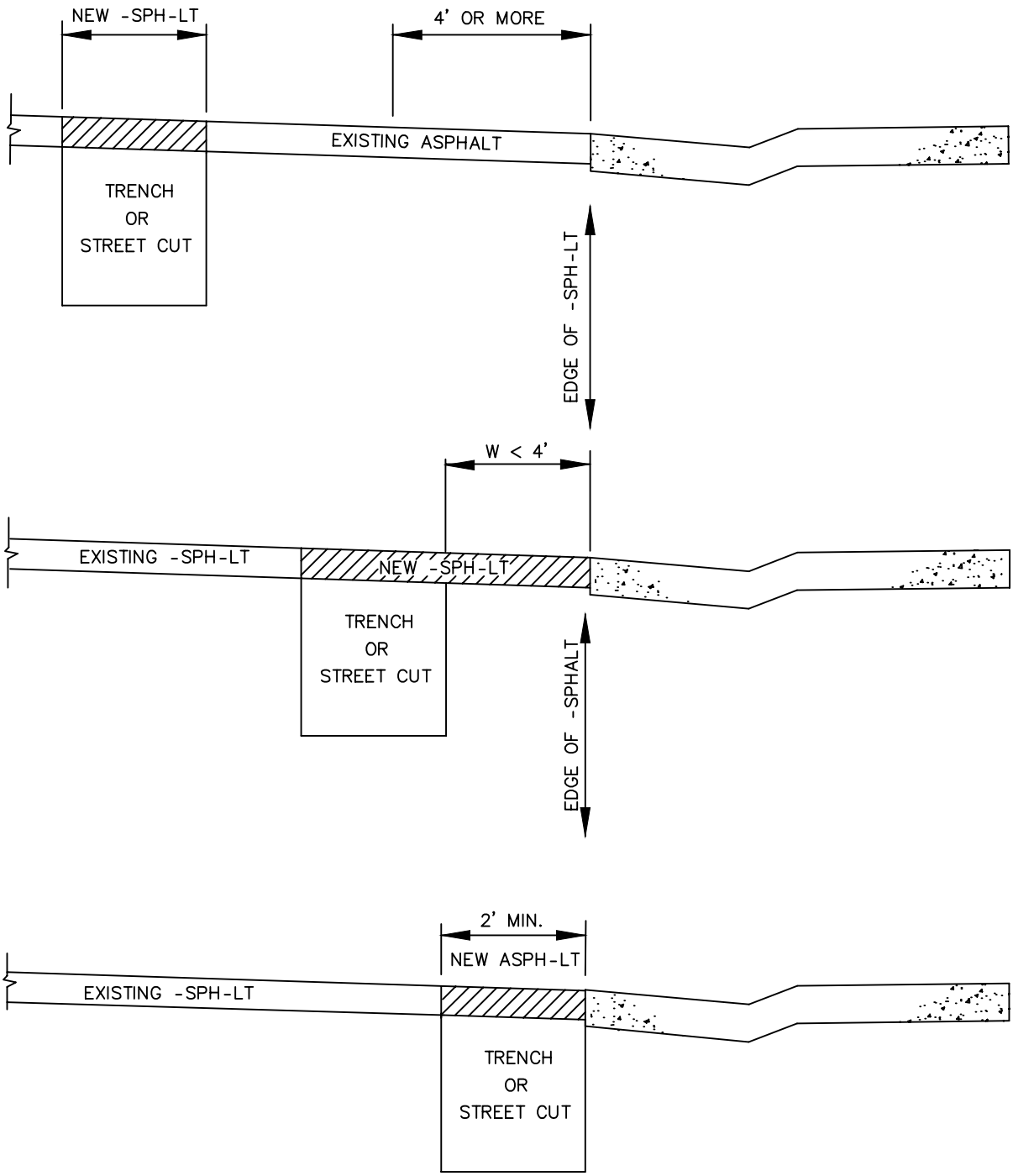
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

LOCATE & POTHOLE STREET REPAIR

SHEET

SD - 36

DATE: 05/30/2025



NOTES:

1. REPL-CEMENT OF THE PAVEMENT WITH - SECTION EQUIV-LENT TO THE EXISTING. (MINIMUM REPAIR THICKNESS IS 6" FULL–DEPTH ASPH-LT)
2. REPL-CEMENT OF ADDITION-L P-VEMENT MAY BE REQUIRED IF ASPH-LT CONDITION IS POOR. CONTACT THE CITY INSPECTOR.

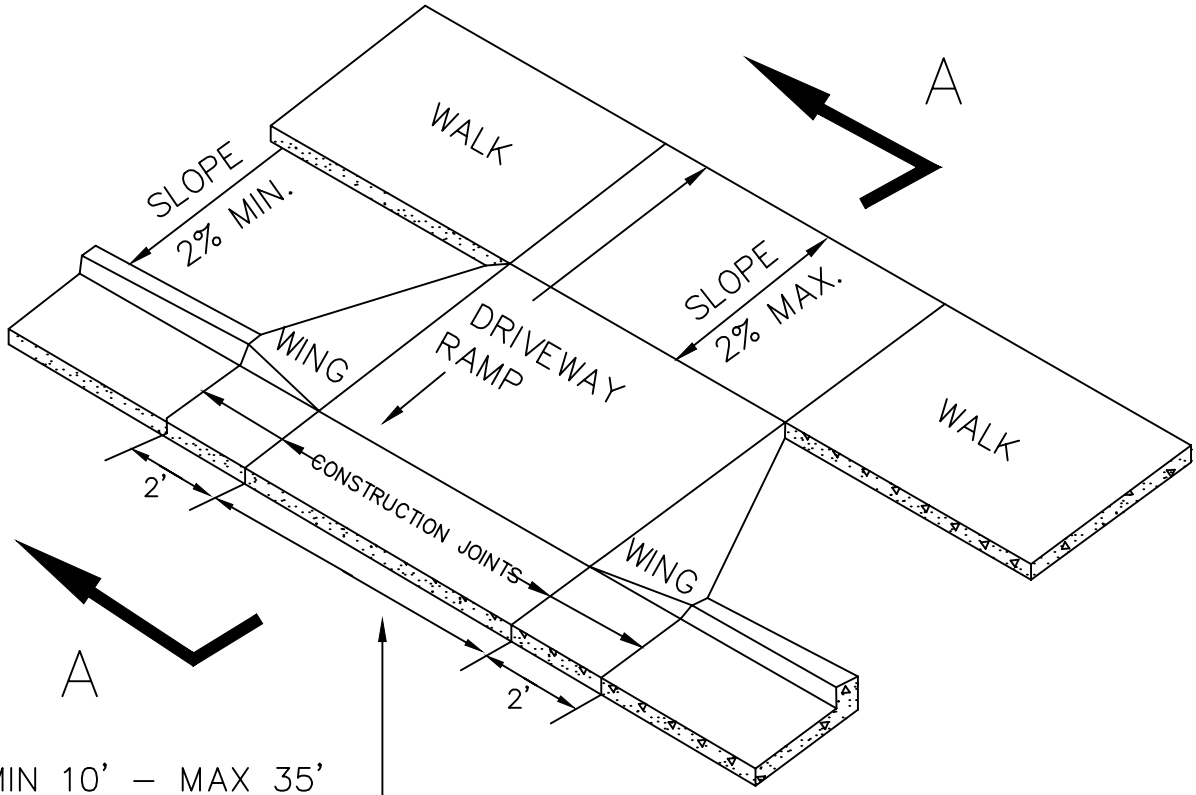
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

TRENCH ZONE REQUIREMENTS

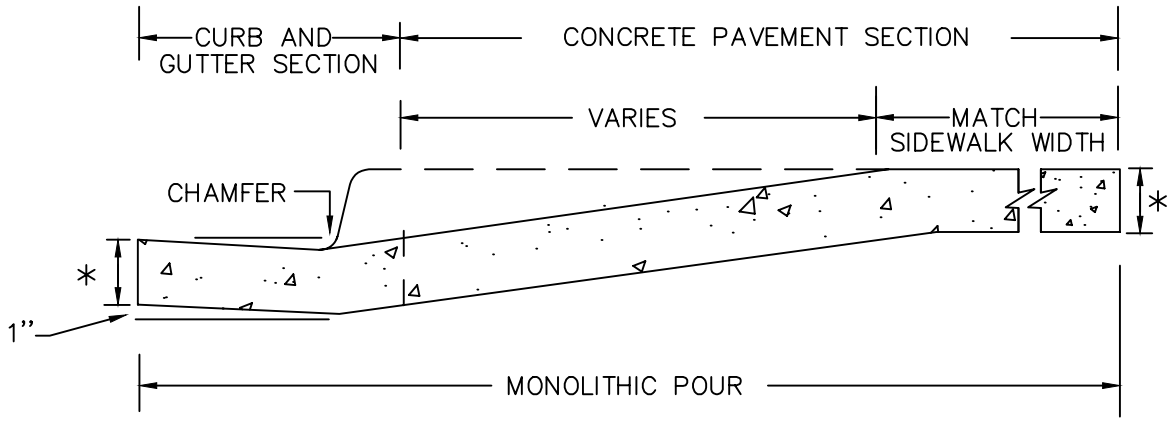
SHEET
SD - 37

DATE:
05/30/2025



COMMERCIAL MIN 10' – MAX 35'
RESIDENTIAL MIN 10' – MAX 20'

NOTE: CONSTRUCTION JOINTS ARE REQUIRED AT EACH SIDE OF WING SECTION AND EVERY 10 FEET (MAXIMUM) ALONG RAMP DRIVE.



SECTION A–A

* 6" RESIDENTIAL
8" COMMERCIAL AND PUBLIC ALLEYS

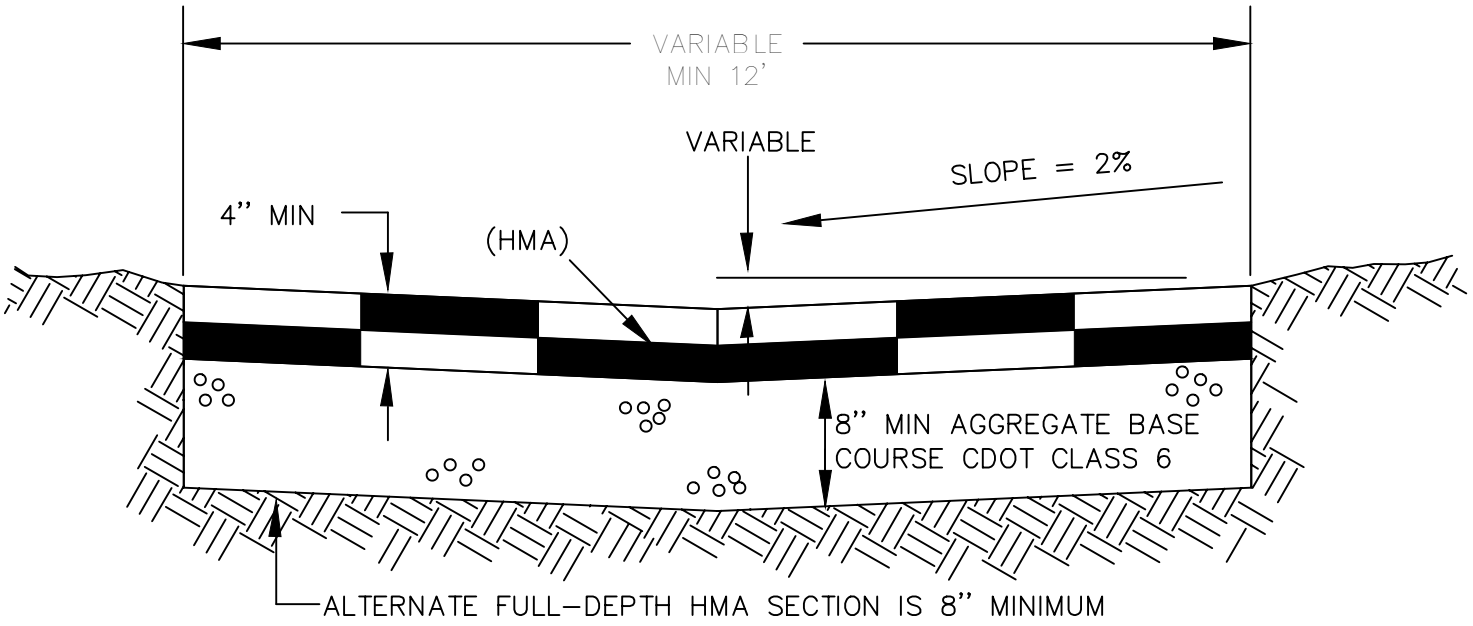
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

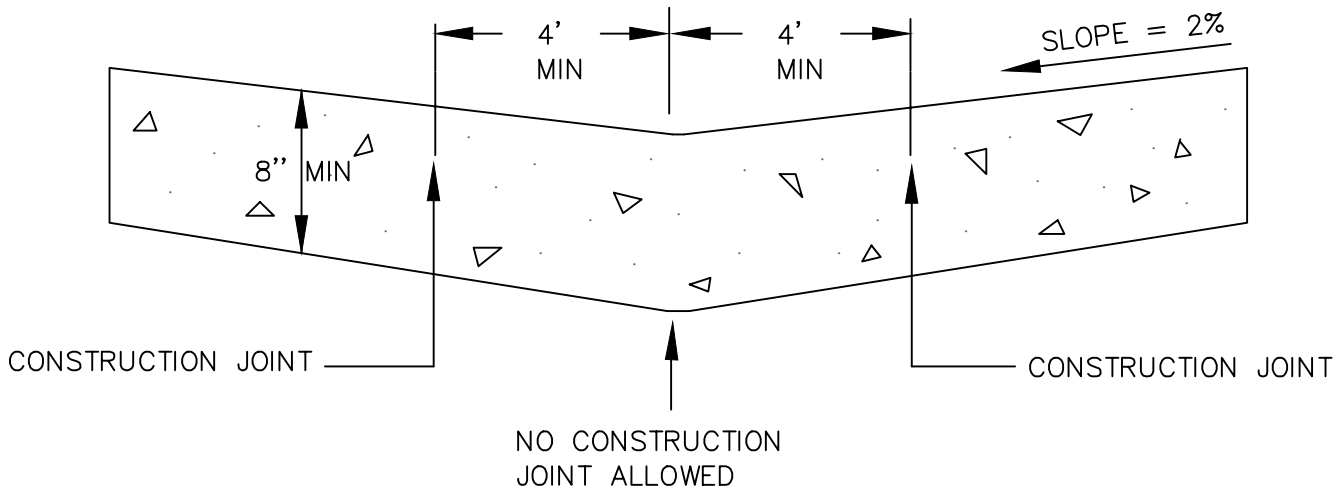
DRIVEWAY RAMP

SHEET
SD - 38

DATE:
05/30/2025



HOT MIX ASPHALT (HMA)



A SOILS REPORT SHALL BE OBTAINED AND WILL BE THE BASIS FOR FINAL PAVEMENT DESIGN FOR CONCRETE AND HMA SECTIONS.

CONCRETE PAVEMENT
NON-RESIDENTIAL

NOTE: DETACHED SINGLE-FAMILY MAY USE 8'' GRAVEL OR 8'' RECYCLED BITUMINOUS PAVEMENT WHERE APPROVED BY DESIGN STANDARDS. MIDDLE OF ALLEY SHOULD HAVE A MINIMUM 1% RUNNING SLOPE

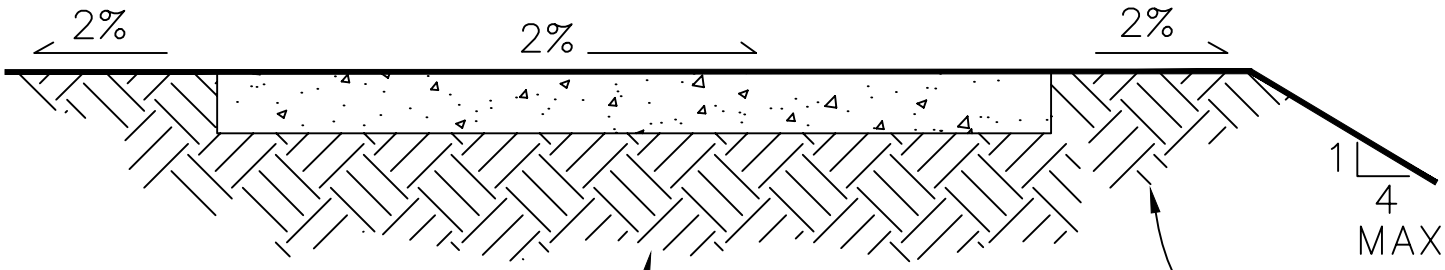
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

ALLEY PAVING

SHEET
SD - 39

DATE: 05/30/2025



BACKFILL EDGE WITH TOPSOIL. FINISH GRADE TO BE FLUSH WITH PATH EDGE (TYP) AND RESTORE TO PRE-EXISTING LANDSCAPING

PREPARED SUBGRADE:
COMPACT ROADBASE OR USE ON-SITE GRAVEL MATERIAL WHERE APPROVED BY ENGINEER. OVER EXCAVATE IF UNSTABLE SUB SOILS ARE ENCOUNTERED AND REPLACE WITH SUITABLE FILL MATERIAL. COMPACT ALL FILL AREAS TO 95% STANDARD PROCTOR AT 2% OPTIMUM. REMOVE ALL TOPSOIL PRIOR TO SUBGRADE PREPARATION.

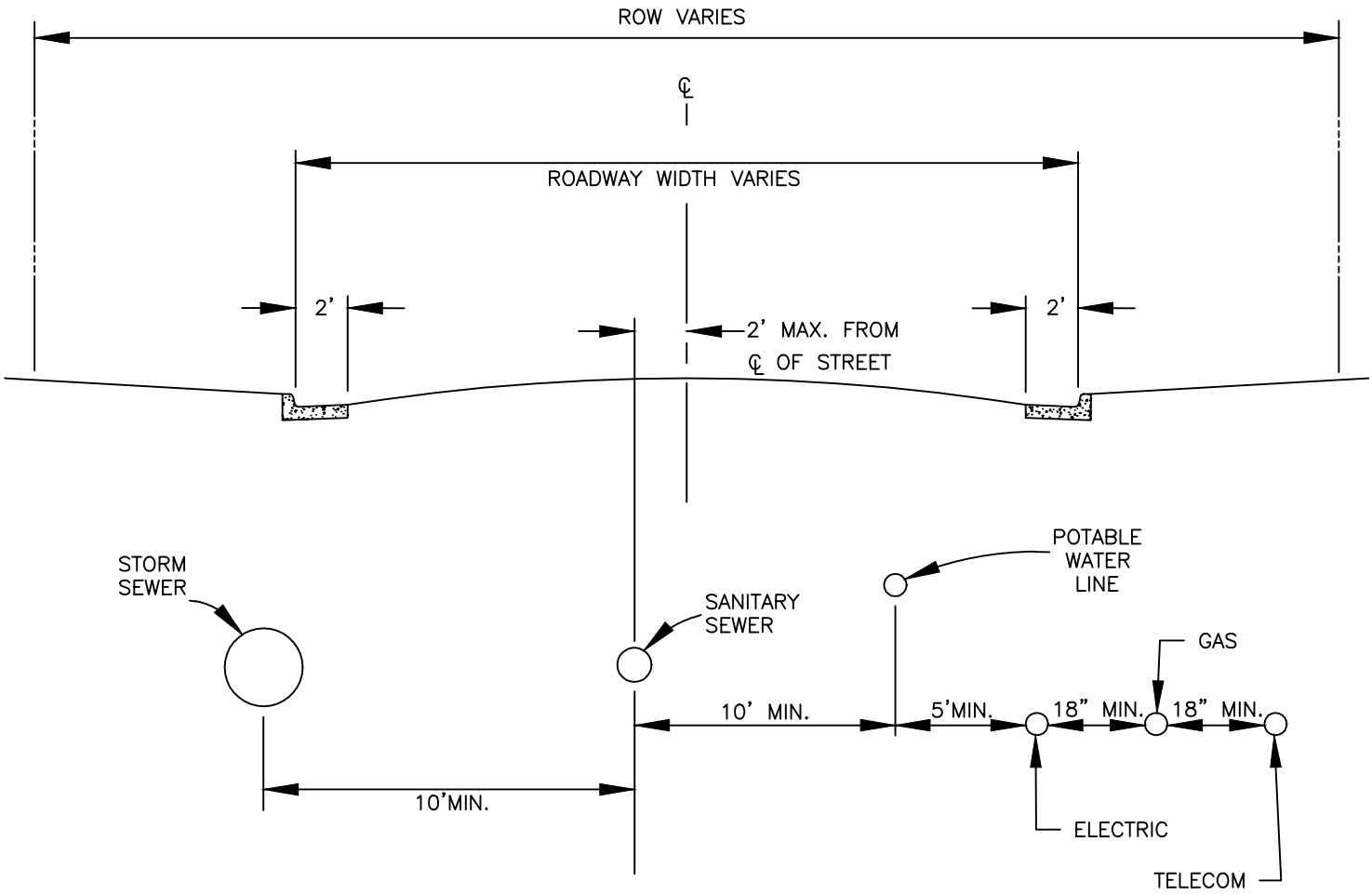
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

SUBGRADE PREPERATION

SHEET
SD - 40

DATE:
05/30/2025



NOTES:

1. REFER TO T-BLE 126.01 FOR REQUIRED HORIZONT-L UTILITY SEP-R-TION

NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

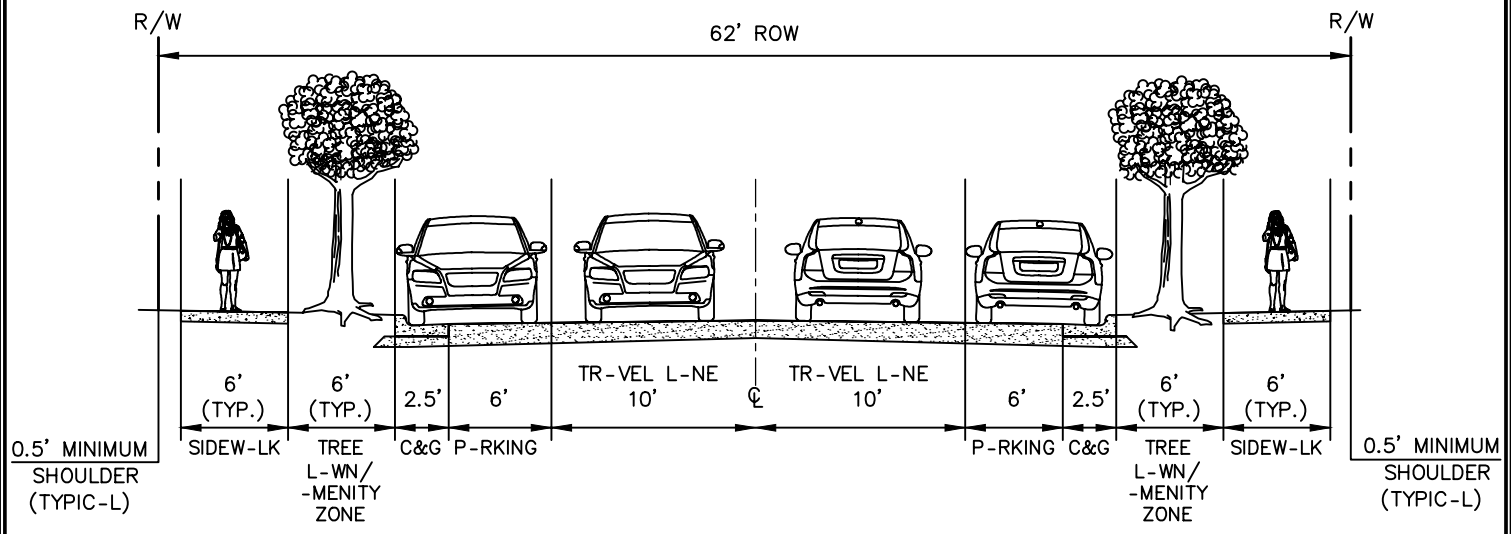
STANDARD LOCATIONS FOR UTILITIES

SHEET

SD - 41

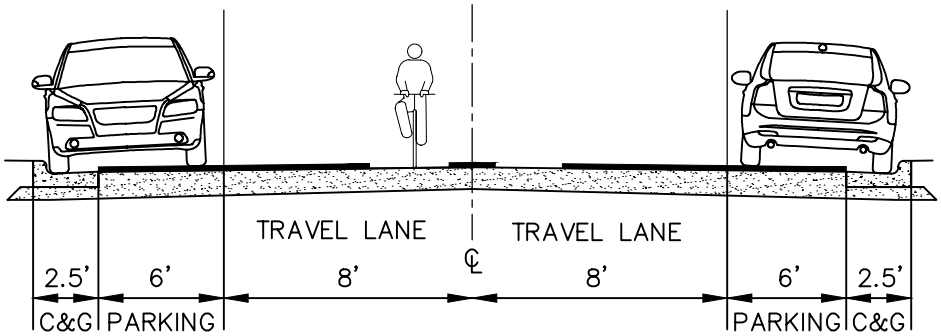
DATE: 05/30/2025

62' RIGHT OF WAY
36' ROADWAY SECTION
(FL TO FL)



NEIGHBORHOOD
GREENWAY OVERLAY
(TRAFFIC DIVERTER)

RIGHT TURN L-NE SIGN AND OBJECT M-RKER REQUIRED PER MUTCD



NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

LOCAL STREET
TYPICAL SECTION

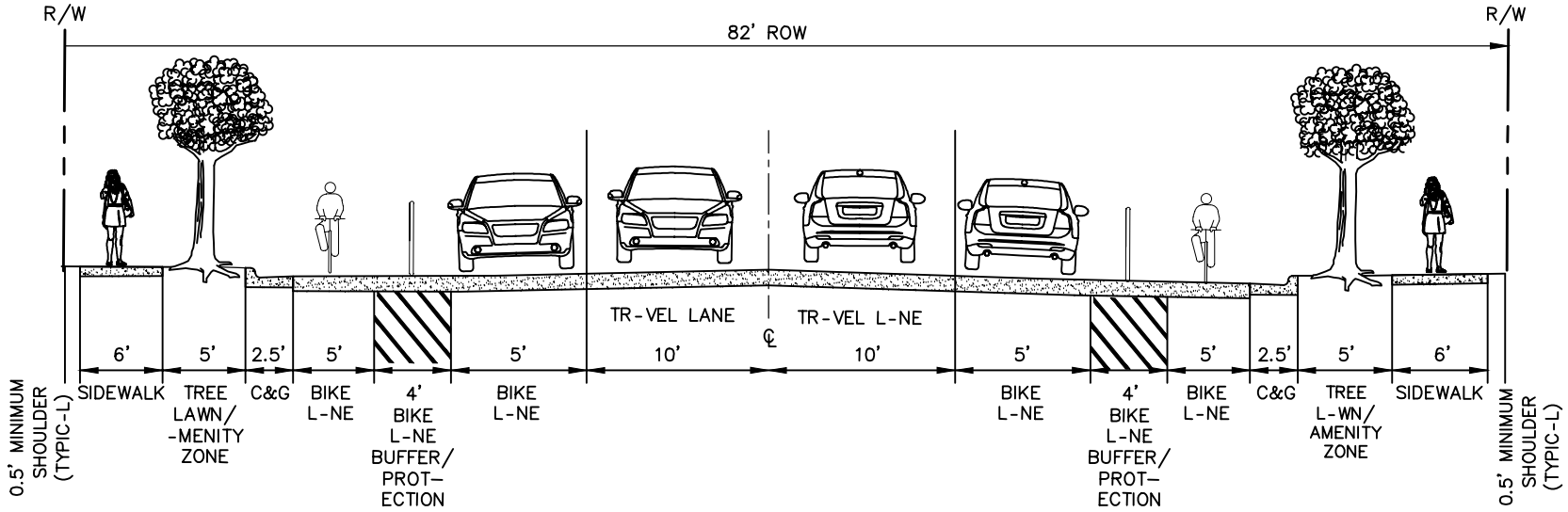
SHEET
SD - 42

DATE:
05/30/2025

Littleton
Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

NEIGHBORHOOD CONNECTOR
TYPICAL SECTION

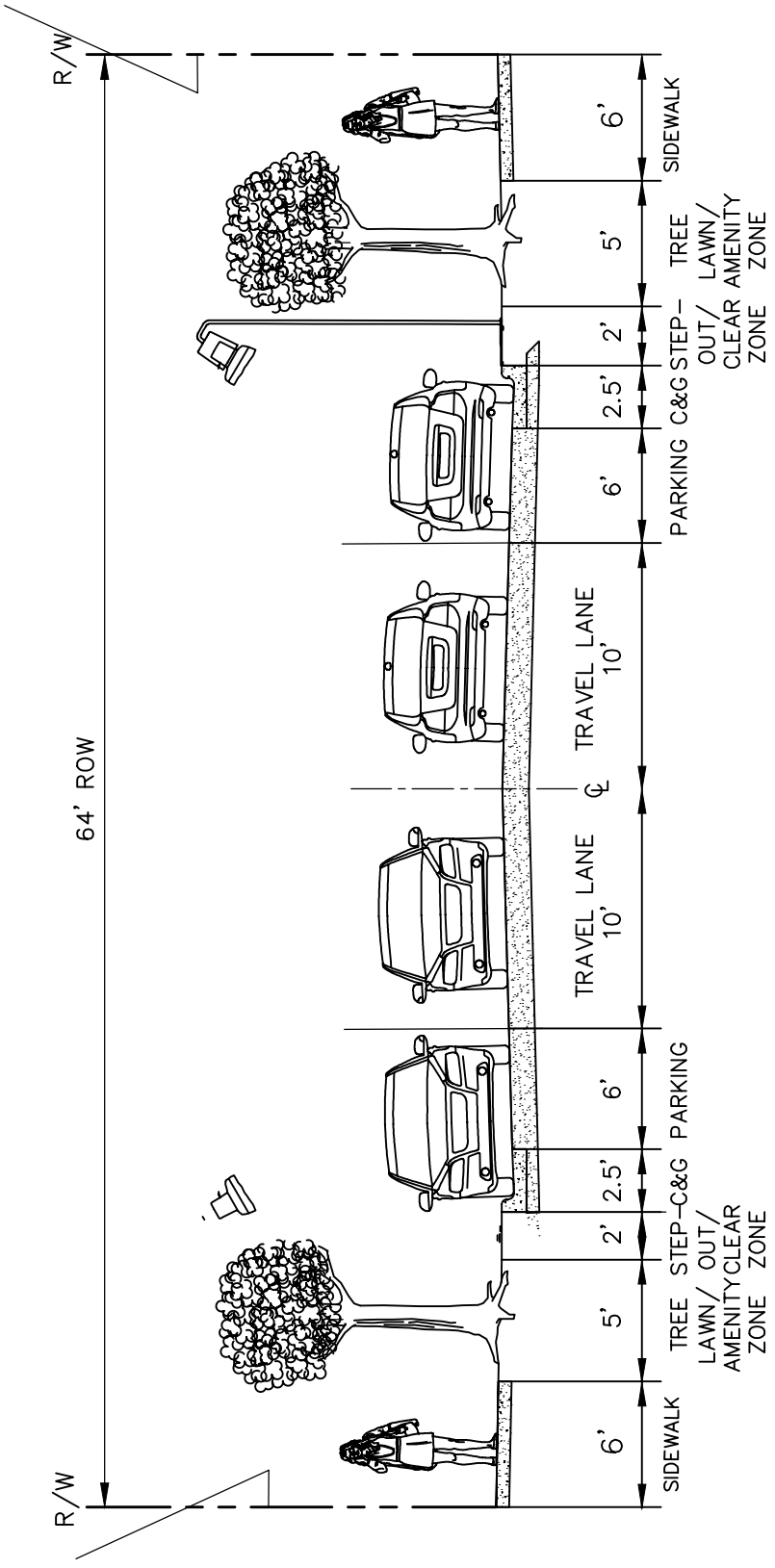
82' RIGHT OF WAY
58' ROADWAY SECTION
(FL TO FL)



NOT TO SCALE

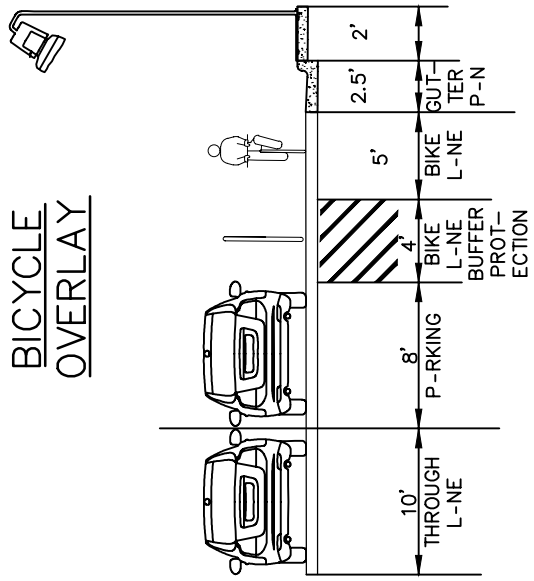
SHEET
SD - 43

DATE:
05/30/2025



63' RIGHT OF WAY
36' ROADWAY SECTION
(FL TO FL)

BICYCLE OVERLAY



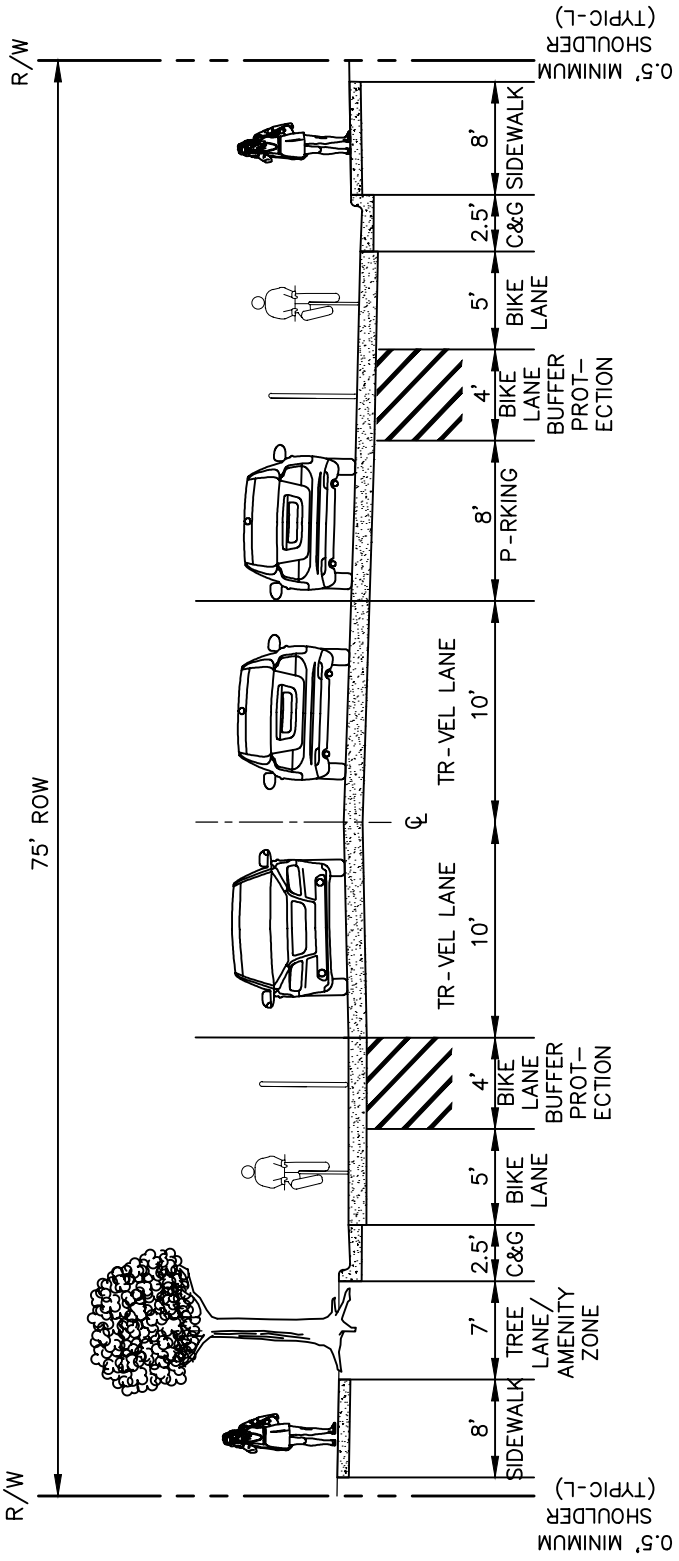
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

DOWNTOWN CONNECTOR TYPICAL SECTION

SHEET
SD - 44

DATE:
05/30/2025



75' RIGHT OF WAY
50' ROADWAY SECTION
(FL TO FL)

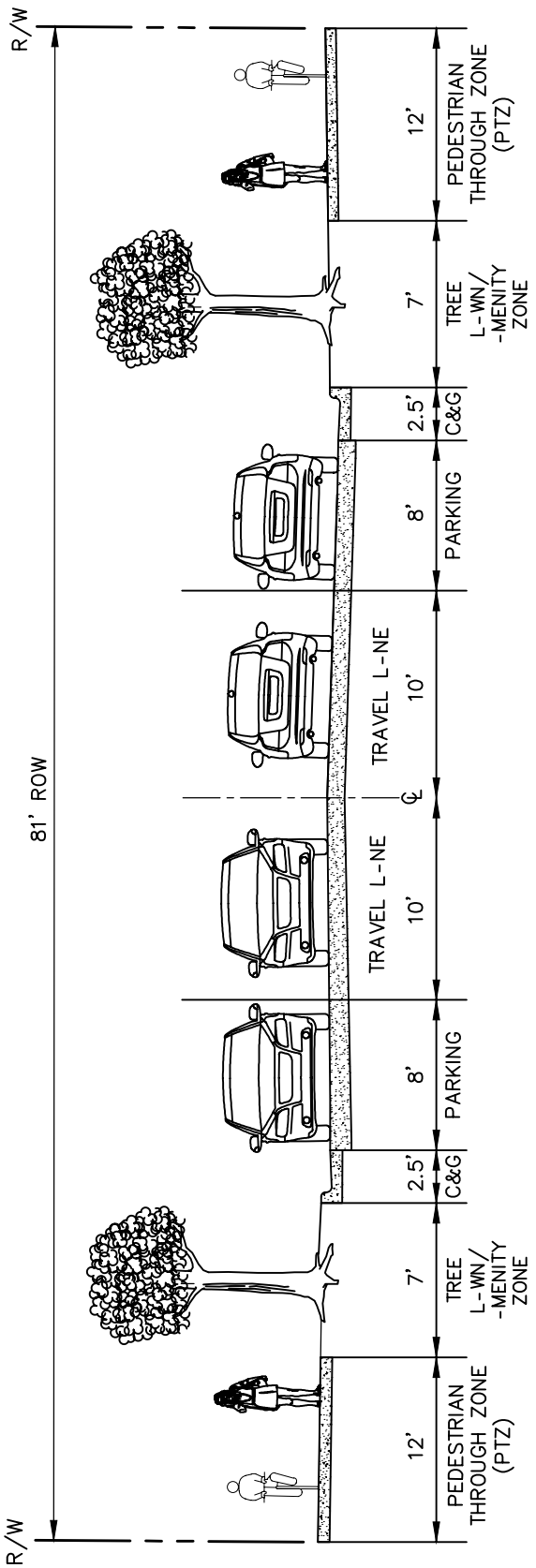
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

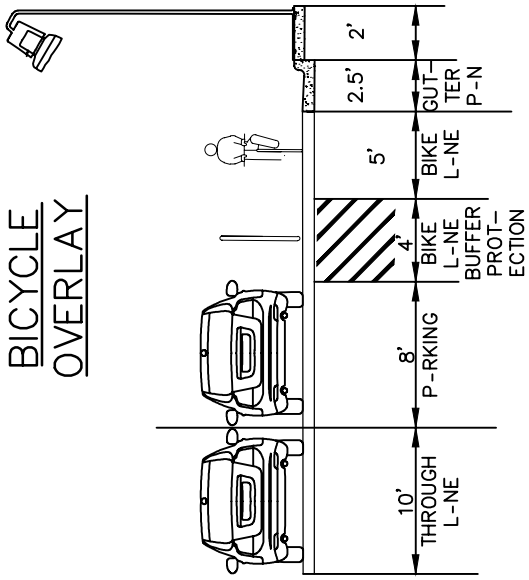
MIXED USE CONNECTOR TYPICAL SECTION

SHEET
SD - 45

DATE:
05/30/2025



81' RIGHT OF WAY
40' ROADWAY SECTION
(FL TO FL)



NOT TO SCALE

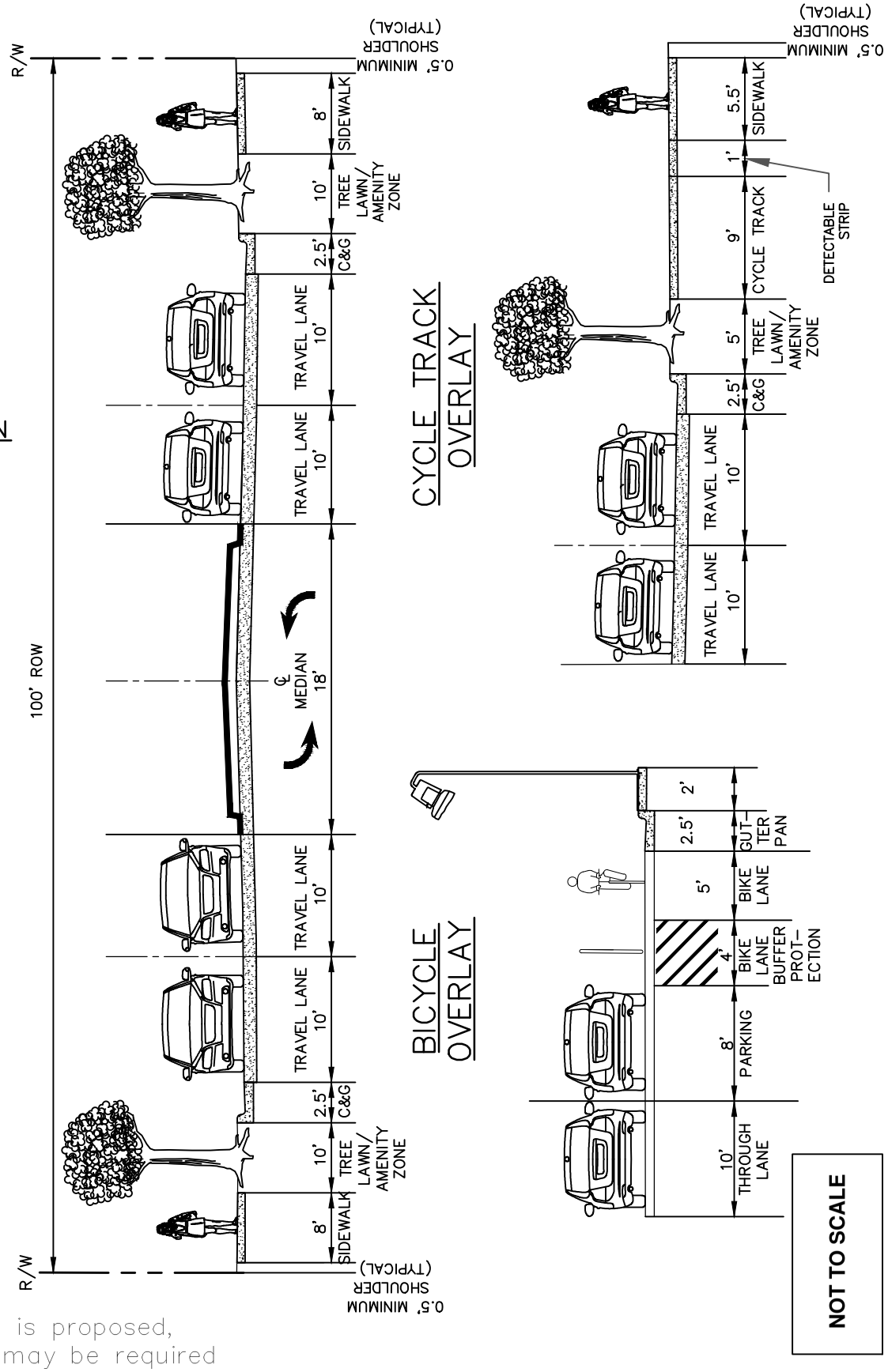
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

MIXED USE DOWNTOWN CONNECTOR TYPICAL SECTION

SHEET
SD - 46

DATE:
05/30/2025

100' RIGHT OF WAY
62' ROADWAY SECTION
(FL TO FL)



NOTES:

1. If a cycle track is proposed, additional ROW may be required

NOT TO SCALE

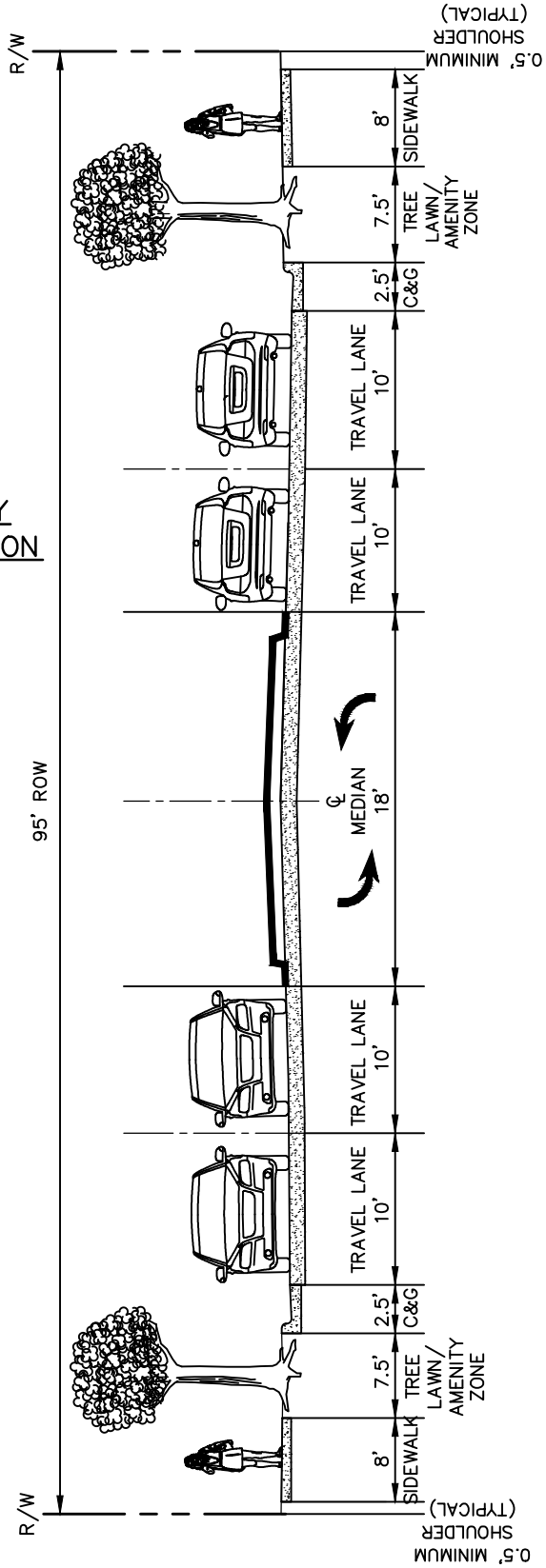
Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

SUBURBAN CONNECTOR TYPICAL SECTION

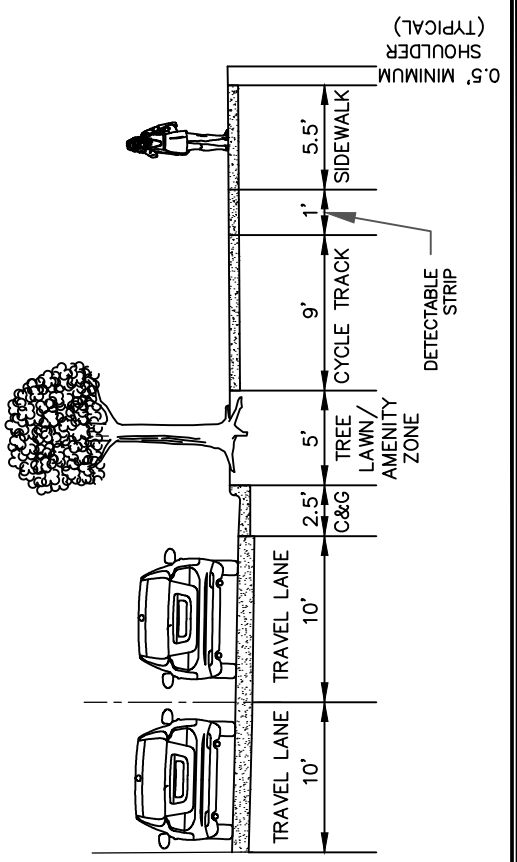
SHEET
SD - 47

DATE: 05/30/2025

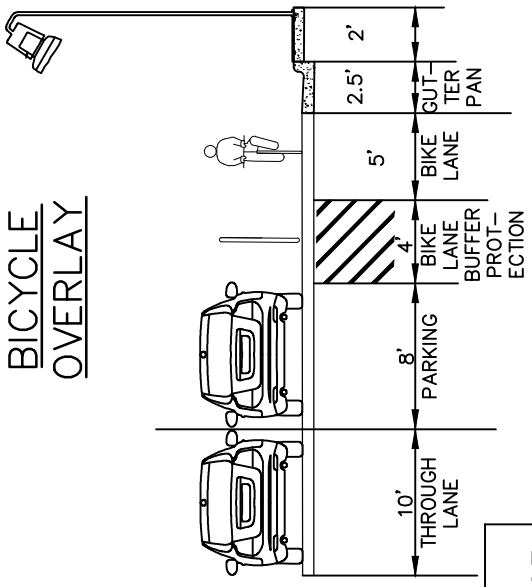
95' RIGHT OF WAY
62' ROADWAY SECTION
(FL TO FL)



CYCLE TRACK OVERLAY



BICYCLE OVERLAY



NOTES:

1. If a cycle track is proposed, additional ROW may be required

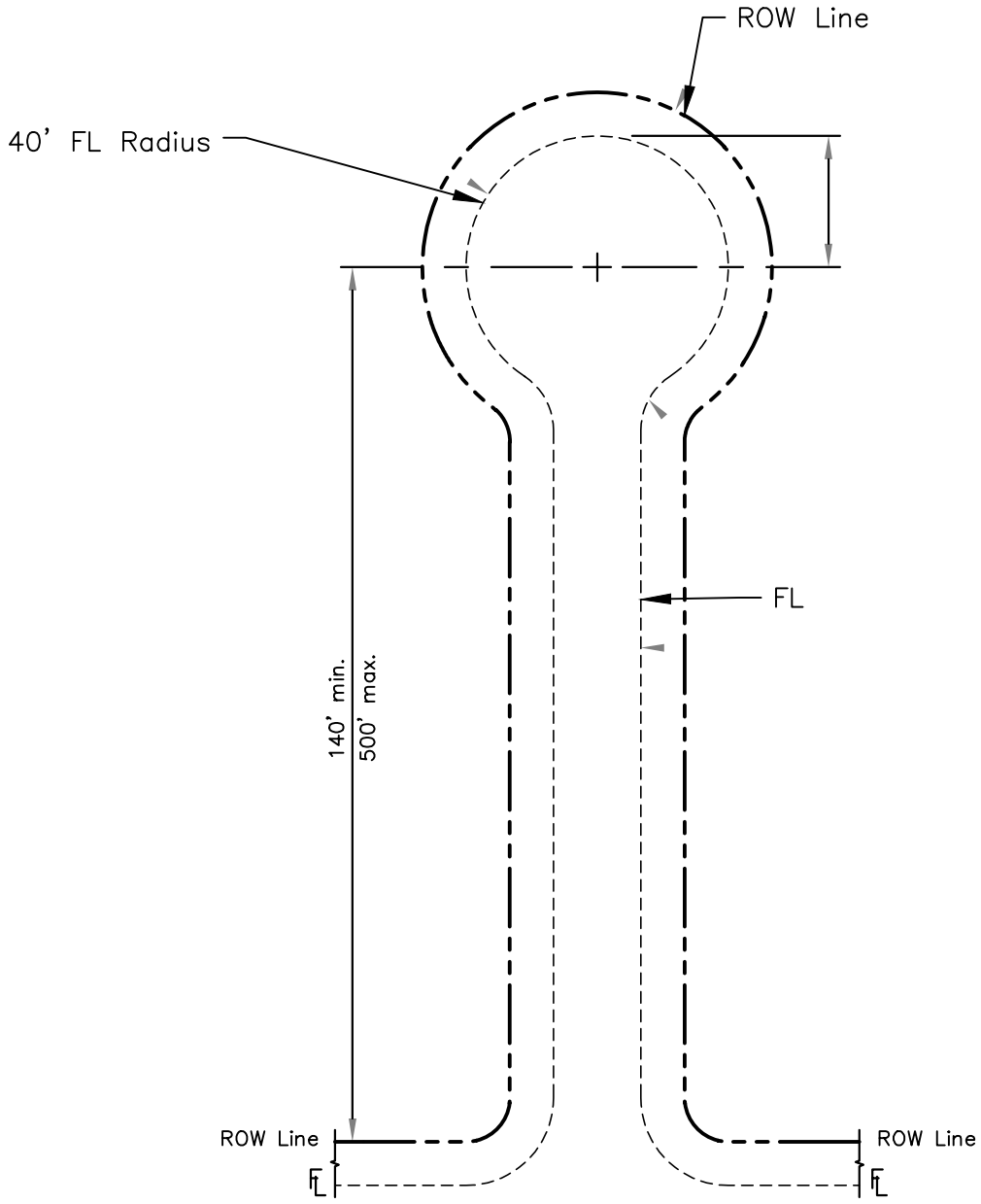
NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

COMMERCIAL CORRIDORS TYPICAL SECTION

SHEET
SD - 48

DATE:
05/30/2025



STANDARD CUL-DE-SAC

NOTES:

1. New cul-de-sacs must be approved by the City
2. ROW Line may vary based on specific site conditions.

NOT TO SCALE

Littleton Colorado
ENGINEERING & UTILITIES DIVISION
2255 West Berry Avenue
Littleton, CO 80120 (303) 795-3865
www.littletongov.org

CUL-DE-SACS TYPICAL SECTION

SHEET
SD - 49

DATE: 05/30/2025