

TOWN OF CASTLE ROCK

**Construction
Methodology and
Materials Manual**

September 2012

Note to User: This manual is a reproduction of Section III of the 1998 Town of Castle Rock – Public Works Regulations. The content of this manual is unchanged with the exception of where references to Town criteria documents, that no longer exist, have been overstruck. An update to this manual is anticipated in the near future. For assistance with the content of this manual, contact the Public Works Department – Engineering Division.

CONSTRUCTION METHODOLOGY AND MATERIALS

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DIVISION 1 GENERAL REQUIREMENTS

01.100.140 PROTECTION OF WORK AND PROPERTY

The Developer shall be responsible for all violations of Town ordinances and state laws involved in the performance of their work; and for obstruction of streets, sidewalks, alleys, and pavements, and shall in all cases make good any damage to any streets, sidewalks, alleys and pavements. They shall use every precaution to brace and otherwise support and secure the structural member and trench walls during the construction of the work; and shall provide, during the progress of their work, every and all safeguards and protection against accidents, injury and damage to persons and property including adjoining property. The Developer shall be responsible for their work and every part thereof, and for all materials, tools, appliances and property of every description used in connection therewith.

Accident Prevention: Precaution shall be exercised at all times for the protection of persons (including employees) and property. The safety provisions of applicable laws, ordinances, building and construction codes shall be observed. Machinery, equipment and all hazards shall be guarded or eliminated in accordance with the safety provisions or the Manual of Accident Prevention in Construction, published by the Associated General Contractors of America, to the extent that such provisions are not in contravention with applicable laws and O.S.H.A.

01.300.310 PROJECT MANAGEMENT COORDINATION

The Developer shall give personal supervision to the work, using their best skill and attention, and shall keep a competent Project Supervisor and necessary assistants constantly on the job site. All directions given by the authorized representative of the Developer shall be as binding as if given by the Developer.

The Developer shall carefully study and compare all drawings, specifications, and other instructions, and where dimensions are governed by existing conditions or by conditions already established. They shall make actual measurements themselves and shall report in writing to the Engineer, within 10 days of the receipt of the drawings, specifications and instructions for explanation or adjustment, any errors, disagreements or inconsistencies in the drawings and specifications or figured dimensions of the drawing, which may exist or appear to exist, before proceeding to execute that part of the work affected thereby. No changes in design may occur in the field without prior approval by the Town.

01.400.430 QUALITY ASSURANCE

The Town will provide an Inspector to oversee the construction process, including permit processing, key inspections, overall compliance with these Regulations and the approved plan set and acceptance procedures. During the construction process the Developer is required to provide testing on all infrastructure installation including compaction, concrete, asphalt and other applicable tests as described in **Table 1.400.450** of this Division.

430.1 General

These Regulations state the minimum requirements for materials sampling, testing, and inspection. All tests shall be made and certified by an approved testing laboratory. The Developer shall be responsible for retaining a qualified P.E. for material testing.

All field personnel shall be NICET, Level II or above. All costs required and pertaining to testing, the work performed and materials supplied to verify compliance with these Regulations, shall be the responsibility of the Developer.

All re-testing shall be at the Developer's expense. Where certified test reports are required to be furnished by the manufacturer, the Developer shall furnish duplicate copies of the reports to the Inspector before the material will be approved for use.

The use of a Geotechnical Engineer's services does not relieve the Developer of the responsibility to furnish the required materials and to perform the required construction in full compliance with these Regulations. Passing test results do not constitute acceptance of the work or materials represented by the test. The Developer is responsible for quality control of their work.

In various Sections of these Regulations, specific testing or other data is required by the Town to insure that the intent of these Regulations is fulfilled. The costs of such tests or other specific data where required by these Regulations or on the approved plans shall be borne by the Developer. Whenever, at the sole discretion of the Engineer, additional tests or data are required beyond that identified as required in these Regulations or on the approved plans, the costs of such tests shall be borne by the Developer. Should such tests or additional data show a failure to meet these Regulations or the approved plans, the Developer shall be responsible for the cost of such testing and data along with all costs associated with repair or replacement of said failure. This procedure is described in ~~Section I Policy & Procedures of these Regulations.~~

430.2 Use of Non-Approved Material

In the event any material or equipment proposed to be used by the Developer is disapproved by the Engineer as not meeting the requirements of these Regulations, said materials or equipment shall not be used on the Project. If, after approval of the Plans, the Developer desires to change any materials or equipment from that previously approved by the Engineer, said change shall be accomplished only by a written request to the Engineer. Any change must be approved by the Engineer before any materials can be ordered.

All materials used on the project shall be on the Town's approved materials list. If a material is not, the Developer shall submit the proper documentation and receive approval or denial from the Town within 45 days.

430.3 Pavement Design Report

The Pavement Design Report required in these Regulations shall be submitted and approved prior to any paving.

430.4 Geotechnical Engineer Access and Assistance

430.4.1 The Developer shall allow the Geotechnical Engineer access to the job site at all times. The Developer shall furnish any labor required to assist the Geotechnical Engineer in obtaining and handling samples at the source of material and at the Project. The Developer shall provide and maintain, for the sole use of the Geotechnical Engineer, adequate facilities for safe storage and proper curing of concrete test specimens on the Project site as required by AASHTO T23.

430.5 Mix Designs

The Developer shall furnish asphalt mix designs or bituminous concrete mix designs meeting the requirements of these Regulations. Concrete mix design shall be performed according to the provisions of ACI-211 or ACI-304. A separate mix design shall be provided if pumped concrete is used. These shall be submitted no less than 7 days prior to the proposed use.

430.6 Reports

Reports shall bear the seal and signature of a Professional Engineer registered in the State of Colorado and competent in the required testing practice. All test reports shall show the location where the test was performed or at which the work or batch represented by the test was placed. Test reports shall include all information specified in the AASHTO or ASTM test procedure used. Improperly completed reports will not be accepted. Certificates of Occupancy will not be issued until all final reports indicating compliance with these specifications are reviewed and placed on file by the Town of Castle Rock. The Geotechnical Engineer personnel are not authorized to stop work, to revoke, alter, relax, enlarge, or release any requirements of the Regulations, nor to approve, accept, or reject any portion of the Work on behalf of the Town.

01.400.450 QUALITY CONTROL
(Procedures to measure and report quality)

450.1 General

450.1.1 All testing methods and procedures performed by the Geotechnical Engineer personnel shall be in accordance with the applicable AASHTO and ASTM requirements and procedures (see Table 01.400.450). Test reports shall include the AASHTO and ASTM test designations of all tests taken. All testing and re-testing services shall be at the expense of the Developer. All re-testing due to failing tests shall be at the Developer's expense.

450.1.2 When changes in materials or proportions are encountered during construction, or when the work fails to pass tests or fails to meet the Regulations, additional tests shall be taken as directed by the Engineer. Failure of the Developer to furnish satisfactory test data shall be sufficient cause for rejection of the work in question.

MATERIALS TESTING
Table 01.400.450

SOILS	AASHTO	ASTM
Sampling	T87	D420
Soil Classification	M145	-
		D3282
Moisture-Density (Proctor)	T99	D698
	T180	D1557
Compaction (Sand Cone)	T191	D1556
(Nuclear) Density	T238	D2922
(Nuclear) Moisture Content	T239	D3017
Expansive Soils	T258	

ASPHALT		
Sampling	T168	D979
		D3655
Compaction (Resistance to Flow)	T245	D1559
Marshall One/650T		
		D1561
Density		DI188
		D2950
Asphalt Content	T164	D2172
	T269	D3203
Thickness		D3549
Aggregate Gradation		C136

CONCRETE		
Sampling	T141	C172
Mold & Cure	T23	C31
Transportation of Cylinders	T23	C31
Slump	T119	C143
Air Content	T152	C173
Pressure Volume	T196	
	T121	C138
Obtaining Cores	T24	C42
Air Content of Cores		C457
Cement Content of Cores	T178	C85

REFER TO APPENDIX III-B FOR THE QUICK REFERENCE

450.2 Soil Testing (For detail see Appendix III-B)

450.2.1 All testing shall be according to AASHTO or ASTM as designated in Table 01.400.450.

450.2.2 When density and moisture content are determined by a nuclear device, a sand cone density test may be taken daily at the discretion of the Engineer. If the sand cone tests do not agree with the nuclear tests, use of the nuclear device shall be immediately discontinued until the cause of the disagreement is determined and corrected.

A moisture-density determination shall be taken for each soil type encountered. The soil shall be moisture-treated to within 2 percent (optimum to +4% for A-6 or A-7-6) of optimum moisture content. For A-6 and A-7 soils, AASHTO T99 shall apply. All other soils use AASHTO T180. All subgrades shall be scarified, dried or have increased moisture to obtain the specified density and stability. The required density will be 95% of maximum density.

450.3 Asphalt Testing (For detail see Appendix III-B)

450.3.1 All testing shall be according to AASHTO or ASTM as designated in Table 01.400.450.

- 450.3.2 In-place density: A minimum of 1 test per 1,000 tons of material placed or fraction thereof or 1 per 250 lane feet.
- 450.3.3 Aggregate gradation: A minimum of 1 test per 1,000 tons or fraction thereof.
- 450.3.4 In addition to the requirements of Table 01.400.450, all reports shall include elevation or depth below finish grade at which test was taken. Results shall report densities (maximum dry and relative) to nearest 0.1lb/ft³, moisture content (optimum and in place) to nearest 0.1%, and compaction (relative and required) to nearest 0.1%, results of the daily standardization checks, and the most recent adjusted manufacturer's calibration curve. The manufacturer's calibration curve shall be adjusted as required by ASTM D2950 whenever a change in either the material to be tested or the testing equipment is made. If a nuclear device is used, the report shall contain the method used (i.e. back scatter, direct transmission, etc.)
- 450.3.5 In-place pavement thickness shall be determined as follows, if requested by Engineer: The pavement shall be cored at 500' intervals, or fraction thereof, in each 12' lane (nominal), with a minimum of 3 cores in any area. The Engineer may require additional cores to define deficient areas.

450.4 Concrete Tests (For detail see Appendix III-B)

- 450.4.1 All testing shall be according to AASHTO or ASTM as designated in Table 01.400.450, 01.400.450.4.4 A, B, and C. All concrete used in any infrastructure facility shall be no less than 4000 psi unless otherwise noted. Unless otherwise authorized, the temperature of the mixed concrete shall not be less than 50 degrees F and not more than 80 degrees F at the time of placing it in the forms. Air content % range shall be 5-8%, with a maximum slump of 4". Developer must submit a design mix to the inspector.
- 450.4.2 Sampling and testing shall be required on all concrete work including curb, sidewalk, pans, pavement, slope paving, retaining walls, inlets, manholes, or any other structures.
- 450.4.3 Maximum time between sampling and casting cylinders shall not exceed 10 minutes. If the concrete cannot be taken to the laboratory and cylinders cast within 15 minutes, the cylinders shall be cast in the field. Cylinders shall be transported to the laboratory within 24 hours of casting but after the concrete has hardened, (see AASHTO T23). All cylinders shall be 6" in diameter.
- 450.4.4 Concrete cylinders shall be broken according to the following table

CONCRETE CYLINDER BREAKS

Table 01.400.450.4.4A

NUMBER OF CYLINDERS	BREAK INTERVAL (days)
FIELD CURED SERIES (4 Cylinders)	
2	7
2	28
LABORATORY CURED SERIES (4 Cylinders)	
2	7
2	28

AIR, SLUMP AND CYLINDER FREQUENCY TESTS
(SDWKS, CURB AND GUTTER, INLETS, MANHOLES, MISC.)

TABLE 01.400.450.4.4B

Description	1 st Three Trucks	50 C.Y.'s and greater
Slump	1 each	1 per additional 50 c.y.'s
Air	1 each	1 per additional 50 c.y.'s
Cylinders	1 st truck only	1 per additional 50 c.y.'s

AIR, SLUMP AND CYLINDER FREQUENCY TESTS

CONCRETE PAVING

TABLE 01.400.450.4.4C

Description	1 st Three Trucks	100 C.Y.'s and greater
Slump -	1 each	1 per additional 100 c.y.'s
Air	1 each	1 per additional 100 c.y.'s
Cylinders	1" truck only	1 per additional 100 c.y.'s

450.5 Acceptance and Testing of Pipe for Water

450.5.1 Disinfection Testing

All water lines shall be disinfected prior to being put into service or being live tapped. Precautions shall be taken to protect the interiors of pipes, fittings and valves against contamination. Pipes delivered for construction shall be strung so as to minimize the entrance of foreign material. All openings in the pipeline shall be closed with water tight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods. Rodent-proof plugs may be used when it is determined that watertight plugs are not practicable and when thorough cleaning will be performed by flushing or other means.

Delay in placement of delivered pipe invites contamination. The more closely the rate of delivery is correlate to the rate of pipe laying the lower the risk of contamination.

Joints: Joints of all pipes in the trench shall be completed before work is stopped. If water ponds in the trench then plugs shall remain in place until the trench is dry.

Cleaning and Swabbing: if dirt enters the pipe, it shall be removed and the interior pipe surface swabbed with a 1- percent hypochlorite disinfecting solution.

Wet trench construction: If it is not possible to keep the pipe and fittings dry during installation, every effort shall be made to ensure that any of the water that may enter the pipe-joint spaces contains an available chlorine concentration of approximately 0 mg/L.

Flooding: IF the main is flooded during construction, it shall be cleared of the water by draining and flushing with potable water until the main is clean. The section exposed to the floodwater shall then be filled with chlorinated

potable water that at the end of a 24-hour holding period will have a free chlorine residual of not less than 50 mg/L.

450.5.1.1 Testing Procedure:
Test One: High Chlorine

There are three methods of high chlorination testing: table, continuous feed and slug. Refer to AWWA C651 for further detail. Free chlorine residual shall not be less than 50 mg/L. An additional test may be required at the Inspector's request within 12 hours of the first test.

Test Two: Low Chlorine

After the applicable retention period, heavily chlorinated water should not remain in prolonged contact with pipe. In order to prevent damage to the pipe lining or corrosion damage to the pipe itself, the heavy chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is less than 3.5 mg/L.

The environment into which the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment then a neutralizing chemical shall be applied to the water to be wasted to neutralize thoroughly the chlorine residual remaining in the water.

Test Three: Bacteriological Tests

After final flushing and before the new water main is connected to the distribution system, bacteriological samples shall be collected from the new main. At least one set of samples shall be collected from every 1200 ft. of the new main, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological quality in accordance with the Colorado Department of Health Regulations.

If trench water has entered the new main during construction or, if in the opinion of the Inspector, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200 ft. and shall be identified by location.

450.5.1.2 Disinfection Procedures When Cutting Into or Repairing Existing Mains

When an existing main is opened, either by accident or by design, the excavation will likely be wet and may be badly contaminated from nearby sewer. Liberal quantities of hypochlorite applied to pen trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue

to release hypochlorite as water is pumped from the excavation.

Swabbing with Hypochlorite: The interior of all pipe and fittings (particularly couplings and sleeves) used in making the repair shall be swabbed or sprayed with a 1 percent hypochlorite solution before they are installed.

Flushing: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valve and hydrant locations permit, flushing toward the work location from both directions is recommended. Flushing shall be started as soon as the repairs are completed and shall be continued until discolored water is eliminated.

Slug Chlorination: When practical, in addition to the procedures above, the section of main which the break is-located shall be isolated, all service connections shut off, and the section flushed and chlorinated as described previously.

Bacteriological Testing: Samples shall be taken after repairs are completed to provide a record for determining the procedure's effectiveness. If the direction of flow is unknown, then samples shall be taken on each side of the main break.

450.5.2 Pressure Testing of Pipe:

No hydrostatic tests shall be made on any portion of the pipeline until all field placed concrete has had adequate curing time. All pipe shall be field pressure-tested to not less than the pressure class of the pipe. The distribution lines shall be segmented for testing so that the test pressure at the high point shall be not less than 150 psi. The Inspector shall approve the method of supplying water for hydrostatic testing as well as the source of the water. The Developer shall be responsible for supplying the equipment, etc., necessary to accomplish the prescribed testing.

The pipeline shall be in a state of readiness for testing; all bulkheads, pumps, taps and appurtenances necessary to fill the pipeline and maintain the required pressure shall be in place. The pipeline shall be filled with water and the test pressure of not less than the pressure class of the pipe, applied to the pipeline by means of a pump, equipped with a suitable pressure regulator and water meter. When filling the pipeline, it shall be filled at a rate which will not cause any surges nor will it exceed the rate at which the air can be released. All air in the line shall be properly purged.

Where blow-offs or hydrants are not available or are not effective in purging air from the line, a tap to purge the line is required. While the test pressure is maintained, an examination shall be made of the pipeline in general, and any leaks shall be repaired. Any pipe or fitting found to be cracked shall be removed and replaced. Cutting and replacing pavement, excavating and back-filling are a necessary part of locating and repairing leaks discovered by pressure testing of pipe. After all visible leaks have been stopped, the full test pressure shall be maintained for two continuous hours. The following are tabulated allowable leakage rates between line valves:

ALLOWABLE LEAKAGE (L) PER 1000' OF PIPELINE = gph
Nominal Pipe Diameter - Inches (DIP or PVC)

TABLE 01.400.450.5

Avg. Test Press (psi +5)	6	8	10	12	14	16	18	20	24	30
275	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	3.73	4.48
250	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.85	3.56	4.27
225	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.70	3.38	4.05
200	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.55	3.19	3.82
175	0.59	0.80	0.99	1.19	1.39	1.59	1.79	2.38	2.98	3.58
150	0.55	0.75	0.92	1.10	1.29	1.47	1.66	2.21	2.76	3.31

Allowable leakage for each section between line valves shall not exceed the leakage rate set forth. No leakage is allowed through the bonnet of the line valve. Any valve leakage through the bonnet shall be repaired in place or removed and replaced. Should testing show a leakage rate in excess of the rates shown, the pipeline shall not be accepted. The pipeline shall be repaired and re-tested as described in this section until it meets the test requirements.

450.5.3 Acceptance of Pipe:

The pipeline system may be placed in operation after all required cleaning, testing and inspection have been completed and written permission has been granted by the Utilities Supervisor. However, this does not imply construction acceptance or initiation of warranty period. Refer to Policy and Procedures 1.2.5 for specifics concerning acceptance and warranty of work and materials.

450.6 Acceptance and Testing of Pipe for Sewer

450.6.1 General:

Tests for water-tightness shall be conducted by the Developer at his/her own expense. The testing will be under the direction of the Inspector on all new sewer construction, after back-filling and compaction and prior to final acceptance. The Developer has the option of using either the water exfiltration test or the air pressure test. Either test must meet the requirements and procedures of the pipe manufacturer or relevant ASTM Specifications, whichever is more stringent. If, in the opinion of the Inspector, excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test for leakage will be replaced with the infiltration test in accordance with pipe manufacturers specifications or relevant ASTM Specifications. When leakage or infiltration exceeds the amount allowed by the relevant specification, the Developer, at its expense, shall locate the leaks and make the necessary repairs or replacements to reduce the leakage or infiltration to the specified limits. Any individually-detectable leaks shall be repaired, regardless of the test results.

Air testing:

1. The air test shall be made when the sewer is clean. The pipe, or sections of pipe to be tested, may be wetted before the air test. The line shall be plugged at each manhole with pneumatic plugs. Low pressure air shall be introduced

into the plugged line until the internal pressure reaches four (4.0) p.s.i.g. greater than the average back pressure or any ground water pressure that may submerge the pipe. At least two (2) minutes shall be allowed for the air temperature to stabilize before readings are taken and the time is started.

2. The portion being tested shall pass if it does not lose air at a rate to cause the pressure to drop from 3.6 to 3.0 p.s.i.g. (greater than the average back pressure of any ground water that may submerge the pipe) in less than the time listed below. If failure of the test occurs in any section that section must be repaired and retested until satisfactory results are achieved.

<u>Pipe Diameter</u> <u>In Inches</u>	<u>Minimum Allowable Minutes</u> <u>3.6 - 3.0 psig Pressure</u>
4	2.0
6	3.0
8	4.0
10	5.0
12	6.0
15	7.5

3. All service plugs shall be secured in place to prevent displacement during testing operations.

Mandrel Test of PVC Pipe:

The Engineer shall require a mandrel test of all, or any portions of, installed PVC sewer line. Following backfill and compaction, but prior to pavement surfacing, the main line shall be cleaned and then mandreled to measure for obstructions, (deflections, joint offsets and lateral pipe intrusions). A rigid mandrel, with a circular cross-section having a diameter of at least 98 percent of the specified average inside diameter, shall be pulled through the pipe by hand. Obstructions encountered by the mandrel shall be corrected by the Developer. All material, equipment, and labor to perform the test shall be provided by the Developer at no cost to the Town.

450.6.2 Acceptance of Pipe:

The sewer collection system may be placed in operation after all required cleaning, testing and inspection have been completed and written permission has been granted by the Engineer; however this does not imply construction acceptance or initiation of warranty period. Refer to Policy and Procedures 1.2.5 for specifics concerning acceptance and warranty of work and materials. Television camera inspection of sewer pipe may be required if unresolved problems are not corrected. If this is necessary, such television camera inspection costs shall be borne by the Developer.

450.7 Acceptance and Testing of Pipe for Storm

450.7.1 Inspection:

The quality of materials, the processes of manufacture, and the finished pipe shall be subject to inspection and approval by the owner.

450.7.2 Repairs:

Pipe may be repaired, if necessary, because of imperfections in manufacture or

damage during handling and will be acceptable if, in the opinion of the owner, the repaired pipe conforms to the requirements.

450.7.3 Rejection:

Pipe shall be subject to rejection of account of failure to conform to any of the specification requirements. Individual sections of pipe may be rejected because of any of the following:

- a) Fractures or cracks passing though the wall, except for a single end crack that do not exceed the depth of the joint.
- b) Defects that indicate proportioning, mixing, and molding not in compliance with section 10.1 of the ASTM Concrete Pipe standard or surface defects indicating honey-combed or open texture that would adversely affect the function of the pipe.
- c) The ends of the pipe are not normal to the walls and centerline of the pipe, within the limits of variation given in 12.3 and 12.4 of the ASTM Concrete Pipe standard.
- d) Damaged or cracked ends where such damage would prevent making a satisfactory joint.
- e) Any continuous crack having a surface width of 0.3 mm or more and extending for a or more, regardless of position in the wall of the pipe.

01.500.520 **CONSTRUCTION FACILITIES**

520.1 Dust Abatement: The Developer shall make sufficient efforts to minimize dust from development of the Project. The Developer shall meet all State requirements for dust abatement. The Developer shall have a vehicle to provide sufficient means to mitigate dust on site at all times during overlot grading or other earthwork activities, in an expedient manner.

- a) If the Developer cannot effect dust abatement immediately upon direction of the Town, all other earth disturbing activities shall be stopped until sufficient measures are taken to the Town's satisfaction.

520.2 Erosion Control Devices: All required Erosion Control Devices, as specified on the plans, shall be installed prior to the start of any construction, but after the issuance of the permit. The Developer shall have the approval of the Town Inspector prior to starting any Work after the erosion control is in place.

520.3 Protection of Work: The Developer shall cover and protect their work from damages and all injury to same, before the completion and final acceptance of the Work by the Town.

520.4 Work in Inclement Weather: No construction work shall occur during freezing or inclement weather, except such as can be done satisfactorily and in a manner to secure quality construction in compliance with these Regulations. No concrete shall be poured when the ambient air temperature is 40 degrees (F) and falling, unless provisions are in place to keep the concrete from freezing in accordance with CDOT. No top lift asphalt shall be placed in temperatures less than 50 degrees (F). All lower lifts of asphalt may be placed in temperatures of 40 degrees and rising. The minimum thickness of the lower lift shall be 4" of Grading G.

520.5 Sanitary Facilities: The Developer shall provide sanitary facilities on-site for the duration of

the construction for the Project. The facilities shall be maintained in a sanitary and safe manner to the satisfaction of the Town.

520.6 **Clean-Up Work:** Complete clean up of the Project Area or other areas affected by the Project is necessary for satisfactory completion of the Project. Clean-up, as a minimum condition of these Regulations, shall include all of the Project Area, which shall be restored to a condition in appearance, usability and functional condition at least equal to that which existed prior to the beginning of the Project. In addition, all Public or Private Improvements shall be thoroughly cleaned to facilitate proper operation of the improvement(s). Clean-up work may also be required during the course of Work for the Project (on-site or for those effected off-site areas) to the satisfaction of the Inspector. Of specific interest to the Town are roadways leading to and from the Project.

520.7 **Traffic Interruption:** The Developer shall not interrupt the flow of traffic (vehicular, pedestrian or other) along, across, through or to any properties, private or public, for a period exceeding four (4) hours, without express written permission through the required Traffic Control Plan. It shall be the sole responsibility of the Developer to provide prior notification to the Town and to make satisfactory arrangements with any affected property owners.

520.8 **Use of Job Site and Private Land:** The Developer shall confine his equipment, apparatus and the storage of materials and operations of his workers to limits indicated by law, ordinances, permits, easements or directions of the Town. The Developer shall not use any vacant lot or private land without written authorization of the Owner of the land. A copy of this written authorization shall be given to the Town.

520.9 **Accident Prevention:** Precaution shall be exercised at all times for the protection of persons (including employees) and property. The safety provisions of applicable laws, ordinances, building and construction codes shall be observed. Machinery, equipment and all hazards shall be guarded or eliminated in accordance with the safety provisions or the Manual of Accident Prevention in Construction, published by the Associated General Contractors of America, to the extent that such provisions are not in contravention with applicable State and Federal laws.

01.500.530 **TEMPORARY TOILET FACILITIES**

Sanitary Facilities: The Developer shall provide sanitary facilities on site for the duration of the construction for the Project. The facilities shall be maintained in a sanitary and safe manner to the satisfaction of the Town.

01.500.560 **TEMPORARY BARRIERS & ENCLOSURES**

560.1 **Traffic Interruption:** The Developer shall not interrupt the flow of traffic (vehicular, pedestrian or other) along, across, through or to any properties, private or public, for a period exceeding four (4) hours, without express written permission through the required traffic control plan. It shall be the sole responsibility of the Developer to provide prior notification to the Town and to make satisfactory arrangements with any affected property owners. The Developer shall obtain all applicable permits and an approved traffic control plan prior to the commencement of construction.

At least 10 working days prior to the commencement of work, the Developer shall provide the Town Engineering Division with a Traffic Control Plan for any work that will affect any public thoroughfare. The plan shall be reviewed and approved prior to the commencement of any work within the jurisdiction of these Regulations. The plan shall be submitted on the Overall Plan as required in ~~Section I – Policy and Procedures – Appendix I-A~~ and meet the requirements of MUTCD, Part VI, latest revision. The plan shall be completed on a 24" x 36" sheet, at a readable scale, showing all adjacent streets and affected areas. The Traffic Control

Plan shall be prepared by a certified ATSSA Traffic Technician, or Licensed Professional Engineer qualified in Traffic/Transportation Engineering. The Town may waive this requirement if the Project is deemed minor and does not require traffic control.

560.2 The Traffic Control Plan: should include a map showing the location and type of advanced warning signs and barricades to be used. The Traffic Control Plan shall include installing, maintaining-, and removing all advance signing at each end and along the construction zone to alert the public. The Plan shall also include all other signs, barricades, flagging personnel, lights, and other devices necessary for the protection of the Work and safety of the public. All traffic control signing and devices shall be in accordance with the "Manual of Uniform Traffic Control Devices.

01.500.660 **PRODUCT STORAGE & HANDLING REQUIREMENTS**

Use of Job Site and Private Land: The Developer shall confine his equipment, apparatus and the storage of materials and operations of his workmen to limits indicated by law, ordinances, permits, easements or directions of the Town. The Developer shall not use any vacant lot or private land, without written authorization of the Owner of the land. A copy of this written authorization shall be given to the Town.

01.700.740 **MAINTENANCE OF THE SITE**

Clean Up Work: Complete clean up of the Project Area or other areas affected by the Developer are necessary for satisfactory completion of the Project. Cleanup, as a minimum condition of these Regulations, shall include all of the Project Area and existing public facilities, and be restored to a condition in appearance, usability and functional condition at least equal to that which existed prior to the beginning of the Project. In addition, cleanup includes cleaning up of the public improvements such as removal of mud or dirt from roadways to such an extent that their functioning is not impaired. This may require the use of a sweeper. The Developer shall be responsible for all costs associated with this cleanup.

APPENDIX III-A
CONSTRUCTION SPECIFICATION TOLERANCES

I. PURPOSE

Below is a construction tolerance list to aid in the construction of subdivision improvements, and to provide technical guidelines for acceptance by Department of Public Works. It is to be used by the Developer prior to any acceptance inspection for repairs or replacement of work to meet Town standards and specifications. It will be used by the Town as guidelines during construction, initial and final acceptances.

This list of construction specification tolerances are additions to the latest edition of the Colorado Department of Highways Standard Specification for Road and Bridge Construction, special provisions and revisions thereto and by the current subdivision regulations of the Town.

II. TOLERANCES

Curb, gutter and walk, crosspans, etc.

1. Any localized humps and/or depressions greater than 1/4 inch (as measured with a 10 foot straight edge) will require removal and replacement of the work in question.
2. No ponding of water greater than 3/8 inch shall be allowed.
3. Combination curb, gutter and walk and/or vertical curb and gutter flowline depth shall not vary from adopted standards by more than + 1/2 inch, measured vertically from the top of curb to the gutter invert.
4. Pedestrian walks shall have a minimum of 2.0 percent and a maximum of 2.5 percent slope toward the roadway.
5. Contraction and construction joints shall be placed at a maximum spacing of 10 feet in curb, gutter, sidewalks, crosspans, trickle channel, etc. A minimum spacing of 5 feet will be allowed for repairs.
6. Heave or settlement of sidewalk, relative to separate curb pour, greater than 1/2 inch shall be cause for corrective action. This provision shall not apply to transverse sidewalk joints.

Roadways

1. Asphalt Roadways
 - a) All manholes, water valves, range boxes, etc., shall be 1/4 inch to 1/2 inch below the final paved grade. The finish grade of pavement shall be 1/4 inch above the rim elevation with a 2 foot transition provided.
 - b) Any humps and depressions greater than 1/4 inch as measured with a 10 foot straight edge shall be cause for corrective measures.

- c) Additional asphalt thickness of up to 1/2 inch will be permitted at the joint of the roadway and gutter pan and will be included in the actual asphalt thickness. Corrective action may be required for additional asphalt in excess of 1/2 inch. In no case will asphalt in excess of 1/2 inch above the cutter pan be included in the asphalt thickness for acceptance purposes.
2. Concrete Roadways
- a) All manholes, water valves, range boxes, etc., shall be flush to 1/4 inch below the final surface roadway grade.
 - b) Where the departure from the design cross slope exceeds 1/2 inch in 10 feet, the pavement shall be removed and replaced.
 - c) Areas showing high spots greater than 1/4 inch as measured with a 10 foot straight edge, but less than 1/2 inch, shall be ground to within the specification of 1/4 inch.

III. GENERAL SPECIFICATIONS

Curb, gutter and walk, crosspans, etc.

- 1. No utility facilities shall be placed in curb, gutter or walk, crosspans, etc., unless shown on the approved construction plans. This includes water stop box, manholes, power poles, fire hydrants, water valves, etc.
- 2. Concrete Cracks
 - a) At the time of initial or final acceptance inspection, no cracks will be accepted and shall be removed to the nearest control joints. Time of replacement (initial or final acceptance) shall be decided by the Town Inspector.
 - b) At the time of final acceptance inspection, the repair of all cracks will be completed.
 - 1) Individual non-connecting cracks that are less than 1/4 inch wide, exhibit no horizontal or vertical shifting, and do not meet the conditions in 2), 3), and 4) below may, at the discretion of the Engineer, be sealed by routing approximately 3/4 inch to 1 inch deep by 1/4 inch wide and filling with Sikaflex 1-A or equal.
 - 2) Any crack that extends through a joint shall require removal and replacement of the entire cracked area.
 - 3) Any crack in a 4-inch thick walk will require removal and replacement of the entire cracked section between joints.
 - 4) Any longitudinal cracked section of concrete will require complete removal and replacement of that section between joints.
 - 5) Repair action for hairline cracks as determined in 1) above may be waived at the discretion of the Town. For the purpose of this section, a hairline crack is one that is reasonably immeasurable and without separation as determined by the Town.

- 6) Two or more connecting cracks shall require removal and replacement of the entire cracked area.
3. Final Grade
- a) A light broom finish (not to expose the aggregate) to all concrete shall be required.
 - b) All concrete work shall have the proper finished grade. No reversal of the flow path will be accepted by Town.
 - c) No abrupt changes in grade shall be allowed, i.e., curb returns from new to existing, driveway entrances, etc.

Roadways

- 1) Asphalt
 - a) Individual and non-deflecting cracks in the asphalt shall, at the discretion of Town, be sealed with rubberized asphalt sealant approved by the Town, to include cracks or open sawed joints at patch areas.
- 2) Concrete
 - a) All panels with cracks wider than 1/8 inch shall be repaired by a partial or total removal of the panel and replacement as required by the criteria herein. At the time of initial acceptance no cracks will be allowed and shall be repaired on full panel basis.
 - b) All panel cracks 1/8 inch and narrower may be routed and sealed.
 - c) There shall be no more than one (1) structural crack per panel. Panels with more than one structural crack shall be repaired by a partial or total panel removal and replacement.
 - d) At Warranty acceptance, the minimum section for removal of any panel shall be 1/3 of the panel width but in no case less than 4 feet. All partial panel removals shall be full panel length (longitudinal).
 - e) All sections removed shall have edges approximately parallel to adjacent panel joints.
 - f) All saw cuts for removal of slabs shall be full depth cuts.
 - g) No panels shall be allowed which has a crack meeting an adjacent panel at an angle more acute than 45 degrees to a finished edge or control joint.
 - h) All corner cracks to a panel shall be removed and replaced as required by the criteria contained herein.
 - i) Any vertical differential movement across a crack greater than 3/16 inch shall be repaired by either partial or total panel removal and replacement.
 - j) All panels with faulted joints resulting from settlement, pumping, and/or curing of the edges shall be repaired by removal and replacement, or in the case of curling, may be repaired by grinding at the discretion of the

Representative of the Town.

- k) All joint seal damage that allows the intrusion of water or foreign material shall be cleaned and replaced in accordance with Town standards.
- l) All compaction shall meet the requirements of ~~Section III~~ of these Regulations.

Requirements and Specifications for Concrete Road Repair Prior to Final Acceptance for Town Maintenance

1. All panels with cracks wider than 1/8" shall be repaired by a partial or total removal of the panel and replacement as required by the criteria herein.
2. All panel cracks 1/8" and narrower may be routed and sealed.
3. There shall be no more than one (I) structural crack per panel. Panels with more than one structural crack shall be repaired by a partial or total panel removal and replacement.
4. The minimum section for removal of any panel shall be 1/3 of the panel length or width but in no case less than 4 feet.
5. All sections removed shall have edges approximately parallel to adjacent panel joints.
6. All saw cuts for removal of slabs shall be full depth cuts.
7. No panels shall be allowed which meet an adjacent panel at an angle more acute than 45 degrees to a finished edge or control joint.
8. All corner cracks to a panel shall be removed and replaced as required by the criteria contained herein.
9. Any vertical differential movement across a crack greater than 3/16" shall be repaired by either partial or total panel removal and replacement.
10. All panels with faulted joints resulting from settlement, pumping-, and/or curling of the edges shall be repaired by removal and replacement, or in the case of curling, may be repaired by grinding at the discretion of the Engineering- Division Inspector.
11. All joint seal damage that allows the intrusion of water or foreign material shall be cleaned and replaced in accordance with Town standards.
12. All compaction shall meet 95% or greater Standard Proctor at plus or minus 2% optimum moisture content.
13. Any other defect not mentioned but noted as a problem by the Inspector.

Appendix III-B

SOILS						
	AASHTO	ASTM			Type of Test	Mitt. Freq..
	T191, T283, T99, T239, T180, T258	D3017, D3282, D1556, D2922, D698, D1557	Trenches			
				Gas, electric, phone & cable T.V.	Moisture/Density	1 per 250 11 every 1' elev. and 1' from all structures
				Sanitary sewer	Moisture/Density	1 per 250 .l.f. every 1' elev. and 1' from all Structures
				Water	Moisture/Density	1 per 250 l.f. every 1' elev. and 1' from all structures
				Water Service Lines	Moisture/Density	Ever), service line, 5' in from ROW line, two tests per service.
		I		Storm	Moisture/Density	1 per 250 11 every 1' elev. and 1' from all structures
			Structures			
				Inlets	Moisture/Density	1' in elevation alternating per 90° per lift
				Manholes	Moisture/Density	1' in elev., spiraling around the M.H.
				Valves	Moisture/Density	1' in elevation, spiraling around the valve.
				Detached sidewalk	Moisture/Density	1 per 250 l.f. every, .5' of fill
				Detached sidewalk	Proof roll	Subgrade
			Overlot		Moisture/Density	1 per 1000 c.y.'s of material placed
			Roadway			
				Sidewalk, curb and gutter	Moisture/Density	1 per 250 l.f. every o.5' of fill
				Sidewalk, curb and gutter	Proof roll	All subgrade
				Subgrade	Moisture/Density	1 per 500 lane feet
				Subgrade	Proof roll	All subgrade
				Subgrade/M.H., inlets, valves	Moisture/Density	1 per each structure
				Roadway Fill	Moisture/Density	1 per 500 l.f. per lift, per lane
				Base course	Moisture/Density	1 per 500 lane ft. with 20% within 1' of structures
				Base Course	Gradation & Atterberg limits	1 per 1000 c.y.'s
				Base course	Proof roll	All basecourse.

CONCRETE						
	T23,24, 119, 121, 141, 152, 178,196	C31, 42, 85, 138, 143, 172, 173				
			Structures	Inlets	Air and slump Cylinders Steel	First 3 trucks, every 50 c.y. thereafter 1 set per first truck every 50 c.y. thereafter Visual documentation
				Manholes	Air and slump Cylinders	First 3 trucks, every 50 c.y. thereafter 1 set per first truck every 50 c.y. thereafter
		I		Sidewalk, curb & gutter	Air and slump Cylinders	First 3 trucks, every 50 c.y. thereafter 1 set per first truck every 50 c.y. thereafter
				Roadways	Air and slump Cylinders	First 3 trucks, thereafter every 100 c.y. 1 set per first truck, every 100 c.y. thereafter
ASPHALT						
	T164, 168, 245,269	D979, 3655, 1559, 1561, 1 188, 2950, 2172, 3203, 3549, 136	Roadways		Density	1 per 250 lane feet
					Extraction, gradation, Marshall I	1 per 1000 tons, interval may be increased to I per 1/2 production.
CORING Note 2			Roadways (asphalt, concrete)		Cores (density & thickness verification)	1 per 500 lane feet
			Roadways (concrete)		Profil-o-Graph	All roadway

Note 1: Testing must happen concurrently with grading and backfilling operations at the required horizontal and vertical intervals per the above table. Note 2: All cored holes must be filled with the same material.
Note 3: On-site mixing prohibited.
Note 4: Roadway fill is the cross section including any embankment fill inside or outside the ROW.

DIVISION 2 SITE CONSTRUCTION

02.0550.000 BASIC SITE MATERIALS & METHODS

02.050.0 SOILS

055.1 Soils

- 055.1.1 General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations.
- 055.1.2 Satisfactory Borrow Soil Materials: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM; free of rock or -ravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.
055. L3 Unsatisfactory, Borrow Soil Materials: ASTM D 2487 soil classification groups GC, SC, ML, MHO, CL, CH, OL, OH, and PT. No top soil shall be used for fill at any time.

055.2 Bedding and Backfilling, General

- 055.2.1 Bedding is defined as the material supporting, surrounding, and extending 1' above the top of the pipe. Where it becomes necessary to remove boulders or other interfering objects at sub-grade for bedding, any void below such subgrade shall be filled with the bedding material designated on the approved plans.
- 055.2.2 If soft, spongy, unstable or other similar materials are encountered upon which the bedding material or pipe is to be placed, this unstable material shall be removed to the depth ordered by the Inspector and replaced with bedding adequately compacted. This additional bedding, if required, shall be provided by the Developer. The required class of bedding should be designated on the approved plans, and if not, the bedding class designations for specific pipe required in these Regulations shall be adhered to. The Developer may select a higher class of bedding at their option. Refer to *Standard Details for the specific utility trenching detail*.
- 055.2.3 Ordinary backfill shall consist of material excavated from the site except topsoil, rubbish, frozen material, broken pavement, stones or other consolidated material greater than 3" in diameter, organic muck or other materials considered unacceptable by the Inspector.
- 055.2.4 Imported backfill material shall be a well-graded mixture of sound mineral aggregate particles containing sufficient, proper quality bonding material, to secure a firm and stable foundation when placed and compacted. A suggested gradation would be material with a liquid limit not greater than 35 and a maximum of 20% of the aggregate by weight passing the No. 200 sieve (Class 3 Aggregate Base Course, CDOT Standard Specifications, Section 703.03). Where the subgrade layer is less than 6", the maximum size shall not exceed two-thirds the depth of the layer. Clay and similar material with a plasticity index in excess of 20, will not be acceptable for back filling trenches located in streets, roads, highways, thoroughfares.

55.2.5.1 Structure backfill material shall be Class I structure backfill (CDOT Standard Specifications, Section 703.08) meeting the gradations below.

Structure Backfill Sieve Size	% by Weight Passing Lab Sieves
2"	100
#4	30-100
#50	10-60
#200	5-20

055.3 Classes of Bedding

055.3.1 Class A Bedding (Concrete Cradle):

Class A bedding shall be defined as that method of bedding in which the lower half of the pipe is set in reinforced concrete. The minimum thickness of concrete under the lowest part of the conduit shall be one-fourth of the outside pipe diameter, but not less than 6". The concrete shall extend upward around the pipe to the spring line widest section of pipe of the pipe barrel. The concrete cradle shall be a minimum of 6" thick in all places. Reinforcement shall be #4 deformed bars 12" laterally on centers. Backfill material shall be hand compacted to a depth of 1' above the pipe.

055.3.2 Class B Bedding (Granular II):

Class B bedding shall be defined as that method of bedding in which the pipe is set on compacted granular bedding material. The trench shall be excavated to a depth below the established grade equal to one-fourth of the outside diameter, but not less than 4". In rock excavation, the minimum depth shall be 6". Granular bedding material shall be placed and compacted under the pipe and around the sides of the pipe to the spring line widest section of pipe. The granular bedding material shall be consolidated and compacted by hand-operated mechanical vibrators. Backfill material shall be hand-compacted to a minimum depth of 1' above the pipe. This type bedding shall be considered equivalent to AWWA Standard C150, Laying Condition Type 5.

055.3.3 Class C Bedding (Granular I):

Class C Bedding shall be defined as that method of bedding material supporting the lower quadrant of the pipe barrel. The trench shall be excavated to a depth below the established grade equal to one-eighth of the outside pipe diameter, but not less than 4". Compacted granular material shall be placed under the pipe and around the sides of the pipe to a minimum of one-quarter of the outside pipe diameter from the bottom of the pipe barrel. The granular bedding material shall be consolidated and compacted by hand-operated mechanical vibrators. Backfill material shall be hand-compacted to 1' above the pipe. This type of bedding shall be considered equivalent to AWWA Standard C 150, Laying Condition Type 4.

055.3.4 Class D Bedding (Flat Bottom):

Class D bedding shall be defined as that method of bedding in which the pipe is placed on a flat bottom trench which supports the pipe barrel throughout its length. Bell holes shall in all cases be provided and the bells shall be kept free of foreign material. Back-fill material shall be hand-compacted under the haunches of the pipe and to a minimum depth of 1' above the pipe. This type of bedding shall only be used for ductile iron pipe water main construction and shall be considered equivalent to AWWA Standard C150, Laying Condition Type 3.

055.3.5 Granular Bedding Material:

- a) Sieve Analysis
Granular bedding material shall comply with the following sieve analysis. Sand shall not be used.

Sieve Size	Percent Passing
1/2"	100
3/8"	90-100
#4	40-85
#8	10-45
#16	0-20
#100	0-3

055.4 Engineered Fill

Subbase or base materials

055.5 Drainage Fill

Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate grading size 57. with 100 percent passing a 1 1/2" sieve and not more than 5 percent passing a No. 8 sieve.

055.6 Filtering Material

Evenly graded mixture of natural or crushed gravel or crushed stone with natural sand, with 100 percent passing a 1 1/2" sieve and 0 to 5 percent passing a No. 50 sieve.

055.7 Subgrade

055.7.1 General:

Subgrade material shall conform to the lines, grades, cross-sections and thickness shown on the approved plans and shall be finished and maintained in an acceptable condition at least one day's progress in advance of base construction.

055.7.2 Subbase:

Subbase is the layer placed between the subgrade and base course in a

paving system or the layer placed between the subgrade and the surface of the pavement or walk. Subbase material shall be well mixed, free of organic matter and lumps or balls of clay, and shall consist of sound aggregate particles and suitable filler or binding materials which, when placed and compacted, will result in a firm, dense, unyielding foundation. Subbase material need not be crushed, but may be of the pit run variety, providing it is graded within the following limits:

GRADATION OF SUBBASE MATERIAL
TABLE 02.050.055.7

Standard Size of Sieve	Percentage of Weight Passing Sieve
2 1/2 inch	100
2 inch	95-100
#4	30-60
#200	5-15
Liquid Limit	35 Maximum
Plastic Limit	6 Maximum

Deviations from the gradation limits above will be permitted on approval by the Engineer for unpaved roads, where it can be adequately demonstrated that the proposed subgrade material can fulfill the intent of these specifications.

Subbase shall be deposited and spread, without particle segregation, in loose layers not to exceed 6" in depth. Each layer shall be thoroughly and individually compacted to 95% proctor (AASHTO T 99) density. Wetting or aerating and rolling of the material shall be required when ordered by the Engineer. Subbase shall not be placed on soft, spongy, or frozen subgrade or other subgrade, the stability of which, in the opinion of the Engineer, is unsuitable.

055.7.3 Subgrade:

055.7.3.1 Subgrade Approval

- a) Notify the Engineer when excavations have reached required subgrade.
- b) When the Inspector Engineer determines the unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- c) Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Inspector.

055.7.3.2 Subgrade Preparation

- a) Compaction:
The subgrade shall be free of organic material and shall be deep-plowed to a minimum depth of 12 inches, moisture-treated to within 2 percent (optimum to +4% for A-6 or A-7-6) of optimum moisture content, disked or sheep-foot rolled, and replaced and compacted in 6" lifts. On all arterials and collectors, in areas of fill, compaction shall be required in accordance with this section, and tested for every 12 inches of fill placed (since most fills are done prior to R.O.W, dedication, certified compaction reports shall be required in accordance with this manual prior to initial acceptance by the Town). Table 02.300.333 shall be used to determine the compaction.

- b) Testing
Field moisture-density tests using acceptable methods will be required per Appendix 111-B at the conclusion of Division I of this Section.

- c) Final Proof-Rolling:
After the subgrade has been compacted, tested and found to meet specifications, the entire subgrade shall be proof-rolled with a heavily-loaded vehicle to ensure uniformity of the subgrade. The vehicle must have a loaded GVW of 50,000 pounds with a loaded single axle weight of at least 18,000 pounds and a tire pressure of 90 psi. Subgrade which is pumping or deforming must be reworked, replaced or otherwise modified, to form a smooth, stable, non-yielding base for subsequent paving courses. The Engineering Division shall be notified at least 24 hours before final proof-rolling.

MOISTURE-DENSITY CONTROL

Table 02.300.333

Soil Classification (ASSHTO M 145)	AASHTO T99 Minimum relative compaction (% std.)	AASHTO T 180 Minimum relative compaction. (% mod.)
A-1	100	95
A-3	100	95
A-2-4	100	95
A-2-5	100	95
All other	95	90

*Chart taken from CDOT Specifications Section 203.11

- d) Acceptance:
The results of field density tests and proof-rolling shall be submitted and reviewed by the Engineering Division. Provided all tests are acceptable, compaction will be approved for the placement of the next paving course. Should testing indicate unsatisfactory work, the necessary reworking, compaction or replacement will be required prior to continuation of the paving process. The approval is valid for 24 hours. Changes in weather such as freezing or precipitation will require re-approval of the subgrade.

055.7.3.3 Subgrade Protection:

During construction, subgrades and excavations shall be kept shaped and drained. Ditches and drains along the subgrade shall be maintained to drain effectively at all times. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped and re-compacted prior to placing of sub-base material. The storage or stockpiling of materials on the subgrade will not be permitted. No subgrade course shall be laid until the subgrade has been inspected and approved. Under no circumstances shall subgrade material be placed on a muddy or unstable subgrade.

055.7.4 Lime Stabilization

55.7.4.1 Scope:

This section specifies requirements for design, materials, construction, and testing of lime-stabilized subgrades. This section is applicable to stabilizing fine-grained soils (clays and silts) only; it is not applicable to stabilizing sands and gravels used as bases or subgrades. Types of stabilization using agents other than lime are not addressed in this section.

55.7.4.2 General:

The purpose of lime-stabilization is to improve the subgrade quality of a clay soil by increasing its strength and reducing its swell-shrink potential during wet-dry cycles. The design, construction, and testing of a lime-stabilized subgrade are interrelated. Therefore, it is necessary for the Consultant Engineer, materials tester, and Developer to work closely together.

055.7.4.3 Design:

A site-specific lime-stabilization design is required prior to construction. The design shall be prepared by a Colorado Registered Professional Engineer competent in the field of geotechnical engineering and shall be included in the Pavement Design Report as required in Section 01.400.430.3.

- a) Soils Report: A lime-stabilization design shall be based on a soils report with the following additional testing required.
- b) Sulfate Tests: Tests for water-soluble sulfates shall be performed on field samples collected at 500' maximum intervals. Where sulfate salts are visually observed in the subgrade, additional sampling and testing shall be performed. Lime stabilization shall not be allowed for subgrades with sulfate concentrations in excess of 0.1 %.
- c) Lime-Soil Tests: Trial mixes of soil with increasing amounts of lime shall be tested to determine the optimum percentage of lime for the lime stabilization design mix.

The samples for lime-soil testing shall be obtained by splitting previously prepared composite samples for untreated subgrade support value testing. If these composite samples are not available, composite samples will be prepared utilizing these on-site soils with the lowest support values. The lime used shall be from the same source and of the same type as that to be used on the project. Trial mixes shall be allowed to mellow a minimum of 48 hours at ambient temperature with a moisture content 2% above optimum prior to testing. Samples from each trial mix shall be tested by pH meter to determine pH value, Atterberg limits, and swell potential. Proctor Curves shall be derived at the lower and upper line percentages for each trial mix. Representative samples from each trial mix shall be compacted to at least 95% standard proctor density at 0 to 2% above optimum moisture-sealed, and oven-cured for 5 days at 100°F. Compressive strength testing shall be performed on the samples.

The determination of optimum lime content for the design mix shall comply with the following minimum requirements:

Compressive strength: 160 psi
pH: 12.4 (after mellowing 48 hours)
Plasticity Index: 0 (non-plastic) Swell Potential: 0 + 0.1 %

The minimum Dry Hydrated Lime Content shall be 3.5% of dry soil weight.

055.7.4.4 Design Testing Summary:

Tabulated summaries of laboratory test results for field samples, composite samples, and lime-soil mixes shall include the following:

Field Sample No. (also shown on map)
Group No. (composite sample) Soil description
#200 sieve analysis
Atterberg limits
AASHTO classification and group index
% soluble sulfates
pH value
Maximum dry density
% optimum moisture content
% lime content
% swell
Compressive strength

055.7.4.5 Pavement Design

- a) Flexible Pavement over Stabilized Subgrade: The 86-AASHTO Guide for the Design of Pavement Structures is the basis of the Town's design procedure. For lime-stabilized subgrades with a minimum compressive strength of 160 psi, a strength coefficient of 0.14 shall be used in the layer-thickness equation. Refer to Section 5.00 for the

flexible pavement design procedure and show calculations in the Pavement Design Report.

- b) Rigid Pavement over Stabilized Subgrade: The appropriate design nomographs for rigid pavement in Section 5.00 shall be used to determine slab thickness. Evidence supporting a total modulus of subgrade reaction for the untreated subgrade and the lime-stabilized layer shall be provided.

055.8 Base Course

The work covered by this Section of the Specifications shall consist of furnishing, placing, and watering gravel or stone to provide a firm and stable foundation for subsequent construction. The base course shall be constructed on a previously constructed subgrade in accordance with the lines, grades, quantity requirements and the typical cross-sections shown on the plans.

Unless specifically modified by a qualified Professional Engineer, as indicated in the preceding paragraph, be following requirements shall apply.

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

GRADATION OF LIMITS OF BASE MATERIAL
TABLE 02.050.055.8.2

Standard Size of Sieve	Percentage of Weight Passing
¾ inch	Sieve
#4	100
#10	30-65
#200	25-55
Liquid Limit	3-12
Plastic Limit	25 Maximum
ASTM (C117)	6 Maximum

**For gravel shoulders, repairing gravel surfaces, or in cases where the BCC allows gravel roads, No.200 shall be 9- 12, and No.4 shall be 30 - 50.

NOTE: The specific gravity must be greater than 2.4 (at the source) for all A.B.C. materials to be used as shoulders or on gravel roads.

055.8.3 Cement Treated Aggregate Base Course

This material shall consist of a mixture of aggregate materials, Portland cement and water as outlined in Section 308 of the CDOT Standard Specifications (latest version). Acceptable aggregates include CDOT Classes 4, 5, and 6. Other aggregates may be used, if previously approved by the Engineer.

The materials to be used in construction shall be tested and a mix design submitted to the Engineer. As a minimum, the mix design report shall contain a description of material sources, gradations, and Atterberg, limits of aggregates, cement type, Proctor compaction curves and unconfined compressive strength results for each mix, strength versus cement content curves, a design mix, and special construction procedures recommended. Testing shall be in accordance with appropriate AASHTO specifications.

To be approved, the mix shall have a 7-day compressive strength of at least 650 psi, and no more than 1000 psi. The minimum acceptable cement content shall be 5 percent by weight. Only mix designs approved by the Town Engineering Division shall be used. Approvals are required on a project basis, or an annual basis for suppliers, prior to issuing construction permits.

055.8.4 Base material shall be deposited and spread without particle segregation in loose layers not to exceed 6" in depth. Each layer shall be thoroughly and individually compacted to 95% proctor (AASHTO T 180) density. Wetting or aerating and rolling of the material shall be required as ordered by the Engineer, following review of all field test results. No base course shall be placed upon a soft, spongy or frozen subgrade or subgrade or other subgrade, the stability of which, in the opinion of the Engineer, is unsuitable.

055.8.5 If the existing base course is untreated, it shall normally be replaced with CDOT Class 6 aggregate base material and compacted in layers not to exceed 6". The resulting total compacted base thickness shall be 8", or to the thickness of the removed base plus 2". If the existing base material is asphalt treated aggregate, it shall be replaced by a minimum of 3" of acceptable asphalt base or the existing base thickness plus 1", whichever is greater. A replacement 2" thick asphalt surface wearing course shall also be used when replacing asphalt treated aggregate.

Note: For the purpose of replacing a full depth asphalt pavement section, it must be replaced with full depth asphalt.

055.9 Trench Cover - Subgrade

055.9.1 After the backfill has been made and compacted as specified, it shall be cut and trimmed to the required depth and cross section. Trench cover subgrade shall be free of all rock over 2 1/2" in size. It shall have a compaction of 95% or more, by standard tests, (see Table 02.050.055.7), at the time of constructing curb, gutter, sidewalk, pavement and/or other permanent trench cover structure.

055.9.2 All excess excavated material shall be removed and disposed of outside the legal limits of the R.O.W. as the work progresses, unless the approval of the Engineer is obtained for disposal of the material within the legal limits of the R.O.W. All parts of the roadway and various structures disturbed shall be restored to a condition equal to or above that which existed before starting the work.

055.9.3 Compaction equipment must be on the job site before excavation is started.

Compaction equipment must be capable of compacting within the trench width limits to avoid bridging the ditch.

055.10 Trench Cover - Asphalt

055.10.1 Temporary Trench Cover:

- 055.10.1.1 All trenches across traffic lanes, where it becomes necessary to remove any existing surfacing or pavement, shall be provided with temporary trench cover if the pavement is not replaced within the same day.
- 055.10.1.2 A temporary patch of cold-mix shall be placed on all pavement surface cuts immediately after backfilling has been completed and shall be removed at the time a permanent patch is made. Cold mix may be approved for cold weather patching only.
- 055.10.1.3 Minimum requirements for temporary trench cover shall be well-compacted surfacing material conforming to "Road Mixed Asphalt Surfacing Material" of the CDOT Standard Specifications and shall match the existing asphalt or concrete thickness, but shall not be less than four inches (4") thick. The mineral aggregate shall, with a tolerance of 5%, conform to the grading specified for 3/8" inch maximum aggregate. Bituminous binder to be mixed with the mineral aggregate shall be liquid asphalt, Grade MC-3000, and shall be between 5 ½ % and 6% by weight of the dry mineral aggregate.
- 055.10.1.4 Temporary trench cover surfacing material shall be stockpiled on the job site and shall be placed within six hours after completion of trench backfill and compaction.
- 055.10.1.5 Temporary trench cover shall be properly maintained until permanent trench cover is placed.
- 055.10.1.6 Trench covered with temporary surfacing will be considered as open to traffic.
- 055.10.1.7 The surface of the temporary re-paving shall be smooth and at the same level as the adjacent undisturbed paved area.

02.050.060 AGGREGATE

060.1 Street Aggregate for Bases and Subbases

- 060.1.1 Scope: This specification specifies aggregate materials to be used for the construction of aggregate bases, subgrades and bituminous or asphaltic concrete pavement for streets, parking lots, walks, drain ways, and other work requiring the use of aggregates. All workmanship and materials shall be in accordance with the Specifications, and in conformity with the lines, grades, depths, quantity requirements, and the typical cross section shown on the plans, or as directed by the Engineer.
- 060.1.2 Aggregates shall be crushed stone, crushed slag, crushed gravel, or natural gravel which conforms to the requirements of AASHTO M147, as hereinafter supplemented. Aggregate shall meet the grading requirement specified below. The type used shall be specified on the plans or special

provisions. The liquid limit (LL) shall be as shown in Table 02.050.060.1.

CLASSIFICATION TABLE FOR AGGREGATES
TABLE 02.050.060.1

	Type 1 (Coarse-Graded)	Type 2 (Normal)	Type 2A (Normal)	Type 3 (Non-Permeable)	Type 4 (Structural)
Use	Subbase	Base	Base	As Specified	As Specified
Sieve	Percentage by Weight Passing Square Mesh Sieve				
6"	100				
2"	95-100			100	100
1-1/2"			100		
1"		100	90-100		
1/2"			60-90		
3/8"	40-85	50-85	45-75		
No.4	30-60	35-65	30-60	75-100	30-100
No. 10		25-50	20-50		
No.40		15-30	10-30	60 max	60 max
No.200*	3-15	3-15	3-12	15-40	5-20
LL (max.)	35	25	25	35	35
*Percent passing No.200 determined by Wash Test (ASTM C117) Fraction passing No.200 shall not be greater than 2/3 of the fraction passing No.40					

060.2 Street Aggregate For Bituminous or Asphaltic Concrete Pavements

060.2.1

New Aggregate: Only aggregate from Town pre-qualified sources shall be used. The mineral aggregate shall consist of hard, durable particles, or fragments of stone or crushed gravel having incorporated in it limestone dust, Portland cement, or other acceptable binder material, in such proportions that the whole will be a homogenous material after mixing at the asphalt plant. The mineral aggregate shall be clean and free from disintegrated stone, vegetable matter, clay lumps, or other deleterious substances. Aggregate shall conform to the following grading limits for the composite material. Aggregate may be conditionally accepted in stockpile at the plant site.

GRADING LIMITS FOR COMPOSITE MATERIAL
TABLE 02.050.060.2

SIEVE	PERCENTAGE BY WEIGHT PASSING			
	Cover Aggregate For Seal Coat		Surface, Base & Overlay	Overlay & . Leveling
Grading	1/2 minus	3/8 minus	E	EX
1/4"	100		100	
"	95-100	100	70-95	100
3/8"	40-70	90-100	60-88	74-95
#4	0-10	15-30	38-72	45-78
#8	0-3	0-8	25-58	30-60
#50		0-5	9-32	12-30
4 200	0-2*	0-2*	3-12	3-12
Asphalt Content			4-7%	4-7%
Depth			1-1/2 to 3"	<1-1/2"

* by Wash Test

060.2.2. Coarse Aggregate: The mineral aggregate retained on the No.4 and larger sieves shall meet the quality requirements of AASHTO M283 and shall consist of particles with not less than 50% having at least two fractured faces. When tested in accordance with AASHTO T96, the percentage of wear shall be not more than 45%.

060.2.3 Fine Aggregate: The material passing the No. 4 sieve shall conform to the requirement of AASHTO M29. The Developer will be required to furnish a screen or other suitable means to eliminate fines as necessary. If sufficient fine material of satisfactory quality is not naturally present in the mineral aggregate, it shall be added separately to each batch at the time of proportioning.

060.3 Street Aggregate (HBP)/Plant Hot Mix Recycled Asphalt Pavement

Scope: This section specifies aggregate materials to be used for Construction and pavement installation of streets, walks, drain ways, and other work, using plant hot mix recycled asphalt. All materials shall be in accordance with the requirements of these specifications and in conformity with the lines, grades, depths, quantity requirements, and the typical cross-section shown on the plans or as directed by the Engineer.

060.3.1 Virgin Aggregate: Virgin aggregate shall be as specified in 060.2.1

060.3.2 Coarse Aggregate: Coarse aggregate shall be as noted in 060.2.2.

060.3.3 Fine Aggregate: Fine aggregate shall be as noted in 060.2.3.

FINAL GRADING LIMITS FOR COMPOSITE AGGREGATE
TABLE 02.050.060.3

Sieve	Percentage by Weight Passing
Grading	Base
	C
¾"	100
½ "	--
3/8"	60-88
¼ "	--
#4	38-72
#8	25-58
#50	9-32
#200	3-12
Asphalt Content	4-7%
Depth	1-1/2 to 3

Note: Recycled mix shall not be allowed on surface course or overlay.

Specification Designation	Test Method	Requirement
Viscosity @ 140°F	ASTM D2170	200-800
Specific Gravity	ASTM D 70	Report
Flash Point c.o.c., °F min.	ASTM D 92	400
Oven Weight Change, 5 hrs, @ 325°F,	ASTM 17S4	4
*Viscosity ratio, % max.	ASTM D2170	3
Saturates, % max.	ASTM 04124	30

$$\text{Viscosity ratio} = \frac{\text{Viscosity after oven wt. Change test, measured @ 140°F}}{\text{Original Viscosity a 140°F}}$$

060.3.8 Filler: Filler shall be as specified in Section 24.03.5.

060.3.9 Hydrated Lime: Hydrated lime shall be as specified in Section 24.03.6.

060.4 Aggregate for Concrete General

060.4.1 Fine Aggregate:

- a) Composition: Fine aggregate shall be natural sand composed of clean, hard, durable, uncoated grains, preferably of siliceous materials.
- b) Deleterious Substances: The maximum percentage of deleterious substances shall not exceed the following values:
 - Material finer than 200 mesh sieve 3% by weight
 - Shale 1% by weight
 - Coal and lignite 0.25% by weight Clay lumps 1% by weight
 - Other deleterious substances 2% by weight

The sum of the percentages of the above deleterious substances shall not exceed 5% by weight.

All fine aggregate shall be free from injurious amounts of alkali and organic impurities.

- c) Grading: Fine aggregate shall be well-graded and conform to the following:

**TABLE 02.050.060.4.1
FINE AGGREGATES FOR
PORTLAND CEMENT CONCRETE**

SIEVE SIZE OR TEST PROCEDURE	PERCENT PASSING OR TEST REQUIREMENT
3/8"	100
#4	95-100
#16	45-80
#SO	10-30
#100	2-10
#200	3, Max.
Friable Particles, °%	1.0, Max.
Coal & Lignite, %	1.0, Max.
Deleterious Material (AASHTO T-1 1), %	3, Max.
Sand Equivalent (AASHTO T 176), %	80, Min.
Fineness Modulus	2.50-3.50
Sodium Sulfate Soundness, %	20.0, Max.

- a. Water shall meet the requirements of Colorado Department of Transportation Section 712.01.
- b. Air entraining and chemical admixtures shall meet the requirements of Colorado Department of Transportation Sections 711.02 and 711.03. No additive manufactured with the purposeful addition of chloride shall be permitted.
- c. Other Requirements: The fine aggregate shall conform to AADHTO M6.

060.4.2 Coarse Aggregate

- a) Composition: Coarse aggregate shall consist of crushed limestone, trap rock, granite, washed -ravel, or other approved inert -materials having clean, hard, strong, durable pieces, free from adherent coating B and conforming to the requirements or these specifications.
- b) Deleterious Substances: The maximum percentage of deleterious substances shall not exceed the following values:

**TABLE .02.050.060.4.2
COARSE AGGREGATES FOR
PORTLAND CEMENT CONCRETE**

SIEVE SIZE OR TEST PROCEDURE	PERCENT PASSING OR TEST REQUIREMENT
2"	100
1 1/2"	95-100
3/4"	35 - 70
3/8"	10-30
#4	0-5
#200	1.0, Max. (1.5% if crusher fines)
% Wear	45, Max.
Clay Lumps & Friable Particles, %	2.0, Max.
Coal & Lignite, %	0.5, Max.
Sodium Sulfate Soundness, %	12, Max.

060.4.3 Aggregate Base Course Material

This material shall consist of hard, durable particles or fragments of stone or gravel, crushed to required sizes, containing an appropriate quantity of sand or other finely-divided mineral matter which conform to the requirements of AASHTO M 147, and to Section 703.03, CDOT Standard Specifications. In addition, the material must have a R-value of 78 or greater, or a CBR of 80+, and must be moisture stable. Moisture stability is determined by R-value testing which shows a drop of 12 points or less in R-value between exudation pressures of 300 psi, and 100 psi.

Only aggregate from the Town Engineering Division approved sources shall be used, unless otherwise approved in writing by the Engineering Division approval of sources will be at the discretion of the Engineering Division and submissions will, at a minimum, consist of supplying documented gradation, Atterberg limits, and CBR/R-value testing on an annual basis. ~~See Section 4.4.2.~~

Only one (1) type of crushed aggregate base course is acceptable in Town. The gradation specifications for this type of base course is listed below:

060.5 Rip-rap

060.5.1 Rip-rap:

Rock used for rip-rap shall be hard, durable, angular in shape, and free from cracks, overburden, shale and organic matter. Thin, slab-type stones, rounded stones, and flaking rock shall not be used. Removed concrete may not be used for rip-rap without specific written approval from the Inspector.

Rock used for rip-rap shall meet the requirements listed in Table A when tested in accordance with the specified procedures. The contractor shall furnish the Inspector with a certified test report showing that the rock meets these requirements. Service records of the proposed material may also be considered by the Inspector in determining the acceptability of the rock.

Classifications and gradations for rip-rap are shown in Table B. The maximum stone size shall not be larger than the thickness of a rip-rap layer. Neither breadth nor thickness of a single stone shall be less than 1/3 its length. Rock used for grouted rip-rap shall meet the requirements for ordinary rip-rap except for the smallest fraction shown in Table C, which should be eliminated from the gradation.

Table 02.050.060.5A
Rip-rap Durability Requirements

	<u>Test Designation</u>	<u>Requirements</u>
Specific Gravity (bulk saturated surface dry)	AASHTO T 85	2.50
Abrasion (Abrasion Grading A)	AAHSTO T 96	Less than 40% loss of weight after 500 revolutions
Freezing & Thawing (edge rock type test sample Tested by Procedure A)	AASHTO T 103	Less than 10% loss after 12 cycles

Table 02.050.060.5B
Classification and Gradation of Ordinary Rip-rap

Rip-rap Designation	% of Total Weight Smaller than the Given Size	D 50 1 Stone Size (in pounds)	(inches)
Class 6	70-100 50-70 35-50 2-10	85 68 10 <1	6
Class 12	70-100 50-70 35-50 2-10	410 275 85 3	12
Class 18	100 50-70 35-50 2-10	1,275 655 275 10	18
Class 24	100 50-70 35-50 2-10	3,500 1,700 655 35	24

- (1) D 50 = Mean particle size. At least D0% of mass shall be stones equal to or larger than this dimension.
(2) Bury on 4 to 1 side slopes or grout rock if slopes are steeper.

060.5.2 Rip-rap Filter Material

Filter material shall be hard, durable particles or fragments of crushed stone or natural gravel and shall meet the durability requirements listed in Table A. The required gradations for filter materials are listed in Table C. Type I has a gradation identical to Colorado Division of Highways Class A filter material (Section 703.03), except that it permits a slightly larger maximum rock fraction.

Table 02.050.060.5C
Gradation for Filter Material

Sieve size	% by Weight Passing Square Mesh Sieves	
	TYPE I	TYPE II
3"	-	90-100
1-1/2"	-	-
3/4"		20-90
3/8"	100	-
#4	95-100	0-20
#16	45-80	-
#50	10-30	-
#100	2-10	-
#200	0-2	-3

060.5.3 Gabions and Slope Mattresses

Rip-rap for gabions and slope mattresses shall meet the durability requirements listed in Table A. The size of the rip-rap shall be 4" to 8" for gabions (cage thickness 12" or greater) and 2" to 4" for slope mattresses. Cages and mattresses furnished by a manufacturer shall be of uniform size.

Wire used in the manufacture and assembly of the mesh shall equal or exceed Federal Specification QQ-W-461G, Wire, Steel, Carbon (Round, Bare and Coated) including the following specific requirements; Finish 5, Class 3 weight of zinc coating.

All wire used, including tie and connecting wire, shall be certified by mill test report(s) Showing compliance with the specification requirements listed in the Colorado Division of Highways Standard Specifications for-Road and Bridge Construction (Section 712.09). Tie and connecting wire shall be supplied for securely fastening all edges of the gabions and diaphragms. Gabions shall be provided with 4 cross connecting wires in each cell 1/2 unit high and 8 in each cell one unit high. Gabions shall also have inner tie wires connecting the front face to the rear at approximate spacing of 12" in both vertical and horizontal dimensions. Tie wire shall meet the same specifications for wire used in the mesh except that tie wire for gabion cages shall not be more than 2 gages lighter.

Wire mesh for gabions (cage thickness 12" and greater) shall be 100 gage (U.S.) soft temper. Wire mesh for slope mattress (cage thickness up to 10") shall be 14 gage (U.S.) soft temper. Wire mesh shall be woven, non-raveling, and have elasticity. The field connections between adjacent wire baskets shall be made as recommended by the manufacturer and shall develop a connection strong enough that the failure under test shall occur in the mesh rather than in the lacing .

Soil anchor stakes shall be steel and may be:

1. Crane rails of a convenient size (mm. 40 lbs. per yd.)
2. 2" size steel pipe conforming to ASTM A 120 either black or galvanized
3. 3" x;" x 3/8" structural steel angles conforming to ASTM A 36 or better
4. Used rails, pipe or angles may be used provided the material is not rusted or damaged to such an extent that the strength of the stakes is affected.

060.5.4 Plastic Filter Cloth

Plastic filter cloth shall be a woven fabric consisting of polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their relative positions to each other. Plastic filter cloth shall also meet the physical requirements shown in Table D. Securing pins shall consist of galvanized wire or other approved material. Wire pins shall be made of wire 0.091" or larger in diameter and "U" shaped having legs 6" long and a 1" crown.

The contractor shall furnish the Inspector a certified test report from the manufacturer showing compliance with the specifications listed in Table D. Plastic filter cloth shall be 100% insect, rodent, mildew, and rot resistant for all applications.

Table 02.050.060.5D
Plastic Filter Cloth

Fabric Property	Test Method	Requirement (Minimum Roll Averages)
1. Grab Tensile Strength *	ASTM D 1682	150 lbs.
2. Grab Tensile Elongation*	ASTM D 1682	50% at Failure
3. Mullen Burst Strength	ASTM D 3786	300 psi
4. Trapezoidal Tear Strength*	ASTM D 1117	60 lbs
5. Puncture Strength	ASTM D 751	80 lbs.
6. Equivalent Opening Size U.S. Std. Sieve	CW 002215	50- 100
7. Vertical Water Flow (5" Constant Head)		150 gal/min/ft ²

*Weakest Principle Direction

060.5.5 Impervious Plastic Lining

Impervious plastic lining shall consist of virgin polyvinyl chloride (PVC) resins, plasticizers, stabilizers, and such materials that, when compounded will meet the physical requirements specified in Table E. The Contractor shall furnish the Inspector a certified test report from the manufacturer showing compliance with the specifications in Table E.

Table 02.050.060.5E
Impervious Plastic Lining

Property	Thickness			Test method
	10 mil	20mil	30 mil	
Thickness	+7%	+5%	+5%	ASTMD 1593
Tensile Strength, lbs./in. width	20	50	70	ASTM D 882, Method B
Modulus at 100%	9	20	30	ASTM D 882, Method B
Elongation, lbs./in Ultimate Elongation, %	250	300	325	ASTM D 882, Method B
Oven Aging (Wt. Loss, % max)	0.7	0.5	.04	2" x 4" sample 16 hours in a forced air circulating oven at 212 deg. F.

Tear Resistant:

Elemdorf, grams	500	4000	000	ASTM D 1922
Low Temperature Impa, Deg. F.	0	-15	20	ASTM D 1790
Water Extraction (% Loss . 104 Deg. F. for 24 Hours)	1.0	.3	15	ASTM D 1239
Volatility % loss max.	1.5	1.0	75	ASTM D 1203 Method A
Pinholes (No. per 10 sq. yd. Max)	I	I	I	-
ed Seam Strength (% of Tensile Strength)	80	80	801	-

060.6 CONSTRUCTION REQUIREMENTS

060.6.1 Preparation of Slopes

Slopes on which riprap is to be placed shall be shaped to allow the full thickness of the specified riprap and filter material. The slopes shall not be steeper than the natural angle of repose of the slope as shown on the plans. Wherever possible, the excavation shall be undisturbed material, or where this is not possible, the underlying materials shall be compacted to 95% density as determined by ASTM D 698.

Areas in which fiber cloth or plastic linings are to be placed shall have a uniform slope, be reasonably smooth, free from mounds and wind-rows and free of debris or projections which could damage the material. The cloth or lining shall be closely laid (not stretched) and in such a manner to avoid rupture of the cloth or lining

Riprap

Riprap shall be placed in a manner, which will produce a well-graded mass of stone with a minimum amount of voids. Riprap may be placed by dumping directly from trucks provided the bedding is not damaged or by hand. Mechanically pushing riprap downhill or dropping it down the slope in a chute shall not be done. Riprap shall be placed to the required thickness and grade shown on the plans. The final surface shall be evenly stepped, conforming to the contour required.

A layer of filter material shall be placed on the slope immediately prior to placement of the riprap stone. The layer shall be shaped to provide the minimum thickness specified. The surface should generally fit the bottom surface of the riprap.

Riprap placed on plastic filter cloth or impervious plastic lining shall not be dropped through greater than 3'. Any filter cloth or lining damaged or displaced before or during placement of overlying layers shall be replaced or repaired to meet their material construction requirements in this section at the Contractor's expense.

060.6 .2 Grouted Riprap

Clean stones shall be placed on the slopes and drenched or sprinkled with water until the stones are thoroughly moistened. The mixed grout shall then be applied while the stone is still moist. During application the grout shall be worked into the voids to completely fill them.

The grout should contain air entrainment, have a 28-day strength of at least 2,400 psi and should have a high slump (5 to 7").

Where depth specified for grouting is in excess of 12", such as in cut-off walls, the riprap stone shall be placed in 12" lifts, and each lift shall be grouted prior to placement of the next lift. The succeeding lifts shall be constructed and grouted before the grout in the previous lift has been set.

Grout shall be placed only when the weather is suitable (as described in Section 01.500.520) and shall be protected from freezing. The surface of grouted riprap shall be covered with moist earth or wet burlap for not less than 3 days after placing to properly cure. Weep holes shall be provided at least every 4 to 6' at the toe of the channel slopes and drops to reduce uplift forces on the channel lining.

060.6.3 Gabions and Slope Mattresses

Wire enclosure segments shall be hand or machine formed to the dimensions shown on the plans. Enclosure segments shall be placed, laced, and filled to provide a uniform, dense, protective coat over the area specified.

Perimeter edges of gabions are to be securely salvaged or bound so that the joints formed by tying the salvages have approximately the same strength as the body of the mesh. Gabion units shall be tied together each to its neighbor along all contacting edges in order to form a continuous connecting structure.

Mattresses and flat gabions on channel side slopes should be tied to the banks by anchor stakes driven 4' into tight soil (clay) and 6' into loose soil (sand). The anchor stakes should be located at the inside corners of basket diaphragms along an upslope (highest) basket wall, so that the stakes are an integral part of the basket. The exact spacing of the stakes depends upon the configuration of the basket; however, the following is the suggested minimum spacing: 2.5:1 and steeper, and every 9' along

and down the slope for slopes flatter than 2.5:1. Counterforts are optional with slope mattress linings. Slope mattress staking, however, is required, whether or not counterforts are used.

Channel linings should be tied to the channel banks with gabion counterforts at least every 12'. Counterforts should be keyed at least 12" into the existing banks with slope mattress linings and should be keyed at least 3' by turning the counterfort gabions end-wise when the lining is designed to serve as a retaining wall.

060.6.4 Plastic Filter Cloth

Plastic filter cloth shall be loosely laid (not stretched) in such a manner to avoid rupture of the cloth. The cloth shall be anchored in place with 2 securing pins at 3' spacing along, but not closer than 2" to, edges and to the extent necessary to prevent displacement. Overlaps shall be at least 18". Laps shall be made with the uphill layer on top. Full rolls shall be used wherever possible to minimize the number of vertical laps.

060.6.5 Impervious Plastic Lining

Impervious plastic lining shall be loosely laid (not stretched) in such a manner to avoid rupture of the lining. If, in the opinion of the Inspector, field lap joints are necessary, the joints shall be formed by lapping the edges of panels a minimum of 2". The contact surfaces of the panels shall be wiped clean to remove all dirt, dust or other foreign materials. Sufficient cold-applied vinyl bonding adhesive shall be applied to the contact surfaces in the joint area and the two surfaces pressed together immediately. Any necessary repairs to the plastic lining shall be done using the lining material itself and cold-applied vinyl to vinyl bonding adhesive. The bonding adhesive shall be applied to the contact surfaces of both the patch and lining to be repaired and the two surfaces pressed together immediately. Wrinkles in the joints shall be smoothed out.

02.050.065 **BITUMINOUS MATERIAL**

02.050.065 Bound Base Courses (bound bases that separate the flexible or rigid paving)

065.1 Aggregate Surfacing

Flexible Pavement:

Construction of bituminous or asphalt concrete pavements:

This section specifies materials and methods to be used for constructing bituminous or asphalt concrete pavements for streets, parking lots, walks, drainage ways, and other miscellaneous areas. This work shall consist of constructing one or more courses of plant mix hot bituminous base, pavement, overlay, or leveling course on a prepared foundation and to the finished dimensions shown on the plans, or as directed by the Engineer. The bituminous pavement shall be hot-mixed at a central plant using non-recycled material.

065.2 Job Mix

- a) Testing Laboratory: At least two weeks prior to paving, the Developer, at their expense, shall submit suitable samples of all materials proposed for use on the project to an independent materials testing laboratory. The Testing

Laboratory shall, at the Developer's expense, test all materials for compliance with these Specifications and establish a job mix formula for each mixture proposed for use on the project. The Testing Laboratory shall submit to the Engineer for approval two copies of a report containing legible copies of all test data, graphs, tables, and charts used to establish the job mix formula. The report shall bear the seal and signature of a Professional Engineer, licensed in Colorado, and competent in asphalt concrete mix design and construction. The Testing Laboratory shall report that the proposed materials and job mix meet or exceed this Specification.

- b) Job Mix Requirements: The job mix formula shall be done in accordance with ASTM D 1559 (Marshall Method) using 50 blows on each end of the specimen. The job mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, and a single temperature at which the mixture is to be mixed.

The design mix for hot bituminous pavement shall conform to the following:

TABLE 02.050.065.2

PROPERTY	TEST METHOD	VALUE
Stability, Minimum (lb.)	ASTM D 1559 (Marshall)	1800
Flow (hundredths of an inch)	ASTM D 1559 (Marshall)	8-16
Voids, Top Layer	ASTM D 1559 (Marshall)	3-5
Void, Layer Below Top %	ASTM D 1559 (Marshall)	4-6
Accelerated Moisture Susceptibility-Tensile Strength Retained (Lottman), Minimum	ASSHTO T283	70

The water resistance of the mixture shall be determined by ASTM Standard Methods of Test, D1074 and D1075, with 4-days immersion at 120°F. The volumetric swell and water absorption of the immersed specimens shall be measured and recorded. The average strength of the immersed specimens, when compared to the average strength of the air-cured specimens, shall be not less than 80%.

Samples of plant run material taken during construction activities and tested by these test methods, as may be directed by the Engineer, shall also meet these requirements.

065.3 Compositions of Mixtures:

The bituminous plant mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. Approved anti-stripping additive shall be used in the minimum amount of 0.5% by weight of the asphalt cement. The Lottman value shall be not less than 70.

The several aggregate fractions shall be sized, uniformly graded, and combined. A job mix formula shall be established for each mixture to be supplied for the project and shall remain in effect, unless modified in writing by the Engineer. After the job mix formula is established, all mixtures shall conform thereto within the following ranges of tolerances:

Passing 4.75 mm (No. 4) and
larger sieves, exclusive of
maximum specified size. ± 8 percentage points

Passing 2.36 mm to 0.150 mm
(No. 8 to No. 100) sieves inclusive.
 ± 6 percentage points

Passing 0.075 mm (No. 200)
 ± 3 percentage points

Bitumen
 ± 0.4 percentage points
Temperature of mixture $\pm 20^{\circ}\text{F}$

Should a change in sources of materials be made, a new job mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer may require the Developer to establish a new job mix formula.

The plant-mixed material will be accepted at or behind the lay-down machine. Paving work shall not begin until a job mix has been reviewed by the Engineer. The Engineer shall have 5 working days to review the job mix formula.

New Aggregate: Only aggregate from Town pre-qualified sources shall be used. The mineral aggregate shall consist of hard, durable particles, or fragments of stone or crushed gravel having incorporated in it limestone dust, Portland cement, or other acceptable binder material, in such proportions that the whole will be a homogenous material after mixing at the asphalt plant. The mineral aggregate shall be clean and free from disintegrated stone, vegetable matter, clay lumps, or other deleterious substances. Aggregate shall conform to the following grading limits for the composite material. Aggregate may be conditionally accepted in stockpile at the plant site.

GRADING LIMITS FOR COMPOSITE MATERIAL
TABLE 02.050.065.3

SIEVE	PERCENTAGE BY WEIGHT PASSING			
	Cover Aggregate For Seal Coat		Surface, Base & Overlay	Overlay & Leveling
Grading	1/2 Minus	3/8 minus	C	CX
3/4'	100		100	
1/2 "	95-100	100	70-95	100
3/8"	40-70	90-100	60-88	74-95
#4	0-10	15-30	38-72	45-78
#8	0-3	0-8	25.58	30-60
#50		0-5	9-32	12-30
#200	0-2*	0-2*	3-12	3-12
Asphalt Content			4-7%	4-7%
Depth			1-1/2 to 3"	<1-1/2 "

*Coarse Aggregate: The mineral aggregate retained on the No. and larger sieves shall meet the quality requirements of AASHTO M283 and shall consist of particles with not less than 50% having at least two fractured faces. When tested in accordance with AASHTO T96, the percentage or wear shall be not more than 45%.

065.4 Material Specifications

General

The Specifications presented in this section are performance oriented. The Town's objective in setting forth these Specifications is to achieve an acceptable quality of roadway structures. All sources for the mined or manufactured materials listed in paragraph 4.5.5 must be annually approved by the Town Engineering Division as having met the appropriate materials performance specifications. This approval is a condition of using those material sources for public improvement construction. For the purpose of these Standards, public improvements are all roadway improvements, sidewalks, curbs and Gutters, appurtenant drainage basins or structures, storm severe and their access ways, other public works within Town right-of-way, and Town mandated storm water detention structures built on private property and maintained by the property owner(s).

Procedure For Material Source Approval:

On or before April 1st of each year, or a minimum of 14 calendar days before construction, a material supplier for any Town public improvements may supply written documentation and material test results from a competent materials testing laboratory that describes:

- a. Material(s) being tested to meet Town specifications
- b. The test procedures employed
- c. The supplier's manufacturing, mining or treating process by which the tested materials were created.

- d. The material test results
- e. A signed statement by the material supplier that the materials to be provided for public improvements in Town during the coming 365 day period.

065.5 Violations of Approval Conditions

Random Testing

The Town Engineering Division may order random tests of materials used in Town public improvements to verify compliance with material specifications.

Any and all material used to construct Town public improvements that is not from a certified source, or that is from a certified source and fails one or more random material tests, may be subject to complete removal as a condition of Town acceptance of that public improvement. Additional tests will be required to confirm the existence and extent of the sub-standard material prior to the initiation of remedial action. The extent of the material to be removed will be at the discretion of the Engineer.

Use Of Materials Not Listed in Section .5.5

Materials in this section and provided with a set of specifications are those deemed by the Town to be the primary structural materials commonly or typically used in public improvements. Ancillary public improvement materials such as manufactured paints and coatings, bonding agents, sealers, gaskets, insulating materials, etc. should be in compliance with Colorado Department of Highways material specifications for the appropriate material employed. Alternative materials for construction may be proposed for use, except where expressly prohibited by the Subdivision Regulations. Decisions on acceptability of alternative materials will be made by the Engineer.

065.6 Material Specifications

Hot Bituminous Pavement

This material shall consist of a mixture of aggregate, filler (if required) and asphalt cement. The aggregate mixture shall meet the grading requirements of the job mix formula. Tests on the aggregates for cleanliness, abrasion loss and fractured faces shall meet the requirements shown below. The job mix formula shall establish a single percent passing each sieve size, an optimum percent of asphalt cement to be added to the aggregate and a recommended mix temperature when discharged at the plant.

**TABLE 02.050.065.6A
MATERIAL SPECIFICATIONS FOR
HOT BITUMINOUS PAVEMENT**

SIEVE SIZE OR TEST PRESSURE	PERCENT PASSING OR TEST REQUIREMENTS	
	C Mix	CX MIX
3/4"	100	
1/2 "	70-95	100
3/8"	60-88	74-95
#4	44-72*	50-78
#8	30-58	32-60
#30	12-23	12-34
#200	3-9	3-9
% Wear, AASHTO T-96	35, Max.	35, Max.
2 Fractures faces on + No.4	70% Min.	70% Min.
Index of Retained Strength ASTM D-4867 Lottman Test	75, Min.	75, Min.
Atterberg Limits	NP	NP

- a. Aggregates shall not contain clay balls, organic matter, or other deleterious substances.
- b. After the job mix formula is established, all mix furnished for the project shall conform to within the range of tolerances in Table 1 1
- c. The natural sand content shall not exceed 20 percent of the weight of the total aggregate blend.

**TABLE 02.050.065.6B
MIX TOLERANCES**

Maximum Size	0%
Passing the 3/8" and Larger Sieves	± 6%
1 Passing the No.4 and No.8 Sieves	±5%
Passing the No.3 Sieve	± 4%
Passing the No.200 Sieve	± 2%
Bitumen Content	± .3%
Discharged Mix Temperature	± 20 °

- d. An additive may be used to meet the requirement for index of Retained Strength, if necessary. Such additives may be hydrated lime, Type I Portland cement, or anti-stripping agents approved by the Colorado Department of Transportation.
- e. he asphalt cement used shall be grade AC-10.

A mix design, including the job mix formula, shall be submitted (with submittal form No.1 6.6) for review and approval a minimum of seven (7) days prior to placing mix on any project. If the mix design has been approved, a copy of the submittal form is required at the time of permit request application for any project. The mix design shall be performed using the Marshall Procedures as outlined in The

Asphalt Institute's, "Mix Design Methods for Asphalt Concrete" (MS-2). Mix design parameters for the procedures are shown in Table .12.

**TABLE 02.0.50.065.6C
MIX DESIGN CRITERIA**

TEST	LOCAL STREET	COLLECTOR	ARTERIAL
Marshall Blows Required (AASHTO T 235)	35	50	75
Air Voids, Percent (± 0.5)	4	4	4
Flow, 0.01"	8-18	8-16	8-14
Voids filled with asphalt (V.F.A.) (%)	70-80	65-78	65-75
Stability, lbs. Minimum	1500	1700	2000
Percent Voids in Mineral Aggregate (VMA)	See Table 4.12A		

**TABLE .02.050.065.6D
MINIMUM VOIDS IN THE MINERAL AGGREGATE (VMA), PERCENT**

NOMINAL MAXIMUM PARTICLE SIZE ^{1,2}				VMA, PERCENT	
				DESIGN AIR VOIDS, PERCENT ³	
	Type	In.	mm	3.0	4.0
		No.16	1.18	21.5	22.5
		No.8	2.36	19.0	20.0
		No.4	4.75	16.0	17.0
	CX	3/8	9.5	14.0	15.0
	C	1/2	12.5	13.0	14.0
		3/4	19.0	12.0	13.0
		1.0	25.0	11.0	12.0
	G	1.5	37.5	10.0	11.0
		2.0	50.0	9.5	10.5
		2.5	63.0	9.0	10.0
1•	Standard Specification for wire Cloth Sieves for Testing Purposes, ASTM Designation E1 1 (AASHTO Designation M92).				
2•	The nominal maximum particle size is one size larger than the first sieve to retain more than 10 percent.				
3•	Interpolate minimum voids in the mineral aggregate (VMA) for design air void values between those listed.				

Portland Cement Concrete Pavement

This material shall consist of a mixture of coarse and fine aggregates, Portland cement, water and other materials or admixtures as required. Colorado Department of Transportation Class "P" or "AX" mix may be used. (The only alternatives to "P" or "AX" shall be according to Section 412.03 of CDOT Standard Specifications). Other high-early strength concretes may be used where special conditions warrant, subject to written approval by the Engineer.

- a. Portland cement shall comply with the Colorado Department of Transportation requirements. The type of cement shall be Type 11, unless sulfate conditions dictate otherwise. Table 2.2.3 in Chapter 2.2 of ACI 201, indicates recommendations for sulfate resistance.
- b. Fine aggregates shall meet Colorado Department of Transportation Section 703.01 requirements and gradation as shown in Table 4.13.
- c. Coarse aggregates shall meet Colorado Department of Transportation Section 703.02 requirements and gradation as shown in Table 4.14.

- d. Fly Ash shall comply with Colorado Department of Transportation Section

02.050.080 MATERIALS (UTILITY PIPING AND ACCESSORIES)

080.1 Water Distribution

080.1.1 Water Pipe, Fittings and Tracer Wire:

All pipe used in the potable water system shall be D.I.P. or PVC AWWA C900 for pipe sizes of 4" to 12" with a pressure class of 200 (DR14) and AWWA C905 for pipe sizes of 14" to 16" with a pressure class of (DR18). The pipes must conform to the requirements of AWWA with push-on gasketed joints or mechanical joint ends, in conformance AWWA C110. All fittings shall be mechanical joint per AWWA. Tracer wire is to be taped to the PVC and warning tape is to be placed 1' above the D.I.P. See figure 1-3. Test stations shall be made of high impact A.B.S. Plastic and heavy duty cast iron collars and covers ASTM Class 25 or higher. Recommended manufacturer shall be Test Services - VALVCO, Inc. Test stations shall be located adjacent to the nearest fire hydrant.

Insulators shall be provided between the main and the service line.

080.1.2 Protective Coatings:

The surface finish of all ductile iron pipe shall conform to the following: A. Exterior. The exterior coating shall be the standard outside bituminous coating as specified in ANSI A21.6 or ANSI 2 L51. B. Interior. Normally, no interior coating other than a cement mortar coating as specified in ANSI A21.4 (AWWA C104) will be required.

080.1.3 Corrosion Protection:

All ductile iron pipe and all Fittings shall be wrapped in polyethylene tubing to prevent corrosion. Polyethylene tubing, tape, and installation shall meet the requirements of ANSI A21.5 (AWWA C105) and these Regulations.

080.1.4 Other Water Pipe Materials (Pipe Restraints):

Ductile Iron Pipe- Glands shall be manufactured of Ductile iron conforming to ASTM53680. The gland shall be such that it can be used with the standardized mechanical joint bell conforming to the requirements of ANSI/AWWA A21.11/C111 and A21.53/C153. Twist off nuts, sized same as tee-head bolts, and shall be used to insure proper actuating of restraining devices. The mechanical joint restraint shall have a working pressure of at least 100 psi with a minimum safety factor of 2:1 and shall be EBBA Iron Inc., Megalug Series 1100, Ford Meter Box Co., Uni-Flange Series 1400 or approved equal.

PVC Pipe - Glands shall be manufactured of ductile iron conforming to ASTM A536-80. The gland shall be such that it can replace the standardized mechanical joint gland and can be used with the standardized mechanical joint bell conforming to the current requirements of ANSI/AWWA A21.11/C1 1 I and A21.53/C153. Twist off nuts, sized the same as tee-head bolts, and shall be used to insure proper actuating of restraining devices. The restraining glands shall have a pressure rating equal to that of the PVC pipe on which it is used and shall be EBBA Iron Inc., Megalug Series 2000, Ford Meter Box Co., Uni-Flange Series 1300 or an approved equal.

Use of water pipe other than ductile iron pipe or the Engineer prior to its proposed use in the design as specified above must approve PVC. The use of Asbestos Cement Pipe in any portion of the potable water system is not allowed.

080.1.5 Hydrants

Fire hydrants shall conform to A W WA C502, be three-way fire hydrants with a five (5') foot bury. Acceptable hydrant to the Town is Pacer WB-100 by Waterous Co., or Super Centurion 200 by Mueller Co. The fire hydrant shall have one 5-1/4" valve opening with two 2-1/2" hose nozzles and one 5 1/4" pumper nozzle, all shall be AWWA C-502-94. All threads shall be National Standard with 1% s" pentagonal cap nuts. All hydrants shall be AWWA C-502-94 standard open left. All hydrants shall be factory painted yellow, Federal Standard 595A. ~~See Standard Drawings W-11 in Section 11, Appendix II A.~~

The mechanical joints of the fire hydrant assembly shall be restrained via all-thread rodding and clamps or meg-a-lug joint clamps, unless more than one section of pipe is used between the hydrant and the valve.

80.1.6 Underground Water Line Valves

All waterline valves shall be manufactured in accordance with applicable AWWA standards and shall open left. Valve ends shall be mechanical joint. Valves and fittings shall be minimum Class 150, unless otherwise required by the Engineer, but never less than the pipe.

080.1.6.1 Gate Valves: up to and including 12":

Gate valves without bypass valves may be used on all lines 12" in diameter or smaller. Gate valves shall be of the iron body, non rising bronze stem, resilient-seat type manufactured to equal AWWA Standard C509. The valves shall be double-rise, parallel seat, and equipped with "O"-ring stem seals. All stub lines shall be harness-rodded to the main. These valves shall open left and be furnished with a 2" square operating nut or hand wheel (where necessary). Valves shall have a full opening flow way of equal diameter of the nominal size of the connecting pipe. The valve disc shall have an integrally cast ASTM B-62 bronze stem nut to prevent twisting or angling of the stem. Coatings shall be equal to or exceed AWWA Standard C550 and the specific requirements outlined.

- a) All internal and external ferrous metal surfaces shall be fully coated, to a minimum thickness of 4 mils.
- b) The coating shall be a two-part thermosetting epoxy suitable for field over-coating and touch-up with the same coating material, without special surface preparation or extreme heat.

080.1.6.2 Gate Valves - Larger than 12"

Butterfly valves shall be of cast iron body, tight closing, rubber sealed, Class 150B, buried service conforming to the requirements of AWWA C504. The valve disc shall rotate 90 degrees from full

open to full closed position and the place of the disc in the full seated position shall be 90 degrees to the axis of the pipeline. The valve shall give bubble tight shut-off against pressure not less than the pressure class of the pipe.

080.1.6.3 Bypass Valves

080.1.6.4 Valve Boxes:

Valve box shall be equal to 6860 Series w/160 base as manufactured by Tyler. With each valve, there shall be furnished and installed a cast iron valve box and cover. The iron valve box shall be substantially made, shall be adjustable for length, and shall be of the screw type. They shall not be less than 5'-11/4" in diameter and the cover shall be of the deep socket type with the word "Water" cast on the top. The protective cover at gate valves shall be increased as necessary to provide a minimum of 5' of protection on the valve bonnet.

080.1.6.5 Butterfly Valves:

Butterfly valves shall be of cast iron body, tight closing, rubber sealed, Class 150B, buried service conforming to the requirements of AWWA C504. The valve disc shall rotate 90 degrees from full open to full closed position and the place of the disc in the full seated position shall be 90 degrees to the axis of the pipeline. The valve shall give bubble tight shut-off against pressure not less than the pressure class of the pipe.

080.1.6.6 Combination Air Release/Vacuum Valve:

Combination air relief valves and boxes shall be located at all high points in the transmission and distribution system. The combination air relief valves shall be separable from the main by a gate valve and be placed in a cast iron or concrete vault to be shown on the approved plans. The valve body shall be of cast iron, designed for a working pressure of 150 psi, shall be fully bronze-mounted and shall have 125 pound ASA flanges. The constant pressure portion of the pilot may be either a hydro, mercury control or a spring-loaded control.

080.1.6.7 Pressure Reducing Valves:

Pressure reducing valves, vaults and piping shall be installed in the locations where required by the Engineer. These valves shall be of a standard type capable of maintaining any desired constant downstream pressure against a higher and varying inlet pressure. All pressure-reducing valves shall have a pressure-sustaining feature. The Engineer will provide the approximate upstream pressure to be maintained. Valves shall be furnished with cast iron bodies and covers, bronze trim and copper floats designed for the pressure class of the pipe. The valves shall be placed in a concrete vault and installed with a bypass loop configuration. Use only Cla-Val brand only.

080.1.6.8 Water Service Lines, Meters, and Taps:

Service lines shall be shown on the plans and be constructed between the distribution system pipe line and the meter vaults. Service lines 2" or smaller shall be of Type K copper, conforming to ASTM B-88. Corporation stops shall be brass or bronze, meeting ASTM B-62, and shall have threads suitable for the saddle to which connection is being made. Tapping saddles shall be brass or bronze, meeting ASTM B-62, and approved for use with ductile iron pipe. For PVC, saddles shall be brass or bronze, meeting ASTM B62. Meters will be provided by the Town. See Drawings W-1a through W-6a for details of potable meter pits and permitted materials. A PRV is required on all service lines where the pressure exceeds 80 psi, unless otherwise approved by the Utilities Department.

080.2 SANITARY SEWER COLLECTION SYSTEM

080.2.1 Sanitary Sewer Pipe

All sanitary sewer collection systems shall be of the following types: PVC or ductile iron pipe. To receive a new material approval, the Developer shall follow the process in Appendix 111-A.

080.2.1.1 PVC (SDR 35):

Polyvinyl chloride (PVC) plastic pipe fittings, couplings and joints shall be in conformance with the requirements of ASTM D-3033 or D-3034. The SDR shall be a minimum of 35 and all pipe shall have gasketed joints. The use of solvent cement joints is prohibited.

080.2.1.2 Ductile Iron Pipe:

Normally used only where structural or pressure sewers may be required. All pipe and fittings shall conform to AWWA C151 and AWWA C110, respectively. Joints shall conform to AWWA C111 for mechanical and push-on and to AWWA C110 for flanged joints. In areas where the lines are close to flat, the Engineer may require the DIP line to be vinyl-lined.

080.2.2 Under-drain

Where required by ground water and/or trench conditions, the following under-drain materials may be used:

- 1) Perforated PVC sewer drain pipe shall conform to ASTM D-2729.
- 2) Corrugated ABS plastic pipe, conforming to ASTM D-2680 and D-275 1.

080.2.3 Manhole Materials

080.2.3.1 Manholes:

Manholes shall be constructed of pre-cast concrete where possible

and be asphalt-coated on the inside when determined necessary by the Engineer. Concrete pre-cast reinforced risers and tops shall conform to ASTM C-478. Manholes shall conform to details shown on SS-3. Cones shall be of the eccentric type. Steps for manholes shall be made of aluminum alloy conforming to CDOT standards, having a minimum tensile strength of 35,000 psi and have an elongation of not less than ten percent in two inches. Steps shall incorporate two non-skid grooves and must, without permanent deformation, carry a load of 1,000 pounds when projected 6" from the wall and 1,500 pounds when projected 4" from the wall. Plastic inserts must be anchored with no movement. Manholes deeper than 20' shall have a "safety" horizontal platform, (for example, a flat grate with removable cover), installed at midpoint to provide an area for refuge and rescue. 18" maximum riser rings are allowed. Openings must align vertically.

080.2.3.2 Mortar for Manholes:

Mortar for manholes shall be mixed in the following proportions by volume: One part Portland cement, one-half part hydrated lime, and three parts sand. Masonry cement, ASTM C-91, Type II, if approved by the Engineer, may be used in place of Portland cement and hydrated lime. The cement, lime and sand shall be thoroughly mixed dry and only enough water added to form a mortar of proper consistency. Mortar shall be used within one hour after mixing, with no re-tempering permitted. Mortar that has taken a partial set shall not be used.

080.2.3.3 Manhole Gaskets:

Where preformed flexible plastic gaskets are used to seal joints between pre-cast manhole sections, they shall conform to Federal Specifications SS-S-00210 (6SAFSS), Type I, Rope Form and shall have a minimum diameter of 1-1/2". An approved water stop gasket assembly shall be placed around all pipe that is incorporated within manhole bases, inlet boxes or other concrete structures. The water stop gasket shall be capable of withstanding an internal hydrostatic pressure of 13 psi for 10 minutes without leakage.

080.2.3.4 Cast Iron Manhole Covers:

All cast iron manhole rings and covers and other iron castings shall be 410 lb. cast iron, 23 7/8", ASTM A-48, with a minimum tensile strength of 30,000 psi (Class 30), (Neenah Type R-1706 ring and cover or equivalent, (see Drawing SS-4). Castings shall be hot-dipped in asphalt varnish in such a manner as to form a firm and tenacious coating. All metal-bearing surfaces between the ring and cover shall be machined or fabricated to ensure good seating. Manhole lids shall be provided with a non-slip pattern on the surface that lies flush with the elevation of the ring. Manholes installed outside of the street right-of-way and/or easement shall have locking lid covers. The first two manholes at the exit of a force main shall have locking lid covers.

080.2.4 Service Lines Materials, Tap Connections

Unless otherwise specified by these Public Works Regulations or the Engineer, manufacturing, inspection, marking, and acceptance of sewer pipe and related products shall be in accordance with the standard specifications listed in this section. Unless otherwise approved by the Engineer and listed as such on the approved plans, all sanitary sewer pipe for collection mains and lines shall be PVC SDR-35 (ASTM 3033 or ASTM 3034). PVC pipe, delivered to the job-site, may be rejected if it does not conform to the ASTM D-3033 or D-3034 or does not conform to ASTM D-2321, "Recommended Practice for Underground Installation of Flexible Thermoplastic Pipe."

080.2.4.1 Materials:

Service line material shall be PVC - SDR 35.

080.2.4.2 Taps:

Normally, taps are required to be made on the main while the line is being laid. These taps are fittings (e.g., 45° degree wye fitting on main to a 45° degree bend on the service line). Refer to Drawing No. SS- 2 for details. If tapping saddles are used in new construction, they shall be of a type manufactured and furnished by the pipe supplier. All PVC tapping saddles shall be of the type which uses stainless steel bands to attach the pipe with a bell gasket on the service side.

080.3 STORM DRAINAGE SYSTEMS

080.3.1 General:

Underground storm sewer lines shall be constructed of reinforced concrete pipe conforming to the requirements of this Article. Culvert pipes, where specifically approved by the Engineer, may be constructed of Corrugated Metal Pipe conforming to the requirements of this Article.

Where the nature of storm drainage facilities required varies from the data shown in this Article, the Developer shall provide detailed specifications for materials and workmanship for review and approval by the Engineer at the time the Engineer reviews and approves the project.

080.3.2 General - Concrete Pipe

Reinforced concrete pipe shall be of the sizes and loading, classes indicated on the approved plans and as approved by the Engineer and shall conform to the requirements as hereinafter provided.

080.3.2.1 Reinforced concrete low-head pressure pipe shall conform to ASTM Designation C361-70 or the latest revision thereof. The pipe shall be furnished in six (8') foot laying lengths or longer. Reinforced concrete pipe shall be a minimum of Class III.

080.3.2.2 Joints for circular concrete sewer pipe and culvert pipe shall use 8" rubber baskets and shall conform to ASTM Designation C443-70, or the latest revision thereof.

- 080.3.2.3 Joint type R-4 from Standard Specifications for Reinforced Concrete Pressure Pipe, February 1,1969 - U.S. Department of the Interior, Bureau of Reclamation.
- 080.3.2.4 Reinforced concrete D-Load culvert, storm drain and sewer pipe shall conform to ASTM Designation C655-70.
- 080.3.2.5 Jointing materials for bell and spigot joints shall conform to ASTM Designation C443-70), C361-70 or the latest revision thereof, joint type R-4 of the Standard Specifications for Reinforced Concrete Pressure Pipe, or the latest edition thereof.
- 080.3.2.6 Jointing materials for tongue and groove joints shall be rings or Mastic (Ram-Neck), or approved equal.

080.3.3 Couplings and Fittings

Corrugated bands shall be used to connect annularly-corrugated and helically-corrugated lock seam pipe from six inch (6") to ninety-six inch (96") diameters. The standard 3 corrugation or 7" band shall be used unless the approved plans call out an alternative size. Material shall be 16 gauge, unless specified otherwise. Material composition and coatings shall be the same as that of the pipe. Metal end sections shall be shop-fabricated and of the gauges indicated on the plans. If no gauge is specified, the gauge shall be the standard specification gauge used by the Colorado Highway Department. All couplings shall be watertight.

All necessary couplings and fittings for the construction of the proposed facilities, complete in place, shall be furnished, whether or not specifically indicated on the drawings.

080.3.4 Corrugated Metal Pipe

All corrugated metal pipe shall conform to requirements of AASTHO M-36 for galvanized pipe and AASHTO M-36, AASHTO M-190 for coated galvanized pipe, and AASHTO M 274 for aluminized corrugated steel pipe, or the latest revision thereto. Seams shall be either riveted, helical lock, bolted or spot-welded. All pipe shall be designed and manufactured so as to conform, when laid, within the lines and grades shown on the plans, with outlets, connections and appurtenances as shown.

All fittings and specials shall be properly reinforced to withstand the maximum internal pressure, both circumferential and longitudinal, and the external loading conditions as shown on the plans. The fittings and specials shall be fabricated in accordance with the manufacturer's recommendations and specifications and in accordance with the approved plans.

The Inspector shall be permitted to make any and all inspections he/she deems necessary during the manufacturing of the pipe, to determine that these Specifications are being followed. All tests shall be made in conformance with these Specifications and shall be made at the expense of the Developer.

080.3.5 High Density Polyethylene Pipe (HDPE)

080.3.5.1 General:

Pipe meeting the requirements of AASHTO 294-90 Type S. Pipe and fittings shall be made of virgin PE compounds which conform with the requirements of Type 3 Category "4" or "5", Grade P33 Class C; or Grade P34, as defined in ASTM D 1248 Standard Specification for Polyethylene Plastics Molding and Extrusion Materials. Materials meeting the requirements of cell classification PE 334433 C or higher cell classification in accordance with ASTM D 3350 are also suitable. Other materials may be used in manufacturing of the pipe for example, as a core tube to support the shape of the pipe during processing provided that these materials are compatible with the base polyethylene material and are completely encapsulated in the finished product and in no way compromise the strength or performance of the pipe. The Town will require Hancor "Titeline" or approved equal. All systems shall be water tight.

80.3.5.2 Pipe Stiffness:

The pipe shall have the following minimum pipe stiffness as at 5% deflection when tested in accordance with test methods below.

Diameter Pipe Stiffness	
(Inches)	(PSI)
12 (305mm)	45 (310 kPa)
15 (381mm)	42 (289 kPa)
18 (457 mm)	40 (276 kPa)
21 (533 mm)	38 (262 kPa)
24 (610 nun)	34 (235 kPa)
30 (760 mm)	28 (193 kPa)
36 (915 mm)	22 (152 kPa)

02.100.000 SITE REMEDIATION

02.100.105 CHEMICAL SAMPLING AND ANALYSIS

105.1 Disposal of Waste Materials

Burning of Developer's Property: Burning is not permitted on Developer's property.
Removal from Developer's Property: Remove waste materials and unsuitable or excess topsoil from Developer's property and legally dispose of it.

105.2 Excavation, Removal and Handling of Hazardous Material

105.3 Site Decontamination

Removal of contaminated residue of toxic and hazardous materials.

02.200.220 **SITE DEMOLITION**

220.1 Removal of Structures and Obstructions

220.1.1 **General:** The work shall consist of the removal, wholly or in part, and satisfactory disposal of all foundations, fences, signs, structures, sidewalk, curbing, old pavements, traffic signal materials, abandoned pipelines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under -other items in the contract. It shall also include the salvaging of designated materials and back-filling the resulting trenches, holes, and pits.

220.1.2 **Construction:** The Developer shall raze, remove, and dispose of all foundations, signs, structures, fences, old pavements, abandoned pipelines, traffic signal materials, and other obstructions, any portion of which are within the project limits, except utilities and those for which other provisions have been made for removal.

Traffic signals and related materials shall include all attachment hardware and other included materials such as, but not limited to, mast arms and span wire.

Concrete adhering to sign posts shall be removed. Pedestals and bases shall be removed to 1' below the surrounding ground or subgrade.

Where portions of structures are to be removed, remaining portions shall be prepared to fit construction. The work shall be done in accordance plan details, and in such a manner that materials to be left in place shall be protected from damage. All damage to portions of structure to remain in place shall be repaired by the Developer at their expense. Reinforcing steel projecting from the remaining structure shall be cleaned and aligned to provide bond with new extension. Dowels as required by plans are to be securely grouted with approved grout. Removal of sign panel shall include all work necessary to remove the panel and its attachment hardware from the existing installation.

Where culverts or sewers are to be left in place and plugged, the ends shall be filled with Class III concrete. Culvert and sewer ends are to be sufficiently filled to prevent future settlement of embankments.

Materials used in detour structures for the project, which are supplied by the Developer, shall be considered to be the property of the Developer. After the detour is abandoned, he shall completely remove the detour structure and shall dispose of materials as specified.

220.2 Removal of Bridges, Culverts, and Other Drainage Structures

220.2.1 Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise directed, the substructures of existing structures shall be

removed down to 1' below natural stream bottom or ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Steel, pre-cast concrete, and wood bridges as specified shall be carefully dismantled without unnecessary damage. Steel members to be salvaged shall be match-marked with waterproof paint.

220.2.2 Removal of Pipe: Unless otherwise provided, all pipe shall be carefully removed, cleaned, and every precaution taken to avoid breaking or damaging the pipe. Pipes to be re-laid shall be removed and stored when necessary, so that there will be no loss or damage before relaying.

In removing manholes, catch basins, and inlets, any live sewers connected with them shall be properly reconnected and satisfactory bypass service shall be maintained during such operations.

220.3 Removal of Pavements, Sidewalks, and Curbs Etc.

PCC concrete or asphalt concrete that is to remain shall be cut in a straight, true line with a vertical face. PCC or asphalt concrete may be cut with a cutting wheel, saw, or broken to the directed point of removal. The Developer shall be responsible for the cost of removal and replacement of all over-break.

If the Developer cannot maintain a straight, true break line by other means, the Engineer shall order sawing;.

The sawing shall be done carefully, and all damages to PCC or asphalt concrete to remain in place due to Developer's operations, shall be repaired by the Developer at his/her expense. The minimum depth of saw cut in concrete shall be 2".

220.4 Pavement

Bituminous pavement shall be removed to clean, straight lines by saw cutting. Concrete pavement shall be removed to neatly sawed edges to a minimum depth of 1 1/2". If the removed portion falls within 3' of a construction joint, cold joint, expansion joint or edge, the concrete shall be removed to the joint or edge. The pavement cut shall follow a line parallel to the pipe centerline and 12" beyond the trench side wall. In the event pavement beyond the original pavement cut is undermined or damaged during construction, additional pavement shall be removed after trench back-filling. The additional pavement shall consist of a cut parallel to the pipe centerline with transitions to the original cut on each side. Any paving that is damaged by the Developer outside the above-stated limits shall be replaced at the Developer's expense. All excavated paving and concrete shall be stockpiled separately and disposed of by the Developer off site of the work at his/her expense and shall not be used as trench backfill material.

220.5 Concrete

Concrete Curb, Gutter, Sidewalk, Crosspans, Driveways, and Alley Intersections: Concrete shall be removed to edges that are neatly sawed to a minimum depth of 1 1/2". Sidewalks, driveways, alleys and pans shall be saw cut in straight lines either parallel to the curb or perpendicular to the alignment of the sidewalk or curb. No section to be replaced shall be less than 3' in either width or length. If proposed saw cuts in the sidewalk, driveway or alley fall within 3' of a construction joint, expansion joint, or edge, the concrete shall be removed to the joint or edge.

- 220.5.1 Salvage: All salvageable material shown on the plans shall be removed, without unnecessary damage, in sections or pieces, which may be readily transported, and shall be stored by the Developer in locations designated by the Engineer. The Developer shall be required to replace any materials lost from storage or damaged by negligence or by use of improper methods.
- 220.5.2 Disposal: The Developer shall make all necessary arrangements for obtaining suitable disposal locations and the cost involved shall be included in the work. If disposal is to be at other than established dump sites, the Engineer may require the Developer to furnish written permission from the property owner on whose property the materials are placed. Broken concrete or asphalt shall not be disposed of in the Town.
- 220.5.3 Backfill: Except in areas to be excavated, all cavities left by structure removal shall be back-filled with suitable material and compacted in accordance with these Specifications. Jetting or ponding will not be allowed.

02.200.230 **SITE CLEARING**

230.1 General:

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

230.2 Construction:

The Consultant will establish construction lines per Town discretion and designate all trees, shrubs, plants, and other objects to remain. The Developer shall preserve all objects designated to remain.

All surface objects and all trees, stumps, roots, and other protruding obstructions not designated to remain, shall be cleared and/or grubbed, including mowing, as required, except nonperishable solid objects which will be a minimum of 2' below subgrade. Perishable objects shall be removed to a depth of 3' below the existing ground or subgrade, whichever is lower.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be back-filled with suitable materials and compacted in accordance with these Specifications. Materials and debris shall be disposed of in a manner

acceptable to the Engineer. Burning will not be permitted.

The Developer shall make all necessary arrangements for obtaining suitable disposal locations. If disposal is to be at other than established dump sites, the Engineer may require the Developer to furnish, in writing, permission from the property owner on whose property the materials and debris are placed. Branches on trees or shrubs shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 20' above the roadbed surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

The Developer shall scalp areas where excavation or embankment is to be made, except that mowed sod need not be removed where the embankment to be constructed is 4' or more in height below subgrade elevation. Scalping shall include the removal of materials such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and other vegetable matter from the surface of the ground.

Hedges shall be pulled or -rubbed in such a manner as to assure complete and permanent removal. Scattered hedge or shrubs not classified as hedge shall be removed as specified for hedge. Sod not required to be removed shall be thoroughly disked before construction of embankment.

02.200.240 **DEWATERING**

240.1 General:

- 240.1.1 Prevent surface water and subsurface or around water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- 240. 1.2 Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- 240.1.3 Do not allow water to accumulate in excavations. Remove water from excavations to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey the water away from the site.
- 240. 14 Convey water removed from excavations and rainwater to collecting or run-off areas acceptable to authorities having jurisdiction. Do not use trench excavations from site utilities as temporary drainage ditches.

02.200.250 **SHORING AND UNDERPINNING**

250.1 Stability of Excavations

- 250.1.1 Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations including Federal and State law.

250.2 Utility Trenches

- 250.2.1 Excavate trenches to indicated slopes, lines, depths, and invert elevations. Beyond building perimeter, excavate trenches to allow installation of top of

pipe below frost line.

250.2.2 Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

a) Clearance: 12 inches each side of pipe or conduit.

250.2.3 Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.

a) For pipes or conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

02.200.285 **REBUILT MISCELLANEOUS STRUCTURES**

285.1 General:

This item shall consist of removing, relaying, resetting, or adjusting structures, fences, guard rail, signs, pipe, end sections, traffic signals, and related materials.

All designated items shall be carefully removed and every precaution taken to avoid damage. Coordinate relocation of permanent traffic devices with the Traffic Division. The Developer will be required to replace or repair any material damaged due to their operations at their own expense. The work shall include the back-filling of any resulting trenches, holes, or pits.

285.2 Construction

Pipe to be re-laid and structures to be reset shall be thoroughly cleaned. Removal sites shall be neatly back-filled with suitable material and compacted in accordance with these Specifications.

Materials in good condition from removed structures or fences may be used in the rebuilding operations. All removed material not reused shall be salvaged or disposed of as directed.

Where fences are to be rebuilt or reset, it will be the Developer's responsibility to supply and install any new materials required to restore the fence to acceptable condition. Unless otherwise stated, the Developer may reuse any existing material that is salvageable. The quality of construction of the reset fence shall equal or exceed that of the existing fence.

Unserviceable material from structures shall be replaced with new material of dimensions similar to those used in building- the original structure. Replacement parts and new materials, including concrete footings, necessary to restore these structures to service at new locations shall be provided and installed by the Developer as part of these items.

All new materials and replacement parts shall be of similar quality to those used in the original structure or as specified. Gates designated or noted on plans to be reset

shall be removed and restored for service at the new locations indicated.

Mailboxes complete with supporting structures are to be removed and temporarily reset at points near their original location to be easily accessible for mail delivery service. Immediately upon completion of surfacing operations, the boxes shall again be reset to a height of 42 to 48" at the locations designated. A supporting structure may contain one or more mailboxes.

Resetting of all traffic control signs and traffic signaling devices will conform to Section 01.500.560.1-2 and be coordinated with the Traffic Division.

Adjusting structures shall include, but not be limited to, manholes rings and covers, inlet gratings and frames, water valve boxes, water meters, gate posts, and other structures and facilities. Construction operations shall include any raising, lowering, moving, removing masonry or concrete, adding brickwork, masonry or concrete, and resetting grates, frames or rings and covers to fit the new construction. At no time shall manholes and valve boxes be covered up or buried. Valve boxes and manholes are to be maintained fully accessible at all times for emergency and maintenance operation by the Town personnel. Work on water services shall be subject to observation and testing by the owners. Damage to any fire hydrant or any part of the system due to Developer's operations shall be repaired immediately at the Developer's expense.

02.300.000 **EARTHWORK**

02.300.310 GRADING

310.1 General

Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross-sections, lines, and elevations indicated. Provide a smooth transition between existing adjacent grades and new grades.

Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.

310.2 Site Grading

Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

- a) Lawn or Unpaved Areas: Plus or minus 1.2 inches.
- b) Walks: Plus or minus 1.2 inches.
- c) Pavements: Plus or minus 1/2 inch.
- d) Overlot

02.300.315 **EXCAVATION AND FILL (extraction, removal, and disposal of material and structures)**

315.1 Excavation

- 315.1.1 Explosives: The use of explosives will not be permitted without a blasting permit.
- 315.1.2 Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.
- 315.1.3 Unauthorized Excavation: Unauthorized excavation consists of removal of materials beyond specified elevations without the specific direction of the Engineer. Replace unauthorized excavation by back-filling and compacting as specified for-authorized excavations.
- 315.1.4 General: This work shall consist of excavation, disposal, shaping, or compaction of all material encountered within the limits of the work, including excavation for ditches and channels.
- 315.1.5 Embankment Material: Embankment material shall consist of approved material acquired from excavations, hauled and placed in embankments in reasonably close conformity with the line, grades, thicknesses, and typical cross-sections shown on the plans or as established.

The type of relative compacting required shall be as called for on the plans or as designed.

When the source of embankment materials is not designated on the plans, approval of the source will be contingent on the material having a resistance value of at least 15 or as shown on the plans when tested by the Hveem Stabilometer, and a maximum dry density of not less than 95 pounds per cubic foot.

315.3 Excavation for Structures

- 315.3.1 Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1.2". Extend excavations a sufficient distance from structures for placing and removing concrete form work, installing services and other construction, and for inspections.
- a) Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- b) Excavation for Underground Tanks. Basins and Mechanical or Electrical Appurtenances: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1.2". Do not disturb bottom of excavations intended for bearing surface.

315.4 Excavation for Walks and Pavements

315.4.1 General:

Set and build into form work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

315.5 Excavation for Utility Trenches

- a) Excavate trenches to indicated slopes, lines, depths, and invert elevations.
 - 1) Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line or 4.5'.
- b) Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1) Clearance: 12 inches each side of pipe or conduit.
- c) Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for joints, and barrels of pipes, and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.
 - 1) For pipes or conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2) For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand back-fill.
 - 3) Where encountering rock or another unyielding bearing surface, carry trench excavation 6 inches below invert elevation to receive bedding course.

02.300.330 EMBANKMENT

330.1 General:

The excavation and embankments shall be finished to reasonably smooth and uniform surfaces. Variation from the subgrade plane shall not be more than 0.08' for soil, nor more than 0.50' for rock. Materials shall not be wasted without permission of the Engineer. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to beginning grading operations in any area, all necessary clearing and grubbing and topsoil in that area shall have been performed in

accordance with Section 02.200.230, Clearing and Grubbing.

330.1.1

Embankment: Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed. These areas include the construction of dikes; the placing and compacting of approved material within project areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits, and other depressions within the project area. Only approved materials shall be used in the construction of embankment and back-fills.

Free running water shall be drained from the material before the material is placed. Rocks, broken concrete, or other solid materials more than 6" in greatest dimension shall not be placed in embankment areas less than 1' deep measured from the subgrade. Materials less than 150 pounds may be placed in fills over 1' deep provided there remains 1' minimum cover measured from the subgrade, with the approval of the Engineer.

Slopes that are steeper than 4:1 when measured longitudinally or at right angles to the roadway shall be continuously benched into the existing slope over those areas where it is required as the work is brought up in layers. This applies when the embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half width at a time. This requirement may be adjusted depending on the recommendations of the soils engineer.

Benching shall be well-keyed, and, where practical, the key should be a minimum of 8' wide and 3' deep. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be re-compacted along with the new embankment material at the Developer's expense.

If embankment can be deposited on one side only of abutments, wing walls, piers, or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of, or excessive pressure against, the structure. The fill adjacent to the end bent of a bridge or to a box culvert shall not be placed higher than the bottom of the back wall of the bent or floor slab of the box, until the superstructure is in place. When embankment is to be placed on both sides of a concrete wall or box type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.

The Developer shall notify the Engineer in sufficient time before beginning excavation that the necessary cross-sections may be taken. The Developer shall not excavate beyond the dimensions and elevations established and material shall not be removed prior to the staking and cross-sectioning of the site.

When the Developer's excavating operations encounter remains of prehistoric peoples' dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued. The Developer will contact archaeological authorities to determine the disposition thereof. When directed, the Developer shall excavate the site in such manner as to preserve the artifacts encountered and shall remove them

for delivery to the custody of the proper state authorities.

The Developer shall at all times take precautions for the protection of culverts, irrigation crossings, mail boxes, driveway approaches, valve boxes, manholes, survey monuments, underground or overhead utility lines, and all other public or private installations that may be encountered during construction. The Developer shall be responsible for the repair of any installations damaged due to their work. Manholes and valve boxes shall be observed by the Engineer for displacements and introduction of foreign matter. It shall be the Developer's responsibility to correct any displacement and to remove any foreign matter resulting from his/her work.

330.2 Excavation

330.2.1 Rock: Unless otherwise specified, rock shall be excavated to a minimum depth of 6" below subgrade within the limits of the roadbed, and the excavation back-filled with material designated on the plans or as approved.

330.2.2 Unclassified: When material encountered within the limits of the work is considered unsuitable by the Engineer, such material shall be excavated as directed by the Engineer and replaced with suitable material. All excess or unsuitable excavated material, including rock and boulders, that cannot be used in embankments will be disposed of as approved by the Engineer.

Wherever shown on the plans or considered necessary, intercepting ditches shall be made above the top of cut slopes and carried to outlets near the ends of the cuts. In order to blend the intersection of cut slopes with the slope of the adjacent natural ground surfaces in a uniform manner, the tops of all cut slopes shall be flattened and rounded.

Excess quantities of excavation not necessary for the construction of embankments, unless otherwise specified on the plans or special provisions, shall become the property of the Developer and shall be disposed of as specified as above. The Engineer may allow disposal by widening and flattening fill slopes if right-of-way conditions permit and if no damage results.

330.2.3 Borrow:

Borrow material should not be placed until after the excavation has been placed in the fill. If the Developer places more borrow than is required and thereby causes a waste of excavation, the amount of such waste will be deducted from the borrow volume. Borrow areas shall be finished so that water will not collect or stand therein, unless otherwise specified.

02.500.000 UTILITY SERVICES

000.1 Water Pipe Installation

Pipe shall be constructed to the lines, grades, and elevations shown on the drawings. Unless otherwise specified by the Inspector or these standards, pipe handling and installation shall follow the recommended practice in AWWA C600. Damages to pipes and appurtenances shall be repaired or replaced by the Developer, as required by the Inspector.

000.1.2 Site Conditions:

Proper implements, tools and facilities shall be provided by the Developer for the safe and convenient execution of work. Water shall be removed from trenches while pipe is being laid and shall not be allowed to rise around the pipe before back-filling. When pipe-laying is not in progress, access to the open ends of the pipe shall be restricted. At all times, precaution shall be taken to prevent foreign materials from entering the pipe.

000.1.3 Bedding Requirement:

The minimum support for pipes shall be Class D bedding, unless otherwise specified. Refer to 02.050.055.2 "Bedding Materials" for class descriptions.

000.1.4 Direction:

Pipe-laying shall commence at the lowest point and proceed upgrade. Pipe shall be laid with the bell ends facing in the direction of the laying.

000.1.5 Placement:

Bedding shall be placed to provide a solid, unyielding uniform-bearing surface for the full length of the barrel. Extra care shall be taken to create unyielding bedding up to the spring line of the pipe.

000.1.6 Joints:

All "push-on" bell and spigot joints shall be pushed home according to the manufacturer's instructions. If a certain section of pipe can not be pushed home, then the section will be rejected. All mechanical joints shall be tightened to manufacturer's recommendations.

000.1.7 Protective Coatings:

Metallic pipe and all fittings shall be wrapped in acceptable corrosion protection materials; e.g., polyethylene tubing . This wrapping, if required on the approved plans or by the Inspector, is required to be installed according to AWWA Standard CI05.

000.1.8 Anchorage of Bends:

Concrete thrust blocks shall be placed where shown on the approved plans. They shall conform to the requirements and dimensions shown on the approved plans. If thrust blocks (see W-22) are not detailed on the plans, they shall be installed, at a minimum, on all tees, plugs, caps, valves, hydrants and bends of 1 1-1/4 degrees or more. Concrete used shall be 3,000 psi compressive strength in 28 days. All thrust blocks shall be separated from the pipe by a 6 mil layer of polyethylene to act as a bond breaker. Normally, restrained joints will not be permitted, except when undisturbed soils are not available for a thrust block, for vertical bends, or to reduce the thrust block size for pipes larger than 12".

000.1.9 Deflections:

Pipe deflections shall not exceed the pipe manufacturer's recommendations. For deflections which are designed, the designer shall not use a higher allowance than half the manufacturer's allowable deflection.

000.1.10 Repair of Broken Pipe:

The Inspector shall approve the repair of broken or damaged water pipe. The broken pipe must be observed by the Inspector prior to repair, and after repair approved for back-fill.

000.2 Fire Hydrants

All hydrants shall be installed to conform to grade and alignment shown on plans. Hydrants are required to be thrust-blocked behind the hydrant and at the tee on the main line and be rodded (two all thread rods) from the tee on the main to the hydrant. All rodding shall be protected by bituminous coating or wrapped in 6 mil polyethylene. The gate valve required as a shut-off for the hydrant shall be located no farther than 18" from the main line, (end of tee to center of hydrant valve). Approximately a third of a yard, pea gravel, shall be placed under the fire hydrant to assist in positive drainage from the hydrant drain hole. Care should be taken to keep the concrete thrust block from covering the hydrant drain hole. The steamer connection shall face the direction as shown on the approved plans or as required by the Fire Department. Additionally, the steamer connection shall be no closer than 18" to finished grade. See also Dr- W 11.

000.2.1 Valves and Boxes:

The type of valves acceptable to the Town are specified in 02.050.080.1.8. Valves shall open left, be Class 150 and normally be mechanical joint.

000.2.2 Installation:

All valves shall be installed at the grade and locations shown on the approved plans. Valve boxes are required to be of the screw type. All valves shall be protected by 5' of cover. If the valve is deeper than 7 1/2' from finished grade to the bonnet top, then an extension shall be installed. Lids for boxes shall have the word "water" on them.

000.3 Service Lines, Taps, Curb Stops

The corporation stop on the main shall be at a 45° degree angle above the center line of the main. All taps shall be done using bronze or brass tapping saddles and shall be installed according to the manufacturer's recommendations. The Inspector shall inspect the main and tap prior to back-filling. In the event the tap is covered before it is inspected, it shall be uncovered by the Developer to allow for inspection. If the tap or water main is damaged during the process of locating, it shall be repaired immediately by the Developer in a manner acceptable to the Inspector. In addition, the location of the service line shall be marked on the curb by a "W" symbol and a 2" x 4" piece of lumber shall be extended from the end of the pipe to above ground level. If the line is not to be connected initially to a meter yoke, the end of the service line shall then be sealed shut to keep rocks and dirt out of the line. Every precaution shall be taken to prevent foreign material, including trench water, from entering the pipe.

000.4 Meter Pits

Air relief valves, vaults and vent pipes shall be installed at the locations shown on the approved plans. See Drawing No. W5, W5a, for details of a typical combination air relief valve and vault. The valve shall be separable from the main by a gate valve. The cast iron lid for the vault shall have the word "water" on it.

000.5 Pressure-Reducing Valves

Pressure-reducing valves, vaults and vent pipes shall be installed at the locations shown on the approved plans. See Drawing No. W3a, W36, W7a, W76, for details of a typical pressure-reducing valve and vault. All pressure-reducing valves shall have an outside by-pass piping arrangement to permit removal of the valve while continuing water flow in the main. The cast iron lid for the vault shall have the word "water" on it.

02.500.530 SANITARY SEWERAGE

530.1 Handling and Installation

Pipe shall be constructed to the lines, grades and elevations shown on the approved plans. The handling and installation of PVC pipe, unless otherwise specified by the Engineer, shall conform to ASTM D-232 1.

530.2 Conditions for Water, Sewer and Storm

a) Protection of Existing-, Underground Utilities:

The Developer shall proceed with caution in the excavation and preparation of the trench, so that the exact location of underground structures, both known and unknown, may be determined. If required, the Developer shall excavate and locate existing underground utilities ahead of trench excavation to anticipate grade changes. The Developer shall notify local utilities whenever working near gas mains or services, or near electrical or telephone cable, or when the presence of these utilities is suspected in the area of construction. In the event of damage, the Town Inspection Department and the affected utility company shall be notified immediately.

b) Wet Trench:

During construction, the Developer shall provide and maintain adequate equipment to proper removal and dispose of all excess water entering the trench or any other part of the work. Use of an active sewer under construction for disposal of the water will not be permitted. Before any pipe is laid, the trench shall be dry and shall be kept dry while joints are completed. In areas where unstable soil is encountered below the bottom of the pipe, the Developer shall excavate such material to the limits determined by the Inspector and back-fill with acceptable, compacted bedding material.

c) Underdrains:

Underdrains shall be installed where shown on the approved plans. Where excessive groundwater is encountered, the Inspector may also require

construction of gravel or piped underdrains, (even if not required by the plans), to reduce infiltration. The trench shall be excavated to the required depth and width and back-filled with the underdrain bedding material. Additional underdrain bedding material shall then be placed to a level 4" over the top of the underdrain pipe and the sewer pipe installed. Bedding for underdrain pipe or for gravel underdrain without pipe shall be composed of washed gravel or crushed rock, well-graded in the size range from 1/4" minimum to 1" maximum. Filter cloth is required..

530.3 Subdrains

All subdrain systems installed, (with or without soils analysis), shall include provisions for access to the subdrain pipe to permit inspection and cleaning. Access points, as a minimum, shall be in the form of two-way cleanouts placed through the bottom bench of sanitary sewer manhole inverts. All cleanouts in manholes shall be capped with a watertight, non-corrodible plug. The plug shall be flush with the top of the bench or countersunk to prevent hindrance to the safe footing of maintenance crews.

530.4 Cleanouts

At manholes, where multiple subdrain branches meet, a cleanout for each branch shall be provided. Branch connection points under manholes shall be via a 45 wye, no tee connections will be permitted. Special consideration and cleanout detail modifications may be needed in these cases due to bench space available within the manhole. Cleanouts shall not be within the sewer flow channel at any time. Details shall be subject to review and approval of the Town. Oversized manhole diameters may be required in these instances.

530.5 Bedding Requirements

The minimum support for PVC pipe shall be Class B bedding if not specified on the approved plans. Refer to 02.050.055.3, "Bedding Materials" for class descriptions and other installation details related to bedding.

530.6 Direction

Pipe-laying shall commence at the lowest point and proceed upgrade. Pipe shall be laid with the bell ends facing in the direction of the laying.

Bedding shall be placed to provide a solid, unyielding uniform bearing surface for the full length of the barrel. Extra care shall be taken to create unyielding bedding up to the spring; line of the pipe.

530.7 Joints

All "push-on" bell and spigot joints shall be pushed completely home. If a certain section of pipe cannot be shoved home, then the section will be rejected.

02.500.600 ENCASEMENTS OF STRUCTURAL SEWER

When the sewer pipe is required to be encased in concrete as shown on the approved plans or by the Inspector, the concrete used shall have a 3,000 psi minimum compressive strength in 28 days and be Type 11. Details of such

encasement are shown in W-25. When the sewer pipe is required to be a structural or pressure pipe as shown on the approved plans or required by the Inspector, the pipe shall be ductile iron, Class 52, meeting AWWA C151 and may be required to be lined with bonded polyethylene.

600.1 Repair of Broken Pipe

The Inspector shall approve the repair of broken or damaged sewer pipe. The broken pipe must be observed by the Inspector prior to repair and after repair approved for backfill.

600.2 Manholes

600.2.1 Minimum Acceptable:

Manholes shall be pre-cast with or without pre-formed inlets and outlets. Manholes shall meet ASTM C-478. Manhole bases may be pre-cast or field poured.

600.2.2 Installation:

a) Manhole Bases:

Manhole bases shall extend at least 8" below the bottom of the pipe and shall be benched up to at least 2" above the top of the highest crown. All concrete used in manhole bases shall be Type II 3,000 psi compressive strength minimum in 28 days. Reinforcing, as detailed in Drawing No. W20, W22, W25, shall be placed in bases. Pipe shall be terminated flush with the interior manhole wall. All PVC pipe shall have suitable water stop protection where the pipe is laid in the concrete. Transitions from inlet to outlet shall be smooth and of the proper radius for uninterrupted flow. Inverts shall be plastered with cement mortar and left smooth and clean.

b) Manhole Sections:

Pre-cast manhole sections shall not be placed on the base for 48 hours after the base pour, unless authorized by the Inspector. The top of the bench shall be thoroughly cleaned and moistened with water. While the bench is still moist, a full mortar bed, at least 1" in thickness, shall be applied to the pre-cast section bearing seat. The first pre-cast section shall be carefully lowered onto the bench so that the mortar bed will be forced out from under the section evenly on all sides. Each succeeding pre-cast section shall be jointed in a similar manner and smoothly finished inside and out. All lifting holes and other imperfections in the interior manhole wall shall be filled with cement mortar. The Developer has the option of using plastic gaskets in conjunction with mortar.

c) Manhole Cover Rings:

Manhole cover rings shall be installed, at a minimum of 2 and a maximum of 6, 2" pre-cast concrete adjusting rings above the lid or cone of the manhole. Manhole rings shall be set in a full bed of mortar to the grade called for on the plans. In new streets, manhole covers shall be left below grade until pavement is completed, then raised to grade and a concrete apron poured around it. See drawing W-26.

d) Reference Markers:

Whenever a manhole is located outside of a traveled street or walkway, a reference marker is required. This marker shall be a plastic marker as specified by the Engineer.

e) Connections to Existing Manholes:

Where there is no existing pipe stubbed out, sewer pipe connections to existing manholes shall be made in such a manner that the finished work will conform as nearly as practicable to the essential requirements specified for new manholes. The Developer shall break out as small an opening in the existing manhole as necessary to insert the new sewer pipe. The existing concrete foundation bench shall be chipped to the cross-section of the new pipe to form a smooth continuous invert similar to what would be formed in a new concrete base. Cement grout shall be used as necessary to smoothly finish the new invert and to seal the new line so the junction is water-tight.

f) Drop Manholes:

All drop manholes are to be installed as detailed on the approved plans and in conformance with Drawing S-1.

02.600.000 DRAINAGE AND CONTAINMENT

000.1 Storm Drainage:

Systems: Underground storm sewer lines shall be constructed of reinforced concrete pipe conforming to the requirements of this Article. Culvert pipes, where specifically approved by the Inspector, may be constructed of corrugated metal pipe conforming to the requirements of this Article.

Where the nature of storm drainage facilities requires a variance from the data shown in this Article, the Developer shall provide detailed specifications for materials and workmanship for review and approval by the Inspector at the time the Inspector reviews and approves the project.

000.2 Reinforced Concrete Pipe

This section details regulations concerning the installation, handling, testing of storm sewer pipe and manholes, concrete flatwork, structural concrete, landscaping and riprap. These Regulations are minimum standards to be adhered to by Developers installing elements of storm sewer systems in the Town. Regulations for trench excavation and bedding materials are found in 02.055.2. General provisions regarding Developer permits, inspection procedures, etc., are in the Policy and Procedures section.

The Developer shall furnish all labor, materials, tools and equipment necessary to complete all storm sewer line installation, as required by the plans, with completion of all work under the development agreement as specified herein. The excavation shall be made to the lines and grades shown on the approved plans.

Pipe-laying shall be in accordance with pipe manufacturer's specifications or relevant ASTM Standards.

The annular space for joints shall be clean and dry when joints are made, except that in hot dry weather, concrete pipe joints shall be moistened with water, as required, immediately before application on mortar joints.

- a) Bell and Spigot Joints: The rubber gasket shall be installed as indicated by the controlling Specification and the manufacturer of the rubber gasket.
- b) Tongue and Groove Joints: These shall be of rubber gasket or Mastic and will be installed as directed by gasket manufacturer with due care that all parts of the joints are properly sealed.

000.3 Corrugated Metal Pipe

The Developer shall furnish all labor, materials, tools and equipment necessary to complete all storm sewer line installations, as required by the approved plans with completion of all work under the development agreement and as specified herein. The excavation shall be made to the lines and grades shown on the plans.

000.4 Jointing

The usual method of jointing corrugated steel pipe is by means of steel connecting bands. The bands overlap the ends of each pipe section an equal amount. All connections must be watertight.

- a) Standard Bands shall be used for most installations on all sizes of pipe.
- b) Two-Piece Bands shall be used on larger diameter pipes under difficult installation conditions.
- c) Rod and Lug Bands shall be used on levees, aerial sewers and similar installation where water-tightness is essential.
- d) Gasketed Type Bands with neoprene gaskets shall be used for restricted leakage applications.

These bands and their method of installation is shown in the C.S.P.A. Installation Manual, latest edition.

- a) Uneven laps
- b) Elliptical shaping
- c) Variation from a straight center line
- d) Ragged or diagonal sheared edges
- e) Loose, unevenly lined or spaced rivets or spot welds
- f) Poorly-formed rivet heads or lock seams

- g) Unfinished ends
- h) Illegible brand
- i) Lack of rigidity
- j) Bruised, scaled or broken spelter coating
- k) Dents or bends in the metal itself that damage it structurally

02.650.000 HANDLING AND INSTALLATION OF PIPE/GENERAL

- a) Pipe shall be constructed to the lines, grades, and elevations shown on the drawings. Unless otherwise specified by the Inspector or these Regulations, pipe handling and installation shall follow the manufacturer's recommended practice and applicable ASTM, AASI-1T0, and AWWA standards for each type of pipe used. Appropriate provisions of this section shall also apply to the handling and installation of culverts. Damages to pipes and appurtenances shall be repaired or replaced by the Developer, as required by the Inspector.
- b) Pipe, fittings and accessories shall be loaded and unloaded, so as to avoid shock or damage. Pipe handled on skidways should not be skidded or rolled against pipe already on the ground. Hooks or bare cables shall not be used to handle the pipe. Under no circumstances shall pipe materials be dropped.
- c) Refer to Section 02.050.055.2 for requirements concerning trenching and excavation. The minimum support for pipes shall be Class C bedding (Section 02.050.055.2).

Pipe-laying shall commence at the lowest point and proceed upgrade. Pipe shall be laid with the bell ends facing in the direction of laying. Corrugated metal pipe shall be laid with the external laps of the seams toward the inlet end.

Bedding shall be placed to provide a solid, unyielding, uniform-bearing surface for the full length of the barrel. Extra care shall be taken to create an unyielding bedding up to the spring line of the pipe. Blocking or wedging of the pipe will not be permitted, except as required for the proper construction of concrete cradles or encasements. Pipe-laying shall terminate at manholes, except for single length stub outs from manholes.

Equipment used in handling and joining pipe shall have adequate Town to handle the pipe smoothly and assure the proper closure of joints. All pipe shall be carefully centered, so that when joined together they will form a smooth, uniform invert. Deflection at field joints shall not exceed the maximum deflection recommended by the pipe manufacturer.

Concrete used for encasements shall have a 3,750 psi minimum compressive strength in 28 days and be Type II. Prior to placing the concrete for cradles or encasements, temporary supports consisting of concrete blocks or bricks shall be used to support the pipe in place. Not more than two supports shall

be used for each pipe length, one adjacent to the shoulder of the bell and the other near the spigot end; no encasements shall be poured until the Inspector has inspected and approved the pipe to be encased and its supports.

Storm sewer pipe shall be cleaned and free of obstructions before acceptance by the Inspector. If visual inspection is not possible, the Developer shall "ball" or televise pipelines under the observation of the Inspector to ensure that the lines are clear.

Pipe deflections shall not exceed 1/2 of the pipe manufacturer's recommendations.

The Inspector shall approve the repair of broken, damaged or misaligned storm sewer pipe. No encasements shall be placed on storm sewer pipes until the Inspector has inspected the unearthed joints to be repaired.

When called for on the plans, grates shall meet the following requirements:

- a) Grating shall be constructed of steel bars with a minimum diameter of 5/8". Reinforcing bars shall not be used.
- b) Welded connections shall be 1/4" minimum.
- c) Spacing between bars shall normally be 6", unless site conditions are prohibitive.
- d) All exposed steel shall be galvanized in accordance with AASHTO Mil.
- e) Welded joints shall be galvanized with a rust-preventive paint.
- f) Grates shall be secured to the headwall or end section by removable devices, such as bolts or hinges, to allow maintenance access, prevent vandalism, and prohibit entrance by children.

02.700.760 TRAFFIC SIGNING AND PAVEMENT MARKINGS

760.1 General

The installation of all traffic control devices shall conform to the Manual on Uniform Traffic Control Devices and the Colorado Standard Specifications for Road and Bridge Construction, latest edition.

760.1.1 Traffic Control Devices on Public Property

All permanently fixed traffic signals will generally be installed by the Town at the developer's expense. However, if the developer submits a signage plan which is subsequently approved by the Engineer, the developer may install these traffic signs. Traffic signs shall be placed to conform to the drawing details.

760. L2 Traffic Control Devices on Private Property

(A) Responsibility: All traffic control devices on private property; i.e.,

pavement markings, regulatory signs, fire lane signs, and handicapped parking signs shall be installed and maintained by the property owner.

(B) Placement: A signage and striping plan specifying the various types and combinations of traffic control devices shall be submitted to the Engineer for approval.

760.2 Signal Heads / Traffic Signal Unit Specifications

- 760.2.1 All signal units shall be of the individual section, adjustable type, black polycarbonate or approved equivalent.
- 760.2.2 Visors shall be detachable, of the eight-inch (8") or twelve-inch (12") tunnel type, open at the bottom; be black in color on the outside and flat black on the inside.
- 760.2.3 Reflectors shall be silvered glass or Alzak type units.
- 760.2.4 Lenses shall be in accordance with Institute of Traffic Engineers Specifications.
- 760.2.5 Sockets shall be fixed focus.
- 760.2.6 Doors on the signal heads for the installation of lamps and lens replacement 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 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-inch (1/2") pipe or pipe mounting brackets. Gaskets shall be supplied for top and bottom openings.

760.3 Pedestrian Signal Units

Sixteen-inch (16"), one-way, ICC or equal pedestrian signal head as specified on the plans. "Walk/Don't Walk" indications shall be symbolized and side by side. Visors shall be egg crate type and heads shall be black.

760.4 Backplates

- 760.4.1 Where shown on the plans, black 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 or plastic construction and shall be the louvered type. Back plates shall provide a five-inch (5") border for all twelve-inch (12") signal heads.
- 760.4.2 Traffic signal heads requiring backboards shall be drilled for three-sixteenths-inch diameter by one-half-inch (3/16" x 1/2") pan head bolt with nut and lock washer. If the manufacturer fails to supply as described, it will then be the Developer's responsibility to do so.

When installing backboards on the traffic signal head, the Developer will furnish three-sixteenths-inch (3/16") fender washers between bolt head and backboard

- 760.4.3 The manufacturer will fabricate all backboards with a three-sixteenths-inch (3/16") washer on both sides of each rivet which is used to hold each section of backboard together.

760.5 Traffic Signal Lamps

- 760.5.1 Traffic signal lamps shall meet the requirements of the latest version of the IET Standard "Traffic Signal Lamps." All lamps shall have 8,000-hour minimum rating. Lamp manufacturers shall be limited to General Electric, Sylvania, Phillips. Size of lamps to be used in traffic signal units shall be as follows:
- 760.5.2 69 watt, 125 volt, lamps for all eight-inch (8") traffic signals and peds.
- 760.5.3 150 watt or 1950 lumens minimum, 125 volt, lamps for all twelve-inch (12") traffic signals.
- 760.5.4 If the manufacturer recommends a lower rating, the Town will be advised of this recommendation and will have the option to decide which rating will be used.

760.6 Electrical Cable

760.6.1 Signal Cable

14 AWG multi-conductor, stranded, copper wire manufactured to meet IMSA 19-1 specifications or approved equivalent. Each conductor in the cable will be individually insulated and rated at 600 volts. There shall be a minimum of four (4) and a maximum of nine (9) strands per conductor. The number of conductors per cable will be specified in quantities and blueprints for the project in question.

760.6.2 Interconnect Cable

- (A) The telephone interconnect wire shall be #19 AWG, 6 twisted pairs, shielded cable, with petrolatum-polyethylene gel filling compound. The cable shall meet R. E. A. Specification PE-39 (Clifford of Vermont Catalog #6P19-B1-BJFC or approved equal).
- (B) No splicing of the interconnect cable will be allowed. The cable shall be installed between two adjacent controller cabinets in continuous runs.
- (C) All telephone interconnect cable pairs will be connected to either active or spare terminal points provided in the controller cabinet. The Developer shall identify and label all terminal points.

- (D) All interconnect wires shall be checked after installation to determine their resistance and resistance to ground. Each pair shall be shorted together at one end and a resistance check will be made at the other end or wherever a splice exists. Resistance will be checked between each conductor and -round. All resistance readings shall be recorded showing value, color and location or wire. Data is to be supplied to the Town's Engineering Division within 30 days of completion of the project.
- (E) At the terminal points the jackets shall be stripped and the ends taped. Gel filling compound shall be removed using filled cable cleaner.

760.6.3 Service Cable

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

760.6.4 Loop Wire

Detect-A-Duct Cable consisting of single conductor No. 14, stranded THHN with an outer protective sleeve.

760.6.5 Pedestrian Push-Button Cable

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

760.6.6 Loop Lead-In Cable

Detector loop lead-in cable shall be a four conductor .25 inch diameter, shielded and jacketed cable suitable for installation in a pavement sawslot, conduit or direct burial. Conductors shall be AWG No. 18 stranded copper with polypropylene insulation. The conductors shall be twisted at least six 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 -60°C to +80°C. (Canoga 30003 43#)8 AWG shielded loop detector lead-in cable or approved equal.)

760.6.7 Ground

Single conductor, AWG No. 8, soft-drawn bare copper wire.

760.6.8 Optical Detector Lead-In Cable

The lead-in cable for the Emergency Vehicle Optical Detectors

shall be 3M Type 138 or approved equal.

760.7 Vehicle Detectors

- 760.7.1 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 24 VDC power supply. Detector units shall be in full compliance with the environmental and size requirements of NEMA standard TSI-Section 15 and meet the design, operation, electrical and functional performance requirements of both TS 1 and TS2 specifications.
- 760.7.2 The front panel shall include an erasable, write-on channel identification area and clearly indicated switch operating position. I.D. area one centimeter square per channel minimum.
- 760.7.3 All component part and test points shall be clearly identified by permanent marking of circuit referenced on the P. C. Board. Integrated circuit devices having 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 years from date of shipment from manufacturer.
- 760.7.4 Each detector unit shall include two or four 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, multi-channel scanning. Only one channel input per unit shall be active at any point in time.
1. Sequential scanning shall fully prevent crosstalk between channels of a detector connected to closely spaced or overlapped loops for directional detection.
 2. Sequential scanning shall allow two detection channels to operate with full performance using a common home-run cable.
 3. Sequential scanning shall allow two 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.
- 760.7.5 Each channel of the sensor unit shall automatically self time to any loop and lead-in inductance from 20 to 2500 microhenries within 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.

- 760.7.6 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 re-inserting the plug-in detector units.
- 760.7.7 Each channel shall include a 16-position Push type wheel switch to allow selection of 8 pulse sensitivities, 7 presence levels and a "Reset" and an "Off" position. Each detector unit shall include 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 or more turns electrically in series, parallel or series/parallel configuration in non-reinforced or reinforced pavements with lead-in/homerun combinations from 50-feet to 1000-feet. The number of turns in a loop, electrical configuration of multiple loops and pavement type will dictate the sensitivity required for proper, predictable detection.
- 760.7.8 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 0 to 3 1 seconds in 1.0 second increments and "Extension" time of 0 to 7-3/4 seconds in .25 second increments.
- 760.7.9 Presence indicators shall be wide angle, high brightness type Led's suitable for sunlight visibility. When timing is selected and a channel is active that channel's indicator shall flash at 4 Hz during Delay and at 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. Circuit shall be designed for AC or DC input control on AC powered units and for DC control on DC powered units.
- 760.7.10 Each detector unit shall utilize a $AL = (\Delta L)$ 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/homeruns will generally require the same sensitivity setting as would be required for a single loop with short lead-in, to simplify setup.
- 760.7.11 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.

- 760.7.12 Extended features shall include: Two serial ports (front panel RS232 and Edge connector Xmit/Recv), TSI and TS2 compatible from manual or software switch, microloop occupancy detection, Traffic counting capable to include long-loop presence count from 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.

760.8 Emergency Vehicle Detectors

Optical communication Detectors for emergency vehicle pre-emption shall be the 3M Model 711, 712 or 722 Optical Detector or approved equal as specified in the construction plan notes. Placement of the Detectors shall be determined by the Engineer. Optical phase selector modules for emergency vehicle pre-emption shall be 3M Model M562 or approved equal.

760.9 Detectors (Pedestrian Push-Button)

- 760.9.1 Pedestrian push-buttons shall be of the direct push-button contact type. They shall operate on a voltage not to exceed 18 volts AC. They shall be of tamper-proof design and equipped with a push-button instruction sign as shown in the Standard Details.
- 760.9.2 The assembly shall be weatherproof.
- 760.9.3 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. Pedestrian signs shall be installed as shown on the Standard Details.

760.10 Traffic Signal Poles, Pedestals and Mast Arms

Traffic signal poles, pedestals, and mast arms shall be of the general configuration shown on standard drawings. All traffic signal poles and mast arms shall be designed to meet the requirements outlined in the 1985 edition of "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals," published by AASHTO, for a wind velocity of 90 mph.

760.10.1 CONTROLLER CABINET

- 760.10.1.1 All controllers and auxiliary equipment shall be housed in a factory wired, weatherproof, metal cabinet following **NEMA** specification **TS2 type 1**. The cabinet shall have minimum interior dimensions, exclusive of stiffeners, shelf brackets, etc., of height - 46 inches, width - 29 inches, and depth - 15 inches.

- 760.10.1.2 The cabinet shall be constructed of 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.
- 760.10.1.3 The main door shall have a self locking, keyed, tumbler lock with two keys. Hinges shall be mounted on the cabinet in such a way that interchange-ability 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.
- 760.10.1.4 The Engineer will provide, during the construction period, an additional external lock for the controller cabinet to maintain security of the controller cabinet.
- 760.10.1.5 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 a panel with labeled switches for automatic to flashing operation and signal power on/off.
- 760.10.1.6 The cabinet shall be equipped with a thermostatically controlled, ball bearing fan with a capability of at least 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 90° F and 150° F and be so mounted as to be easily accessible for adjustment from the front of the cabinet. An internally mounted incandescent lamp socket shall be provided with 150 watt capability and switched "on" only when the main door is open.
- 760.10.1.7 The cabinet shall have two shelves each capable of supporting 75 pounds. Shelves shall be supported on brackets which provide for height adjustments. Each cabinet shall contain a 10 mil thick plastic envelope with side opening. It shall be a minimum size of 10" x 12" and be attached to the door by screws.
- 760.10.1.8 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.
- 760.10.1.9 Terminal Facilities - Terminal facilities (load bays) shall be firmly attached in a position not less than 6 inches from the bottom of the cabinet so as to provide easy access and maximum convenience to the user.
- 760.10.1.10 Side mounted auxiliary panels should be firmly installed with the forward edge not more than 4 inches from the door sill and not less than 6 inches from the bottom of the cabinet in all cabinets.
- 760.10.1.11 The load bay and it's associated equipment, harness, switches, etc., shall be grouped on removable panels. Each panel or group of receptacles and connecting cables shall be arranged to pen-nit so that work can be performed on panel backs or cables.

- 760.10.1.12 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.
- 760.10.1.13 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 electrode type with the following ratings:
1. Impulse Breakdown - less than 1,000 volts in less than .1 microseconds at 10 KV per micro-second.
 2. Standby Current - less than 1 milliamperere
 3. Striking Voltage greater than 212 VDC
 4. Energy Capability - capable of withstanding pulses of peak current each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak voltage at 3 minute intervals.
 5. Peak Current Ratings shall be 20,000 amps. The MOV shall have ratings equal to or better than a General Electric type VI5OLA20A. The RFI filter shall have a current rating equal to or greater than the main circuit breaker capacity.
- 760.10.1.14 Field terminals shall be screw type, capable of accommodating at least three number 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.
- 760.10.1.15 A convenience outlet with a ground fault interrupter fused at 15 amps shall be provided. It should be located in a position which is convenient and safe for service personnel.
- 760.10.1.16 All AC power busses, switch or relay lugs and/or similar activity connection points which extend more than 1-1/2 inches from the panel are to be protected by insulation for safety. The locations of these items shall provide reasonable protection for service personnel.
- 760.10.1.17 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 equal.
- 760.10.1.18 Flasher. The cabinet shall be equipped for flashing operation of signal lights with a 2 circuit solid state flasher in accordance with the latest NEMA specifications (15 amps per circuit). Flashing operation shall be set for flashing yellow on all main street approaches and red on all other approaches. Pedestrian and turn signals shall be extinguished during flashing operation. The flashing mechanism shall remain in operation during shutdown or removal of controller.

- 760.10.1.19 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 3 input LED indicator. Load switches shall contain 3 separate cube type solid state relays, which use a solid state switch which is capable of operations at 240 VAC and 25 amps when properly heat sunked but derated to 10 amps when used in load pack assembly.
- 760.10.1.20 Conflict Monitor. 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. Conflict monitors shall be as manufactured by Eberly Designs, 12 LEP or approved equal.
- 760.10.1.21 Emergency Vehicle Preemption. The cabinet shall be equipped and wired with an Opticom Card rack mount for 3M Model 562 or approved equal. All equipment shall be capable of accommodating a minimum of two modules with capability of four-channel operation.

760.10.2 ACTUATED CONTROLLERS

- 760.10.2.1 Compatibility - THE LOCAL CONTROLLER AND CABINET SHALL BE 100%, COMPATIBLE WITH THE TOWN'S SIGNAL SYSTEM WHICH UTILIZES ECONOLITE EQUIPMENT OR NECESSARY MODIFICATIONS OF THE SOFTWARE AND HARDWARE SHALL BE INCLUDED TO MAKE BOTH SYSTEMS FULLY COMPATIBLE.
- 760.10.2.2 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 of each major vehicular phase, including concurrent associated pedestrian movements. The controller shall conform to the latest NEMA specifications and shall provide for complete and full operation of eight phases from within either a TS1 or TS2 type I cabinet.
- 760.10.2.3 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 may be removed and replaced without permanent damage to the board or track.
- 760.10.2.4 Timing shall be adjustable on the controller face by keyboard programming. A security code or other means shall be provided to prevent unauthorized or accidental entry.
- 760.10.2.5 Timing shall be readable from a display which is sufficient to make certain that all register positions can be easily and definitely recalled. Every keyboard controller shall have an easily followed legend silk screened on the face of the controller or on a metal or

plastic card or placard which is securely attached by screws or rivets.

- 760.10.2.6 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.
- 760.10.2.7 Overlap programming shall be provided by NEMA standard overlap board and/or keyboard.
- 760.10.2.8 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.
- 760.10.2.9 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.
- 760.10.2.10 Each controller shall be supplied with a complete set of operational and service manuals, wiring schematics and part's layout up to a maximum of ten sets per order. Any controller for which these documents are not available is not a production model within the meaning of these specifications.
- 760.10.2.11 Each controller shall have a removable data module.
- 760.10.2.12 Pre-emption. All actuated controllers shall be equipped to accommodate four E.V.P. inputs and one railroad preemption input.

760.10.3 COORDINATION UNIT

- 760.10.3.1 The coordination unit shall be an internal function within each local controller and shall meet, as a minimum, the following functional requirements.
- 760.10.3.2 The coordinator shall provide for at least four cycle lengths adjustable from 30 to 255 seconds, three offsets adjustable from 0 to 99 percent with offset correction by dwelling in coordinated phase or smooth transition, and four splits per cycle.
- 760.10.3.3 Standard NEMA functions shall be used to control the intersection timing.
- 760.10.3.4 The coordinator shall be capable of changing the controller's phase sequence upon command and telemetry failure.
- 760.10.3.5 The coordinator shall be capable of setting the intersection free by loss of system sync, cycle/offset false commands, free command and telemetry failure.
- 760.10.3.6 The coordinator shall be capable of setting the intersection into a flashing operation in accordance with the Manual : on Uniform Traffic Control De-vices, latest edition.

- 760.10.3.7 The coordinator shall be capable to operate with telemetry module without additional hardware or software.
- 760.10.3.8 Time-base coordination mode shall be provided as a backup with all standard coordination features available. At least two 7-day programs shall be available with 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.

760.10.4 SYSTEM TELEMETRY

- 760.10.4.1 Telemetry equipment shall be an internal plug-in module to a local controller with easy access for removal. Master controller or stand-alone chassis may contain standard plug-in module. Each telemetry unit shall be capable of transmitting data to and from local controller, local detectors and system detectors (8 per intersection). A provision shall be made to reject invalid messages. The system command shall be transferred each second to maintain time sync.
- 760.10.4.2 The telemetry equipment shall be designed so that all communications among intersections in one system can be accomplished over no more than two pairs of hard wire interconnect or leased phone lines. Dedicated pairs from the master to each local intersection are not permitted.

760.10.5 ON-STREET MASTER

- 760.10.5.1 Cabinet Assembly - The master controller shall be wired into a cabinet assembly which also includes a local intersection equipment configuration. The cabinet shall be wired complete with master connecting cables in accordance with applicable portions of the local controller cabinet specifications. The incoming power service and interconnect terminals shall be adequately equipped with surge arrestors to protect against high energy transients.
- 760.10.5.2 Incoming Sensor Data - The master shall have the ability to receive output data from at least eight sensors from each local intersection. It shall be possible to assign at least 32 of the incoming sensors to internal computational channels for pattern selection analysis.
- 760.10.5.3 Traffic Pattern Selection. The program-in-effect shall be selected on a priority basis with the following priority arrangements:
 - I. Manual entry from keyboard
 - 2. External command from a master
 - 3. Time-of-day/day-of-week schedule
 - 4. Traffic responsive -based on sampling sensor analysis
- 760.10.5.4 The master shall select one of six different cycle lengths or "free" operation based on inbound or outbound volume levels. It shall be possible to program segments in the volume range levels to change

to the next higher or lower cycle lengths.

- 760.10.5.5 The master shall be able to select any of five different offset plans per cycle. Offset plans shall be chosen based on the differential between inbound and outbound volume levels. The five offset plans shall be designated as follows:
1. Heavy inbound
 2. Inbound
 3. Average
 4. Outbound
 5. Heavy outbound
- 760.10.5.6 When balanced flow occurs, the master shall select the Average Offset plan. When the volume in one direction exceeds the volume in the other direction by the programmed amount, a standard preferential offset shall be implemented. If the volume differential exceeds a second (higher) programmed amount, a heavy preferential offset must be implemented. It shall also be possible to reserve the heavy preferential offset plans for special pattern implementation only. Programmable settings must be provided for both entering and leaving each offset.
- 760.10.5.7 Split plan selection shall be identical to offset plan selection except that arterial traffic volume levels must be compared to side street volume levels. Three different split plans shall be provided:
- 760.10.5.8 The master shall call for the average split plan during normal conditions. If the arterial volume exceeds the side street volume by the programmed amount, the heavy arterial split shall be selected. In the same manner, if side street volume exceeds arterial volume by a programmed amount, the heavy side street split shall be called.
- 760.10.5.9 Crossing, Artery Synchronization - The master controller shall have capability to coordinate with a separate master controller of the crossing, artery through the common intersection for both systems.
- 760.10.5.10 System Diagnostics - Diagnostic tests shall be performed on system detectors, telemetry communications and intersection operation.
- 760.10.5.11 Sampling- sensors shall be monitored for absence of calls or constant calls. If a sensor fails, it shall be automatically disconnected from the calculations for traffic responsive plan selection. If normal sensor operation resumes, the sensor shall be automatically reinstated.
- 760.10.5.12 Telemetry communications diagnostics shall monitor readbacks for no response condition including local telemetry and telemetry channels.
- 760.10.5.13 Intersection diagnostics shall be available to display intersection status

condition. All fault conditions shall be reported and logged.

- 760.10.5.14 Count storage - The master shall have the ability to tabulate and store 15 minute count data from up to 32 different sensors. The data shall be available for automatic transfer to the central off-ice facility upon request.
- 760.10.5.15 The selection of the sensors to be counted in any 24 hour period shall be completely programmable from the central office computer.
- 760.10.5.16 Miscellaneous Data Storage. The master shall store all of the following data:
- 1 . The time of day and location of all sampling sensor failures. If normal operation resumes, this time shall also be recorded.
 2. The time of day, location and mode of all local intersection failures. The time that normal operation resumes must also be recorded.
 3. The time and mode of all pattern changes. Changes due to external override must be distinguished from normal pattern changes.
 4. The average volume or occupancy level for each 15 minute period for all computational channels.
- 760.10.5.17 It shall be possible to transmit any of the data listed above to the central office computer automatically or upon demand.
- 760.10.5.18 Downloading Local Coordination Settings. It shall be possible to download any local intersection coordination setting (offset, force off or permissive period) from the master via the unit's keyboard.
- 760.10.5.19 Display. During normal operation, the timing patten in effect shall be displayed on the front panel, including the cycle, offset plan and split plans selected. Also, the unit shall indicate how the timing plan was selected - through normal volume calculations, by an occupancy channel or by manual or central computer override. The master shall also indicate when the time of day mode is in effect and show whether this mode was selected manually or because of sensor failures.
- 760.10.5.20 External Override. The master controller shall have appropriate inputs to externally select any timing pattern and override the pattern selected through traffic analysis.
- 760.10.5.21 Telemetry. The master shall include a telemetry module for two way communications between the master and local controllers. The equipment shall be compatible with the telemetry equipment specified for the local controllers.

760.10.6 MISCELLANEOUS HARDWARE

- 760.10.6.1 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.

760.10.6.2 Covers for water valve pull boxes shall have the word "Traffic" cast into them to avoid confusion with a water department pull box.

760.10.6.3 Mast arm brackets shall be Astro brackets or Town approved equivalent and shall be installed 90 degrees to the roadway.

760.10.7 PAINT - SIGNAL POLES

760.10.7.1 All new signal poles and mastarms shall be factory painted with an epoxy primer and Polyurethane top coat liquid coating. Surface preparation shall be blast cleaned to Steel Structure Painting Council Surface Preparation Specification No. 6 (SSPC-SP6) requirement utilizing cast steel abrasives conforming to the Society of Automotive Engineers (SAE) Recommended Practice J827.

760.10.7.2 All accessible interior surfaces shall be coated with a lead and chromate free red oxide rust inhibitive alkyd primer to a minimum dry film thickness of 1.0 mils.

760.10.7.3 All exterior surfaces shall be coated with a rust-inhibitive Epoxy-Polyamide Primer to a minimum dry film thickness of 2.0 mils. The top coat shall consist of one coat of Semi-Gloss High-Build Acrylic Polyurethane Enamel, Tnemec Endura Shield or approved equal, to a minimum dry film thickness of 2.0 mils. The top coat color shall be Federal Green No. 14056.

760.10.7.4 Any surface areas damaged during handling or installation shall be repaired immediately with a spot coat of epoxy primer and a polyurethane finish as specified above. The paint manufacturer's application instructions shall be followed.

760.10.8 EXISTING STRUCTURES

760.10.8.1 All designated previously installed signal poles and mast arms 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 re-painted. 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 feet (8') of the pole. Inspection of the poles prior to application of the finish coat is required.

760.10.8.2 A finish coat of Sherwin Williams DTM (Direct to Metal) Acrylic Gloss or approved equal shall be applied over the primer or previously painted surfaces. Two coatings shall be applied leaving approximately 6 mils of dry film. The color shall be a dark green formula (Federal Green No. 14056) which is available from the Engineer.

760.10.8.3 The painting shall be done in a neat and workmanlike manner and may be applied either by hand brushing or spraying. The Engineer

reserves the right to require the use of brushes for the application of paint should the work done by the paint spraying machine prove unsatisfactory or objectionable.

- 760.10.8.4 All designated traffic and pedestrian signal heads shall be painted flat black unless otherwise specified. Previously painted controller cabinets shall be painted white.

760.10.9 INSTRUCTIONS AND WIRING DIAGRAMS

All equipment shall be provided with three 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.

760.10.10 GUARANTEE

The Developer shall include in his proposal all warrants and/or guarantees with respect to materials, parts, workmanship and performance of the product to be supplied. The minimum guarantee period for the product shall be one (1) year from the date of final acceptance of the contract. The Developer 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 accord with the specification and on which the Developer has indicated no exception shall be cause for rejection of the equipment and correction of the non-specification items entirely at the Developer's expense.

760.10.10.1 Sign Face Materials

All stop signs, yield signs, and "Do Not Enter" sign faces shall be fabricated from Scotchlite reflective sheeting, high-intensity grade or approved equal. All other sign faces shall be fabricated from Scotchlite reflective sheeting, Engineer grade or approved equal.

760.10.10.2 Sign Post Materials

All sign posts shall be fabricated from 12-gauge galvanized, perforated Telespar tubing or approved equal. The sign post assembly shall consist of a two-inch by two-inch by three-foot (2.25"x2.25"x3') anchor sleeve and a one-and-three-quarter-inch by one-and-three-quarter-inch by ten-foot (2"x2"x 10') post. See detailed drawing in Appendix 11-A of these Regulations.

02.800.810 IRRIGATION SYSTEMS

810.1 General

- 810.1.1 Comply with the Uniform Plumbing Code: Comply with Electrical Code.

- 810.1.2. Any deviation in taps from the approved construction plans to be approved by the Town Water I Wastewater Division prior to installation. Any water service line above 218 shall be coordinated with Town Engineer.
- 810.1.3. Any deviation in layout of the irrigation system from the approved construction plans shall be reviewed and approved by the Town Parks Division prior to installation.
- 810.1.4. Design, System is to be designed to provide fill coverage and matched precipitation rates. Lateral piping shall be sized based on flow demands; velocities shall not exceed 5.5 feet per second. Principles of Xeriscape shall be utilized in the design of irrigation system. Some design considerations will include: shrub and perennial beds are to be zoned separately from turf areas, sloped areas to have separate zoning for heads at the higher elevations from those at the lower elevation and areas with different exposures to be zoned separately. Check valves-in-head are to be use for all areas adjacent to walkways and at the bottom of berms and pond areas.

810.2 Materials

- 810.2.1 Taps: Contractor is responsible for supplying saddle for the PVC pipe.
- 810.2.2 Back-flow Prevention Device, Water Meter and Flow Meter: Back-flow device and Water Meter per the Town
- 810.2.3 Copper: Type K rigid conforming to ASTM Standard B88.
- 810.2.4 Mainline: Class 200 PVC, NSF approved. 1.2 U2" or larger: J.M. Ringtite pipe
- 810.2.5 Laterals:
 - 1. 2" or larger: Class 200 PVC, NSF approved.
 - 2. 1 1/2" or 1": Class 200 PVC, NSF approved.
 - 3. No laterals smaller than 1".
 - 4. Trickle tubing shall be weather and UV resistant material
 - 5. Polyethylene Drip Pipe: NSF approved, SDR pressure rated pipe, only as approved for drip applications.
- 81 0.2.6 Pipe Fitting: Pipe fittings shall be molded fittings manufactured of the same material as the pipe.
 - 1. Funny Pipe (pop-up heads only): to be compatible to the elbows needed for the sprinkler heads
 - 2. PVC: Schedule 40, Type 1, PVC solvent weld with ASTM Standards D2466 and D 1784.
 - 3. Wrought copper or cast bronze fittings, soldered or threaded per installation details for all copper pipe.

- 810.2.7 Sleeving: Ductile Iron Pipe or PVC under all paved surfaces.
1. Sizes to be a minimum of two sizes larger than the pipe being sleeved. Minimum 4" diameter, or larger where appropriate, for irrigation lines.
 2. Wires to be in separate sleeve from pipe, 2" min. size pipe for control wire sleeves.
 3. Shall have marker tape on upper side and both ends for future locates.

- 810.2.8 Valves:
1. Remote Control Zone Valves: Electrically operated, appropriate for the water supply, with manual bleed device and flow control stem. Shall have a slow-opening and slow-closing action for protection against surge pressure. Brand and model to be Rain bird PE Series Remote Control Valves, scrubber option with self cleaning screen unless Town specifies other brand and model.
 2. Isolation Gate Valves: Kennedy 1571X or approved equal, able to withstand a continuous operating pressure of 150 psi. Clear waterway equal to full diameter of pipe. Shall be opened by turning square nut to the left (wheel opening is unacceptable).
 3. Manual Drain Valve: 3/4" ball valve with tee handle. Watts, 9B-6000, or approved equal.
 4. Quick Coupling Valves: 1" brass, Rainbird 44RC units with rubber cover. Keys Rainbird 44R 1" brass key.

- 810.2.9 Valve Boxes:
- House valves in valve box with matching locking cover: Carson, Ametek or approved equal Only one valve per box. Install in box sizes as specified.

- 810.2.10 Control System:
1. Controller: Titrol Dial B Series controller or approved equal. Number of stations shall include two extra stations for possible future use. Controller box shall be weather tight and vandal resistant with locking exterior disconnect.
 2. Satellite Control Field Unit (one per water tap):
 - a. Bucklier COPS Universal Ultima, truliked radio field unit (with data retrieval), Model UL£-24T and/or UIIE-36T. Basic capabilities: 100% solid state electrical components with surge protection, 24 VAC transformer rated at minimum of 10 watts, battery backup of at least 14 days, manual activation of remote control valves from the satellite, a minimum size as shown on the drawings and capable of basic, stand alone operation even when the satellite is not connected to communicating with the central unit, (by use of Irritrol controller).

- b. Miscellaneous materials per field unit): (1) E.F. Johnson Clear channel LTR 8600 Mobile Sending Unit (#242-8600-001); (1) Astron RS- IOA Regulated Power Supply; (1) mounting bracket for LTR 8600 sending unit; (1) Eicon pigtail for each 12 stations; (1) E.F. Johnson 10 foot length of Universal Cable (#023-4144-410); (1) Buckner 800 Mhz Dome Antenna.
- 3. Control System Enclosure: HoITh-- Model A242408LP with A-24P24 steel panel, Model A-FK1208 floor stand kit and AL-2BR lock kit, or approved equal.
- 4. Surge Protection: 8 foot copper grounding rod, #4 solid copper wire, grounding buss receptacle, ground terminal strip and Irritrol SPD-587 surge protector per details.

810.2.11 Electric Control Wiring: #14 solid copper direct burial UF or PE cable, UL approved, or larger, per system design and manufacturer's recommendations.

- 1. Five wires with consistent color scheme throughout:
 - Red = live
 - White = ground
 - Black, blue and green extra
- 2. Wire connectors and waterproofing sealant to be used to join control wires to remote control valves.

810.2.11 Sprinkler heads: All heads shall be of the same manufacturer as specified on the plans, and marked with the manufacturer's name and model in such a way that materials can be identified without removal from the system. The Town will specify brand and models to match other equipment in use in public system in the vicinity.

- 1. Gear driven Rotor heads: Hunter, Rainbird, or approved equal.
- 2. Pop-Up Spray heads: Rainbird, or approved equal.

810.3 Inspection

810.3.1 Locate all utilities prior to trenching and protect from damage.

810.3.2 Inspect tap or other existing irrigation system, as applicable, prior to work.

810.4 Execution

810.4.1 Water Service Connections (Taps): Contact Town of Castle Rock Water Department 48 hours prior, to schedule work at 660-1020 for water taps and inspections. Tap Fee Waiver request forms need to be submitted to the Water Department, and approved, prior to tapping. Call Water Meter Shop at 660-1020 to purchase back-flow prevention device and water meter. Minimum two weeks prior notice to be given Water Meter Shop for installations which will require meters and I or back-flow devices larger than two inch. Larger devices and meters are not always kept in stock and may have ordering stocking delay.

1. Contractor is responsible for excavation, connection to corporation stop at the water main, providing the saddle for the PVC or A.C. pipe, making the connection to the existing water service, back-fill and compaction, and pavement/shoulder/surface treatment replacement as needed. ~~See Section 500 of Town of Castle Rock Standards and Construction Specifications for Water I Wastewater materials and procedures.~~ All items in Section 500 pertain, including requirement that no soldered joints or fittings are allowed on water service lines where buried. Soldered joints or fittings are pennse above grade or inside a vault. No solder, sealants, fluxes, pipe dope, and other materials shall contain any lead. Call Engineering at 660-1015 for questions. The Town Water Department will make the actual tap on the line if the tap is 2" in size or less. Larger taps must be made by the contractor; all taps and installations are subject to approval and inspection by the Water Department.

Water meter jumpers will be finished from the Water Meter Shop free of charge. All backflow devices require payment at the time of delivery, unless prior arrangements have been made.

2. Install meter, back-flow, flow meter and drain valves as specified in pre-cast vault. Inspection of service line (where appropriate), vault, water meter and back-flow is to be coordinated with Town Water Department.
3. Install winterization assembly downstream of meter vault on copper (with no size reduction) for mainlines greater than 2". Install winterization assembly on PVC (no size reduction) for mainlines 2" or less.

Copper pipe to be soldered so that a continuous bead shows around the joint circumference. Insert a dielectric union wherever a copper-based metal (copper, brass, bronze) and an ironbased metal (iron, galvanized steel, stainless steel) are joined.

810.4.2 Pipe trenching:

1. Install pipe in open cut trenches of sufficient width to allow thorough tamping/puddling of suitable backfill material under and over pipe.

810.4.3 Sleeving: Boring shall not be permitted unless obstruction in pipe path cannot be moved, or pipe cannot be re-routed.

1. .Maine installed in existing sleeves at greater depth than adjacent pipe, shall have a manual drain valve at each end if the sleeve is longer than 20 feet, or at one end if the sleeve is less than 20 feet.
2. Install sleeve so ends extend past edge of curb, gutter, sidewalk, bike path or other obstruction, a minimum of 2 feet.
3. Mark all sleeves with an "x" chiseled in walk directly over sleeve location.

4. Shall be laid to drain at minimum grade of 5"/100'.
5. Shall be bedded in 2" of fill sand and covered by 6" of fill sand.
6. Sleeves installed for future use shall be capped at both ends.
7. Separate sleeve (2" min. size) shall be used for all wiring.
8. Sleeving shall not have joints unless necessary due to length of sleeving run. If joints are necessary, only solvent welded joints are allowed.
9. Compaction of backfill for sleeves shall be 95% of Standard Proctor Density, ASTM D698-78. Use of water puddling around sleeves for compaction, will not be allowed.

810.4.4 Pipe Installation:

1. Use Teflon tape on all threaded joints; only schedule 80 pipe may be threaded.
2. Reducing pipe size shall be with reducing insert couplings: at least 6" beyond last tee of the larger pipe.
3. Snake PVC lateral pipe from side to side within trench.
4. Cut pipe ends square and debur. Clean pipe ends before using primer and solvent cement. Join in manner recommended by manufacturer and in accordance with accepted industry practices. Cure for 30 minutes before handling and 24 hours before allowing water in pipe.
5. Backfill only after hydrostatic pressure test inspection is complete. Back-fill shall be free from rubbish, stones larger than 2' diameter, frozen material and vegetative matter. Do not backfill in freezing weather. If backfill material is rocky, the pipe shall be bedded in 2" of fill sand covered by 6" of fill sand.
6. After puddling or tamping, leave all trenches slightly mounded to allow for settling.
7. Compact to proper densities depending on whether surface area over the line will be paved or landscaped.

810.4.5 Thrustblocks:

1. Shall be installed where PVC mainline (2 1/2" or larger) changes direction over 20 degrees.
2. Minimum of one cubic foot of concrete.
3. Keep pipe joint clean of concrete. Do not encase.
4. Place wiring away from thrust block to avoid contact with concrete.

810.4.6

Valve Installation: Install at least 12" from and align with adjacent walls or paved edges:

1. Automatic Remote Valves: Install in such a way that valves are accessible for repairs. Make electrical connection to allow pigtail so solenoid can be removed from valve with 24" (min.) slack to allow ends to be pulled 12" above ground.

Valve assembly to include ball valve and union per detail for ease of maintenance and repair.

2. Manual Drain Valve: Install per plans, but in no case shall be less than at the low points of the system and at the end of the mainline. Install in 6" CL-200 PVC sleeve access with 10" locking valve box lid. Install valves on swing joint assembly per detail. Sump to be 4 Cubic feet of crushed gravel over filter fabric.

3. Quick Coupler Valve: Install in 10" round locking valve box. Flush completely before installing valve. Thoroughly flush piping system under fill' head of water for three minutes through furthest valve, before installing valves.

4. Isolation Gate valves: Install in valve box

5. Valve Boxes:

- a. Brand all valve boxes with the following codes: "SW and the controller valve number per As-Built Record Drawings for all remote control valves; "DV" for all drain valves; "GV" for all isolation valves; "DRGV" for all drip system isolation valves; "QC" for all quick coupling valves; "WA" for all winterization assemblies; "FM" for all flow meter assemblies; and "MV" for all master valve assemblies. Use a branding iron stamp with 3" high letters.

- b. Valve box shall NOT rest on in a line; use brick or other noncompressible material per detail. Top of valve box to be flush with finish grade.

- c. Install valves in box with adequate space to access valves with ease. Valves shall not be too deep to be inaccessible for repairs. 3" depth of 3/4" washed gravel to be placed in the bottom of each valve box with enough space to fully turn valve for removal (see detail).

810.4.7

Head Installation:

1. Set heads plumb and level with finish grade. In sloped area, heads to be tilted as necessary to provide full radius spray pattern.

2. Finish lateral lines before installing heads. Thoroughly flush piping system under full head of water for three minutes through furthest head, before installing heads. Cap risers if delay of head installation occurs.

3. Pop-Up Heads along walks and bikeways: Bed heads in 6"

layer of sand under the base of the head.

4. Nozzles: Supply appropriate nozzle for best performance.
5. Adjustment: Adjust nozzles and radius of throw to minimize overspray onto hard surfaces.

810.4.8 Electrical Connections:

1. New connections to be approved through Public Service.

810.4.9 Controller Installation:

1. To be installed in an above ground location suitable to prevent vandalism and provide protection from adverse weather conditions, and per Town direction. All exposed wiring to and from the controller shall be encased in galvanized metal conduit. Exterior controllers to be installed on 6" thick concrete pad.
2. Install Controller and Satellite Control Units per Town direction and in accordance with manufacturers specifications. Install surge protection, grounding rods and other accessory components as specified.
3. Attach wire markers to the ends of control wires inside the controller unit. Label wires with the identification number of the remote control valve active by the wires.

810.4.10 Wiring:

1. Comply with Town of Longmont electrical codes
2. Power source brought to controller to a ground fault receptacle installed within controller casing. Clock shall be plugged into receptacle.
3. String control wires as close as possible to mainline, consistently along and slightly below one side of the pipe.
4. Leave minimum loop of 24" at each valve and controller and at each splice, at the ends of each sleeve, at 100 foot intervals along continuous runs of wiring, and change of direction of 90 degrees or more. Band wires together at 10' intervals with pipe wrapping tape.
5. Install common ground wire and one control wire for each remote control valve. Multiple valves on a single control wire are not permitted. Install three extra wires, as specified, to the furthest valve on the system and/or each branch of the system.

810.5 Testing

810.5.1 All tests to be run in the presence of Town Inspector. Schedule all tests a minimum of 48 hours in advance of tests. Repeat any failed tests until full acceptance is obtained.

1. Hydrostatic Test: Hydrostatically test the piping system in place

before sleeving and back-filling. Maintain normal working pressure of not less than four hours. Test is acceptable if no leakage or loss of pressure is evident during test period. Test must be run in the presence of Town of Longmont Parks and Forestry inspector.

- a. At conclusion of pressure test, install heads, etc. after flushing system as outlined above.
2. Operational Test: Activate each remote control valve from the controller in the presence of Town of Longmont Parks and Forestry inspector. Replace, adjust or move heads and noes as needed to obtain acceptable performance of system. Replace defective valves, wiring or other appurtenances to correct operational deficiencies.
3. Central Control System Acceptance Test: Town of Longmont Parks and Forestry inspector will activate each remote control valve from the Central Control System base station. If acceptance of Central Control System is not obtained within 90 days following initial test, the Town of Longmont has the option of requesting replacement of equipment, or portions thereof, as needed to correct deficiencies.

810.6 Completion Services

810.6.1 When project construction is complete, request from Parks and Forestry a punchlist inspection for Construction Acceptance:

1. Demonstrate system to Town personnel.
2. Provide Town personnel with ordering information including model numbers, size and style for all components.
3. Provide two sets of as built drawings per below, showing system as installed with each sheet clearly marked "AS-BUILT DRAWINGS", the name of the project and all information clearly provided:
 - a. One set of reproducible mylars, no larger than 24" x 36".
 - b. One set of all sheets reduced to 11" x 17", with each station color coded, and each sheet plastic laminated.
4. Clean Up: Remove all excess materials, tools, rubbish and debris from site.

810.6.2.1 Request Construction Acceptance from Public Works.

Once Construction Acceptance is obtained, begin warranty and maintenance period by contractor. Maintain irrigation system in optimal working condition for duration of period between Construction Acceptance and Final Acceptance (one year minimum). Make periodic adjustments to system to achieve most desirable application of water.

810.6.3 Request Final Acceptance inspection at least 30 days before the end of one year maintenance period, from Town Parks and Forestry personnel. A 30 day project work through will take place where Parks and Forestry personnel will be on-site to operate and inspect the system. Schedule a operator's training

session with Town Parks and Forestry personnel at the beginning of this project work-through period.

- I. Provide Town personnel operating keys, servicing tools, test equipment, warranties guarantees, maintenance manuals, and contractor's affidavit of release of liens. Keys, tools and other operating equipment need to be turned over to Parks and Forestry prior to commencement of the work-through inspection. Submittal of all these items must be accompanied by a transmittal letter and delivered to the Parks and Forestry offices (delivery at the project site is not acceptable).
2. Problems identified during the project work-through will be coordinated with Parks personnel and solutions executed by the Contractor. Contractor shall complete punch list of items requiring resolution prior to request for Final Acceptance.
3. Request Final Acceptance from Public Works at 660-1015. Once final acceptance is formally obtained, the Town will release any relevant securities, and begin maintenance.

810.7 Guarantee, Warranty and Replacement

- 810.7.1 For the period following Construction Acceptance notice by Town of Longmont Public Works Division, and prior to Final Acceptance, all irrigation materials, equipment, workmanship and other appurtenances are to be guaranteed and warranted against defects. Settling of trenches or other depressions, damages to structures or landscaping caused by settling and other defects to be corrected by the contractor at no cost to the Town of Longmont. Make repairs within seven days of notification by the Town of Longmont Parks and Forestry representative. Guarantee Warrantee applies to all originally installed materials and equipment, and to replacements made during, the guarantee warrantee period.

02.900.910 PLANT PREPARATION

910.1 General

- 910.1.1 Soils tests conducted by the CSU Soils Lab must be completed and submitted to the City for review; recommendations in the lab reports shall be followed in all cases. Generally this will include soil amendment and fertilizer recommendations; in some cases, a II new top soil will be required.
- 910.1.2 If site is undisturbed, topsoil is to be stripped to a 6" depth (typ.), or to topsoil depth as determined by field inspection. Stockpile and respread stripped topsoil over landscape areas after rough grades are established. If site has been disturbed, or sufficient topsoil is not available, topsoil is to be imported to achieve 6" depth in all landscaped areas.

910.2 Submittals

- 910.2.1 Soil Amendment: Submit sample and written confirmation from supplier of material composition including: percent organic matter, salts, nutrient composition and trademark.

Sample is to be representative.

- 910.2.2 Topsoil: Submit sample and written conformation from supplier of material composition including: percent organic matter, salts, and nutrient composition. Sample is to be representative.

910.3 Materials

- 910.3.1 Soil Amendment: Premium 3, by A-i Organics, or approved equal. A high quantity composted material containing a minimum of 50% organic matter. The mixture shall be free from clay subsoil, stones, lumps, plants or roots, sticks, weed stolons, seeds, high salt content and other materials harmful to plant life. The compost shall be coarsely ground with an even composition and have an acidity in the range of pH 5.5 to pH 7.0. All material shall be sufficiently composted such that no material used is recognizable.
- 910.3.2 Topsoil: A friable loam, typical of cultivated local top soils, containing at least 2% humus. It must be taken from a well drained, arable site and shall be reasonably free of subsoil, stones, clods, sticks, roots and other objectionable extraneous matter or debris. No stones or other mates over 2" in size shall be allowed. It shall contain no toxic materials. Topsoil shall have an acidity in the range of pH 5.5 to pH 8.5.
- 910.3.3 Fertilizer: Triple superphosphate with a chemical analysis of (0-46-0).

910.4 Inspection

- 910.4.1 Locate all utilities prior to trenching and protect from damage. Required calls shall include, but are not limited to the following
- 910.4.2 Accept rough grading from other contractors per approved plans and obtain approval from Public Works. Rough grade inspection is to allow for 6" minimum depth of topsoil and specified soil amendments as part of the fine grading work.

910.5 Execution

- 910.5.1 Grub and remove unsuitable woody and rock material present in the surface grade.
- 910.5.2 Take precautions to accommodate proper drainage and flow during and after grading and soil preparation.
- 910.5.3 Apply herbicide to areas where noxious weed beds have been established and/or where seed mix is to be planted. Herbicide must be applied by certified contractors at the rate recommended by the manufacturer after proper notification has been done in accordance with chemical applicator's standards. Precautions must be taken to avoid drifting of spray onto other properties and shall not be done in breezy conditions. Harm to plant material not designated for herbicide application shall be replaced by the contractor.
- 910.5.4 Rip to 6" depth with agriculture subsoiler in all areas to receive plantings. Remove all objects greater than 2" in diameter.

910.6 Application

- 910.6.1 Spread 6" topsoil over entire landscaped area and grade to smooth and even lines. Establish swales and drainage as required per plans.
- 910.6.2 Evenly distribute soil amendment at rate of 3 cubic yards per 1000 square feet of area, or 1" depth over the entire area to be prepared; alter rate if soils test recommends otherwise. Till amendments into top 6" of soil, Compact to a firm, but not hard (80% of Standard Proctor Density at 2% optimum moisture).
- 910.6.3 Trim finish grade elevations adjacent to paved areas to 1' below pavement fill grade.
- 910.6.4 Evenly distribute triple superphosphate fertilizer at the rate of 15 pounds per thousand square feet; modify type and rate if soils test recommends otherwise.

02.900.920 LAWNS AND GRASSES (SOD AND SEEDING)

920.1 General (Sod)

- 920.1.1 Sod Mix: Turf mix shall be approved by the Town of Longmont Parks Division based on the activity to take place, planned irrigation method and maintenance to be performed in the area being sodded. In all cases a drought tolerant mix shall be used that does not contain more than 20% bluegrass.
 - 1. Pre-approved Sod Mix:
 - 2.
 - 60% Eldorado, Silverado and Monarch Turftype Tall Fescue
 - 30% Manchar Smooth Brome
 - 10% Bluegrass Mix (drought tolerant blends)
- 920.1.2 Sodded Areas: Sod is required for landscaped areas on Arterial rights of way and at the bottom of detention ponds to be maintained by the Town. Other areas may require use of sod as determined by the Town of Longmont Parks and Forestry Division.

920.2 Submittals

Certificates showing State, Federal or other inspection showing source and origin.

920.3 Materials

- 920.3.1 Sod: Sod shall have a clay-loam base that will not break, crumble or tear during sod installation. It shall have a healthy, vigorous root system that has under-one a program of regular fertilization, mowing and weed control to obtain thick turf free of objectionable weeds. It shall be free of nematodes, pests and pest larvae as inspected by the entomologist of the State Department of Agriculture.
 - 1. Thickness: 1" thick excluding top growth and thatch.
 - 2. Thatch: Not to exceed 1/2" uncompressed.

3. Width: 18" wide strips.

920.3.2 Fertilizer: Ammonidm sulphite and diammonium phosphate, with chemical analysis of N 20%, P 10%, K 5%, 5 8%, Fe 3%. (Urea and suiphur coated Urea only).

920.4 Inspection

Inspect finish grade and trim where needed to obtain finish grades of 1" below all adjacent paved surfaces. Verity or complete removal of rock larger than 1/2" which may hinder sodding and perform fine grading as necessary to maintain drainage per plans. Verity that irrigation system is fully operational prior to sodding.

920.5 Execution

920.5.1 Clean out drainage inlet structures.

920.5.2 Adjust irrigation heads to proper watering height according to depth of sod material but lower than mower blade height to enable lawn mowers to cut grass freely without damage to sprmkler system.

920.5.3 Sod Cutting and Delivery: Cut no more than 24 hours prior to delivery, laid in place within 24 hours of delivery.

920.5.4 Transportation: Do not pile sod more than 2' deep. During delivery process, protect roots from exposure to drying sun, winds and heat. Store in shady area and keep moist or store covered with moistened burlap.

920.5.5 Timing: Install sod only between spring and fall. Do not install on frozen or saturated soil.

920.5.6 Watering: Lightly-water area to be sodded.

920.5.7 Fertilizer: Distribute fertilizer uniformly at a rate of 50 lbs. per acre.

920.5.8 Apply within 48 before laying sod.

Sodding:

1. Lay sod on slightly moist soil
2. Lay with longest dimension parallel to contours in continuous rows.
3. Tightly butt ends of sod together. Stagger joints. Compact vertical joints between sod strips by rolling so sod will be in contact with the ground surface. Cut rows terminating on property lines to straight line.
4. When sod and soil are moist, roll sod lightly as soon as possible after laying. Roll with enough weight to ensure contact with soil for proper rooting.
5. Add topsoil along exposed edges to match existing grade; feather

topsoil out approximately 1 foot.

6. Make sure filled sodded areas positively drain so that no irrigation water or storm water will pond in sodded areas. Relay sod if necessary to correct.
7. Water thoroughly with fine spray immediately after planting.
8. Resodding: Resod spots larger than 1 sq. ft. not having uniform stand of grass during Warranty Period.

920.6 Maintenance

- 920.6.1. Mowing: When grass reaches 3" in height, mow to 2" in height. Mow weekly and maintain grass between 2" and 2-1/2" in height. Do not cut off more than 1/3 of grass leaf in a single mowing. Remove grass clippings from all paved surfaces.
- 920.6.2. Fertilizing: Distribute fertilizer uniformly at a rate of 5 pounds per 1000 square feet of sodded area, three weeks after sodding is complete. Fertilizing thereafter is to be in accordance with standard maintenance practices for turf areas, and as needed to achieve and maintain a vigorous and healthy stand of grass.

920.7. Guarantee/Warranty

Warrant sodded areas for consistency and completion of coverage. Resod areas as needed to obtain acceptance by the Town. Once a vigorously growing stand of grass is achieved, the request for Construction Acceptance may be made.

DIVISION 3 CONCRETE

03.100.000 CONCRETE FORMS AND ACCESSORIES

000.1 Structural Cast-in-Place Concrete Forms

- 000.1.1 Forms General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:
- a) Variation from plumb in lines and surfaces of piers, walls, and arises; $\frac{1}{4}$ " per 10 ft., but not more than 1". For exposed corner columns, control joint grooves, and other conspicuous lines, $\frac{1}{4}$ " in any bay or 20 ft. maximum; $\frac{1}{8}$ " maximum in 40 ft. or more.
 - b) Variation from position of the linear building lines and related columns, walls, and partitions, $\frac{1}{2}$ " in any bay or 20 ft. maximum, and 1" in 40 ft. or more.
 - c) Variation in sizes and locations of sleeves, floor openings, and wall openings, $\frac{1}{4}$ "
 - d) Variation in cross-sectional thickness of slabs and walls, minus $\frac{1}{8}$ " and plus $\frac{1}{2}$ ".
 - e) Variations in footings plan dimensions, minus $\frac{1}{2}$ " and plus 2"; misplacement or eccentricity, 2% of the footing width in direction of misplacement but not more than 2"; thickness reduction, minus 5%.
- 000.1.2 Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work_ Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.
- 000.1.3 Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.
- 000.1.4 Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing

concrete mortar. Locate temporary openings in forms at inconspicuous locations.

000. LS Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

000.1.6 Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

000.1.7 Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

000.1.8 Before concrete placement, check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems. During concrete placement, check formwork and related supports to ensure that forms are not displaced and that completed Work will be within specified tolerances.

000.1.9 Forms shall conform to the shape, lines, and dimensions, as shown on the plans and be of wood, metal, or other material as specified below or approved by Engineer. Approved flexible forms shall be used for construction where the radius is 150' or less. Unexposed surfaces shall have forms of No. 2 common (or better) lumber. Forms shall not be disturbed until the concrete has adequately hardened. The Developer or his superintendent shall be present at the time forms are removed and shall be responsible for the safety of this operation at all times. In no case shall the minimum time between placing concrete and removal of forms be less than the following:

	<u>Time</u>
Curb & Gutter	4 hours
Side forms for footings and slabs	12 hours
Side forms for walls, beam & columns	24 hours
Forms under structural beams and slabs requiring shoring	7 days or when concrete has reached 2/3 of 28-day field design

Strength as indicated by compressive strength tests on field cured specimens.

000.1.10 Forms Material: Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable size to minimize number of joints.

000.1.11 Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

000.1.12 Forms for Cylindrical Piers and Supports: Metal, glass-fiber-reinforced

plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

- 000.L13 Carton Forms: Biodegradable paper surface, treated for moisture-resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- 000.1.14 Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 g/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- 000.1.15 Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.
- a) Provide ties that, when removed, will leave holes not larger than 1-inch in diameter in the concrete surface.
- 000.1.16 The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members. Suitable moldings or chamfer strips shall be placed in the corners of column, beam, and wall forms, except where specifically directed otherwise by the Town Engineer.
- 000.1.17 Where necessary to maintain the specified tolerances, the formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and construction loads.
- 000.1.18 Positive means of adjustment (wedges or jacks) of shores and struts shall be provided, and all settlement shall be taken up during the concrete placing operation. They shall be securely braced against lateral deflections.
- 000.1.19 Temporary openings shall be provided at the base of column and wall forms, and at other points where necessary, to facilitate cleaning and inspection immediately before concrete is deposited.
- 000.1.20 Forming, accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be a commercially manufactured type. Wire is not acceptable. The portion remaining within the concrete shall leave no metal within one inch of the surface when the concrete is exposed to view. Spreader cones on ties shall not exceed one inch diameter. Embedded ties used in water containment structures shall have approved water seal washers.
- 000.1.21 Removal of Forms and Reshoring,
- a) Form work for columns, walls, sides of beams, and other parts not supporting the weight of the concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations. (See Section 03.100.110.1.9)
- b) Form work for beam soffits, slabs, and other parts that support the weight of concrete shall remain in place until the concrete has reached its specified twenty-eight (28) day strength, unless

otherwise specified or permitted. (See Section 03.100.1 10.1.9)

- c) Forms shall not be removed in any case until the concrete has had time to set sufficiently to carry the deadloads and any construction loads it has to sustain, and in no case will the forms be removed until permission is obtained from the Town Engineer or his representative.
- d) When shores and other vertical supports are so arranged that the form-facing material may be removed without loosening or disturbing the shores and supports, the facing material may be removed at an earlier age as specified or permitted. The shores and supports shall remain in place until the concrete has reached its specified (see Section 03.100.110.1.9) strength, unless otherwise specified or permitted.
- e) Re-shoring for the purpose of early form removal shall be performed, so that at no time will large areas of new construction be required to support their own weight. While reshoring is underway, no live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads, but they shall not be over-tightened so that the new construction is over-stressed. Reshores shall remain in place until the concrete has reached its specified twenty-eight (28) day strength, (see Section 03.100.1 10.1.9) unless otherwise specified or permitted.
- f) Removal strength shall be based upon test cylinder strengths or pullout tests in accordance with ASTM C900, and upon the approval of the Town Engineer.

03.200.000 CONCRETE REINFORCEMENT

000.1 Reinforcing Materials -General

- a.) Reinforcing Bars: ASTM A 615 Grade 60, deformed (unless otherwise specified on plans).
- b.) Welded Wire Fabric: ASTM A 185, welded steel wire fabric, flat mats only.
- c.) Fiber Reinforcement: See Section 03.200.240.
- d.) Supports for Steel Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire barype supports complying with CRSI specifications.
 - 1) For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2) For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with

legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

000.2 Shop Drawings

- a) Before fabrication of the reinforcement, the Developer shall prepare or have prepared complete strength, fabrication, and setting drawings and bar lists covering all required reinforcement steel. Such Drawings and bar lists shall be submitted to the Engineer for his/her review of general conformity to specified requirements. The review of the Shop Drawings by the Engineer in no way relieves the Developer of sole responsibility for correct placement of reinforcing steel.

000.3 Placing, Reinforcement

- a) General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports, and as specified.
 - 1) Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
- b) Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- c) Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Project Manager.
- d) Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- e) Install welded wire fabric in lengths as ion- as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- f) Placing: Reinforcing steel, before being placed, shall be thoroughly cleaned of coatings that will destroy or reduce bond. A light coating of rust may be allowed by the Engineer. Reinforcement shall be carefully formed to the dimensions indicated on the plans. It shall not be bent or straightened in a manner that will injure the material. **THE USE OF HEAT IN BENDING BARS SHALL NOT BE PERMITTED.** Bars with kinks or bends not shown on the plans shall not be used. Reinforcing steel shall be accurately placed and secured against displacement by using annealed iron wire of not less than No. 18 gauge, or suitable clips at intersections; and where necessary, reinforcing steel shall be supported by metal chairs or spacers, pre-cast mortar blocks, or metal hangers. Reinforcing, bars shall not be spliced at points of maximum stress. Splices, where

permitted, shall be placed in the position and at the spacing shown on the plans with the tolerances specified in ACI 301, Section 5.4.

- g) All reinforcing bars shall be supported and wired together to prevent displacement by construction loads or the placing of concrete. On ground, and where necessary, supporting concrete blocks shall be used. Over formwork, approved bar chairs and spacers shall be furnished. Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories in contact with the formwork shall be galvanized or shall be made of plastic. Where the concrete surface will be exposed to plant water, all accessories in contact with formwork shall be stainless steel or plastic.
- h) Mesh shall lap at least 1-1/2 meshes, plus end extension of wires, but not less than 12 inches in slabs and shall extend across supporting beams and walls. In lieu of adequate support for mesh, one man shall be designated to lift the mesh during placing of concrete so that it is completely surrounded by concrete and not less than 2 inches above the bottom of slabs on ground or 1/2 inch above formwork.
- i) Vertical bars in columns shall be offset to permit the bars to be adjacent and in contact at splices.
- j) All splices not shown on the drawings must have prior approval of the Engineer. Reinforcement shall not be bent after being partially embedded in hardened concrete.
- k) Laps in tension splices shall be 36-bar diameters and 30-bar diameters in compression splices, or as noted.
- l) Cover: The minimum clear cover for reinforcing steel shall be as specified in ACI 301, Section 5.5, and as shown below, unless otherwise shown on the plans.
 - a) Bottom bars on soil bearing Foundations & Slabs 3 inches
 - b) Bars adjacent to surfaces exposed to weather on earth backfill:
 - Bars more than 1/2" in diameter 2 inches
 - Bars 1/2" or less in diameter 1 1/2 inches
 - c) Interior Surfaces: Slabs, walls, joints with 1 3/8" diameter or smaller bars 3/4 inches

000.4 Fabrication and Placing Tolerances

- a) Bars used for concrete reinforcement shall meet the following requirements for fabricating tolerances:
 - Sheared length +1 inch

	Stirrups, ties	+1/2 inch
	All other bends	+1 inch
b)	Bars shall be placed to the following tolerances:	
	Concrete cover to formed surfaces	+1/4 inch
	Minimum spacing between bars	+1/4 inch
c)	Top bars in slabs and beams:	
	Members 8 inches deep or less	+1/4 inch
	Members more than 8 inches but not over 2 feet deep	+ 1/2 inch
	Members more than 2 feet deep	+1 inch
d)	Crosswise of members spaced evenly within 2 inches	
	Lengthwise of members	+2 inches
e)	Bars shall be placed with the following minimum concrete cover, including tolerance unless noted on the drawings:	
	Concrete cast against earth	3 inches
	Concrete exposed to earth or water	2 inches
	Beams, girders, and columns	1-1/2inches
	Inside face of walls not exposed to earth or water	1 inch
	Structural slabs not exposed to earth or water	3/4 inch

03.200.220 WELDED WIRE FABRIC

- 220.1 Welded wire fabric shall be electrically-welded wire fabric of cold-drawn wire (70,000 psi yield point) of gage and mesh size shown on the Drawings, and shall conform to "Specification for Welded Steel Wire Fabric for concrete Reinforcement" (ASTM A185).
- 220.2 Placing Welded Wire Fabric: Wire fabric in crosspans and curb cuts shall be placed as shown in the plans and details. The fabric shall be fully supported on pre-cast mortar blocks or other approved supports prior to placing the concrete.

03.200.240 FIBROUS REINFORCING

- 240.1 Fiber Reinforcement: Polypropylene fibers engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C 1116,

Type III, not less than 1/4 inch long

- a) Products: Subject to compliance with requirements, provide one of the following:
 - 1) Fibermesh, Fibermesh Co., Div. Synthetic Industries, Inc.
 - 2) Grace Fibers, W.R. Grace & Co.
 - 3) Hi-Tech Fibers.
Div. Martin Colon-Fi Co.
P.O. box 469 Edgefield. SC 29824
(800) 344-1572 (803) 637-7012

03.200.350 CONCRETE FINISHING

350.1 Finishing/Final Surface

- a) General: Exposed faces of curbs and sidewalks shall be finished to true line and grade as shown on the plans. The surface shall be floated to a smooth, but not slippery finish. Sidewalk and curb shall be broomed and edged, unless otherwise directed by the Engineer. After completion of brooming and before concrete has taken its initial set, all edges in contact with the forms shall be tooled with an edges having a 3/8" radius.
- b) No dusting or topping of the surface, or sprinkling with water, to facilitate finishing shall be permitted.

350.2 Types of Finish and Final Surface

Types of finishes shall conform to CDOT standards. Unless otherwise authorized, all formed surfaces shall be finished with a Class I finish.

- a) Class 1: Ordinary Surface Finish - Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces, except from those which are not to be exposed. 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, and the surface left sound, smooth, even, and uniform in color. Mortar used in pointing shall be left carefully tooled and free of all excess mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges. All concrete surfaces shall be given a Class I finish per CDOT 601.14. Additional finish classes may be specified by the plans for designated surfaces.
- b) Class 2: Rubbed Finish - All culvert headwall and wingwall surfaces above ground, where visible from a traveled way unless otherwise specified. After completion of Class I Ordinary Surface Finish, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be moistened with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the

pointing to thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the same proportions as the concrete being finished. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids filled and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. After the final rubbing is completed and the surface has dried, it shall be wiped with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

- c) Class 4: Sand Blasted Finish - The cured concrete surface shall be sand blasted with hard, sharp sand to produce an even fine-grained uniform surface in which the mortar has been cut away. An exposed aggregate finish will not be required. However, aggregate exposed incidental to achieving the specified surface will be acceptable.

- d) Class 5: Masonry Coating Finish - The specified surfaces shall be coated with a cement base concrete coating as specified herein:
 - A. Materials. Masonry coating shall conform to the requirements of CDOT subsection 708.08. It shall be pearl gray in color unless otherwise specified in the Contract.

 - B. Preparation of Surface. Surfaces shall be thoroughly cleaned by approved methods, free of dirt, projections, loose mortar particles and laitance.

 - C. Mixing. One part by volume of liquid acrylic to three parts by volume of water shall be mixed in a clean container. The dry powder shall be added to the liquid mixture and stirred until the resulting mixture attains the consistency of a batter mix. If the components are hand mixed, the mixture shall set for 15 minutes, additional liquid shall be added, and the mixture shall be re-stirred to the batter consistency. The Contractor shall not use mixed quantities that cannot be applied within time limits specified by the manufacturer.

 - D. Application. The masonry coating shall be applied in two coats using a tampico fiber brush, roller, trowel, or spray. The first coat shall be applied at the rate of approximately two pounds per square yard of surface area and the second shall be applied at the rate of approximately one pound per square yard. The second coat shall be applied the day following the first application or before material has become too hard or glazed for good bond. Surfaces to be coated shall be dampened immediately ahead of the application. The masonry coating shall not be laid on the surface and leveled out. If the wall becomes dry or the coating starts to pull during application, the wall shall be

dampened again. The mixture shall not be applied on frost-covered surfaces, frozen walls, when the temperature is below 40 degrees F or when temperatures are predicted to fall below 40 degrees F within 24 hours. If the surfaces have been exposed to hot sun conditions, they shall be cooled by hosing with clean water. When the work is progressing under hot sun, drying wind, or when evidence of extremely rapid drying appears, the finished surface shall be cured by fog spraying with water until final set occurs.

E. Class 5 finish shall be the final finish for the following surfaces:

1. All surfaces of bridge superstructure including undersurfaces of deck overhangs, and vertical faces of curbs, but excluding the top of the slab and sidewalk, the undersurfaces between girders, inside vertical surfaces of T girders, and undersurfaces of slab and box girder spans and T girders.
2. All exposed surfaces of bridge piers including cap and debris wall, abutments, wing walls, and retaining walls. The finish shall extend at least one foot below finish ground or low water elevation.
3. All surfaces of pedestrian under-crossings except floors and surfaces to be covered with earth.

Culvert headwalls and wing wall surfaces above -round, where visible from a traveled way, shall receive either a Class Z or Class 5 finish at the Contractor's option.

Surfaces other than listed herein or surfaces requiring special consideration shall receive the finish show on the plans.

350.3 Markings

- a) Concrete used in curb-gutter, sidewalk, curb cuts, driveways, inlets, bicycle paths, retaining walls, and slope paving, shall have the year of construction impressed therein, using letters not less than 1" high and 3/8" deep. Impressions shall be made in concrete at the beginning and end of each pour and in each driveway. Structures shall have the year constructed impressed therein, using letters 3" high and 1/2" deep.

350.4 Final Surface Test

- a) All work shall be true to line and grade as established by the Engineer. Prior to acceptance of the work, the Developer shall test the surfaces with a 10-foot straight-edge. Any areas higher than 1/8", but not higher than 1/2", above the correct surface thus indicated shall be ground to the correct surface by the Developer at his expense. When the deviation exceeds the foregoing limits, the contractor shall remove and replace that portion of the work at his

expense, as directed by the Engineer.

350.5 Repairs

- a) If, after stripping of forms, any concrete is found to be not formed as shown on the drawings, or is out of alignment or level, or shows a defective surface, it shall be considered as not conforming with these Specifications. The defective area shall be removed and replaced by the Developer at his expense, unless the Engineer gives written permission to patch the defective area. Patching, if allowed, shall be done as described in the following paragraphs.
- b) Ridges and bulges shall be removed by grinding. Honeycombed and other defective concrete that does not affect the integrity of the structure shall be chipped out and the vacated areas shall be filled in a manner acceptable to the Engineer. The repaired area shall be patched with a non-shrink, non-metallic grout, with a minimum compressive strength of 5,000 psi in 28 days. All repair areas shall be treated with an epoxy bonding agent before the repair filling is placed.
- c) Bolt Holes, tie-rod holes, and minor imperfections, as approved by the Engineer, shall be filled with dry-patching mortar composed of one part Portland cement to two parts of regular concrete sand (volume measurement), and only enough water so that after the ingredients are mixed thoroughly, the mortar will stick together upon being molded. Mortar repairs shall be placed in layers and thoroughly compacted by suitable tools. Care shall be taken in filling rod and bolt holes so that the entire depth of the hole is completely filled with compacted mortar. The mortar mix proportions described above are approximate.
- d) An approved mix shall be prepared to insure that the grout has a 28-day compressive strength equal to that of the area to which it is placed. All costs for mix design and testing shall be paid by the Developer. Those areas with excessive deficiencies, as determined by the Engineer, shall be removed and replaced at the Developer's expense.

03.200.390 CONCRETE CURING

390.1 General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

390.1.1 Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

390.2 Curing, Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.

- 390.2.1 Provide moisture curing by the following methods:
- a) Keep concrete surface continuously wet by covering with water for at least 5 days,
 - b) Use continuous water-fog spray.
 - c) Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
- 390.2.2 Provide moisture-retaining cover curing as follows:
- a) Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
- 390.2.3 Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:
- a) Apply curing compound to concrete slabs as soon as final finishing operations are complete, (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller, according to manufacturer's directions. The second application shall be applied after the first application has set. Re-coat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period, rate of application shall not be more than 300 square foot per gallon.
 - b) Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete, conforming to AASHTO M 148, Type 1-D, Class B with fugitive dye or Type 2, Class B except Type 2 cannot be used on exposed aggregate or colored concrete.
- 390.2.4 Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist-curing with forms in place for the full curing period, or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- 390.2.5 Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.
- 390.2.6 Blanket Method: Electrically heated curing blankets or insulation blankets may be used in cold weather to maintain specified curing

temperature and to retain moisture in concrete. Blankets shall be free of holes. Blankets shall be secured at laps and edges to prevent moisture from escaping.

03.200.400 CONCRETE STRUCTURE INSPECTIONS

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

400.1 Plan and Specifications Review

It is the Developer's responsibility to familiarize the materials testing firm with the plans and specifications approved by the Town Engineering Division prior to any construction.

400.2 Structural and Inspection Requirements - General

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

The structural Consultant Engineer or his representative, familiar with assumptions inherent in the structure design, shall review the construction in sufficient detail to confirm that the construction is appropriate.

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

400.3 Material Testing Requirements - General

Testing of materials shall conform to the requirements of AASHTO "Standard Specifications for Highway Bridges," latest edition, and applicable interims, and applicable CDOT standards.

400.4 Foundation Testing & Inspection Requirements

Unstable foundation material shall be removed to a minimum of 2' below the finish grade elevation and be replaced with Class 1 structural back-fill material if there is no suitable material available on site. Class I structural back-fill shall meet the requirements of Table 6.1 when tested with laboratory sieves.

TABLE 03.200.400A
CLASS I STRUCTURAL BACKFILL

SIEVE DESIGNATION	DRY SITE % BY WEIGHT PASSING LAB SIEVES	WET SITES % BY WEIGHT PASSING LAB SIEVES
2"	100	100
#4	30-100	90-100
#50	10-60	10-60
#200	5-20	0-2

In addition, this material shall have a Liquid Limit not exceeding 25 and a Plasticity Index of not over 6 when determined in conformity with AASHTO T 89 and T 90 respectively.

Testing of the foundation will be done at random locations with a minimum depth requirement of one foot (1') and the minimum moisture and density for the foundation material as required by T-99 or T-1 80. If Class I structural backfill material is used, the minimum moisture shall not be lower than two (2) percentage points under optimum moisture at 95% compaction as determined by AASHTO T-1 80 modified, tested at random through the depth of the fill.

400.5 Inspection of Forms and False work

- a. The forms shall be clean of all dirt, mortar and all foreign material. Forms which will later be removed shall be thoroughly coated with an approved form oil.
- b. The forms shall be mortar tight and of a quality (in addition to the bracing) to withstand the deposited concrete,
- c. Unless otherwise specified, forms for exposed surfaces shall be constructed with triangular fillets $\frac{1}{4}$ inch at all exterior corners.

400.6 Inspection of Reinforcing Steel

- a. The material grade and size shall be as specified by the design engineer on the certified construction drawings.
- b. Tying.
 1. Slab bars should be tied sufficiently, at least three times in any bar length, to prevent shifting at every intersection around the periphery and at spacing according to bar sizes.

#5 and smaller staggered	- 5'0" to 6'0" #6 to #9- 8'0" to 10'0"
#10 and #11	- 10'10" to 12'10"
 2. Wall bars should be tied sufficiently to prevent shifting, at least three times in any bar length at every third or fourth intersection and at spaces according to bar sizes, staggered:

#5 and smaller	- 3'0"
#6 to #9	- 4'0" to 5'0"
#10 to #11	- 6'0" to 8'0"

Upper and lower mats shall be tied or otherwise fastened at 4 ft. maximum spacing in each direction. Minimum splice length shall be 24 bar diameters.

3. Supports for reinforcing steel shall be: slabs on grade or footings, concrete blocking or approved blocking material. All other reinforcing steel shall be supported with steel chair or pre-cast mortar.
4. Reinforcing steel shall be clean and free of all foreign material before concrete is placed.
5. All clearances shall be in compliance with approved plans and specifications.
6. A daily log of all work shall be kept by a resident project observer. A copy of this log shall be furnished to the Town Engineer at or prior to the request for probationary acceptance.

400.7 Placement

- a. Concrete placement shall be done in a manner so that the concrete is not segregated or altered before placing. It shall not be allowed to free fall more than five feet. Concrete shall be placed in lifts not to exceed eighteen (18) inches. Each layer shall be so consolidated as to avoid the formation of a construction joint with a preceding layer, which has not taken initial set.
- b. A sufficient number of vibrators shall be used to properly consolidate the concrete as required. They shall be capable of frequencies of not less than 10,000 vibrations per minute, in air. Vibrators shall not be used as a means to cause concrete to flow or run into position in lieu of placing.
- c. Weep-holes should be installed in the structure at the locations noted on the plans or specifications and the inlet side shall be surrounded with one cubic foot of filter material in a burlap sack securely tied.
- d. Work in Inclement Weather.

Cold Weather Concrete Protection. From November 3rd to April 9th, when the mean daily temperature is less than 40 degrees F, in accordance with A.C.L Specifications OR when concrete is placed with ambient temperatures below 40 degrees F, the Contractor shall provide satisfactory methods and means to protect the mix from injury by freezing. Placing of concrete may be started in the morning if the Contractor desires, but shall be discontinued at 3 P.M. of the same day if freezing weather threatens. The concrete or aggregates shall be protected during transit, mixing, and before and after placing, as directed by the County inspector, to retain all heat possible in the concrete mix. All protection for the job must be on-site and approved by the County Inspector prior to beginning the concrete placement.

After the concrete has been placed, the Contractor shall provide sufficient protection such as cover, straw (as determined by R-factor per A.C.I. specs), canvas, framework, heating apparatus, etc., to enclose and protect the structure and maintain the temperature of the concrete at not less than 50 degrees F for a minimum of five (5) days, or until at least sixty percent (60%) of the design strength has been attained. It shall be the Permittee's responsibility to provide proof of temperature compliance with surface temperature recording devices as certified (by a P.E.) b a testing lab. If surface temperature recording devices are not provided, the Permittee shall be required to provide the County with petrographic tests for every 50 C.Y. of concrete placed. Except as provided above, cold weather concreting shall be in accordance with ACI-306. If, in the opinion of the County Inspector, the protection provided is not in accordance with the above specifications, concreting shall cease until conditions or procedures are satisfactory to the County Inspector.

NOTE: Dates for Mean Daily Temperature as determined over the last 25 years by the Colorado Climate Center, Department of Atmospheric Science by: (min. temp. + max. temp.)/2 (which is accurate to within + or- 1 degree).

Hot Weather Limitations. Placing of concrete during hot weather shall be limited by the temperature of the concrete at the time of placing. Mixed concrete which has a temperature of 90 degrees F or higher, shall not be placed. The Contractor shall provide fogging with an approved atomizing nozzle until the curing material is in place. The aggregate stockpiles shall be kept moist at all times.

- e. Construction joints shall be made only where located on the plans or shown in the placing schedule, unless otherwise approved. All construction joints shall be cleaned of surface laitance, curing compound, and other foreign materials before fresh concrete is placed against the surface of the joint. Where construction joints are allowed on visible surfaces, chamfer strips attached to the forms or other approved methods shall be utilized to provide an even joint appearance. When the plans show new concrete to be joined to existing concrete by means of bar reinforcing dowels placed in holes drilled in the existing concrete, the diameter of the holes shall be the minimum needed to place non-shrink grout or epoxy or grout and the dowel. Immediately prior to placing the dowels, the holes shall be cleaned of dust and other foreign material and sufficient grout placed in the holes so that there are no voids in the drilled holes after the dowels are inserted.

03.200.410 MATERIALS SPECIFICATIONS

Proportioning, batching, mixing shall be per CDOT 601.04 to 601.07.

All concrete used in any infrastructure facility shall be no less than 4000 psi unless otherwise noted. Unless otherwise authorized, the temperature of the mixed concrete shall not be less than 50 degrees F and not more than 80 degrees F at the time of placing it in the forms. Air content % range shall be 5-8%, with a maximum slump of 4". Developer must submit a design mix to the inspector.

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

TABLE 03.200.410 C
 CONCRETE AGGREGATE GRADATION TABLE*
 PERCENTAGES PASSING DESIGNATED SIEVES
 AND NOMINAL SIZE DESIGNATION

COARSE AGGREGATES (From AASHTO M 43)										
Sieve Size	No 3	No 4	No 6	No 7	No 8	No 57	No 67	No 357	No 467	FINE AGGREGATE AASHTO M6
	2" to 1"	1-1/2" to 3/4"	3/4" to 3/8"	1/2" to 4"	3/8" to 8"	1" to 4"	3/4" to 4"	2" to 4"	1-1/2" to 4"	
2 1/2"	100							100		
2"	90-100	100						95-100		
1 1/2"	35-70	90-100		1		100			100	
1"	0-15	20-55	100			95-100	100	35-70		
3/4"		0-15	90-100	100			90-100		35-70	
1/2"	0-5		20-55	90-100	100	25-60		10-30		
3/8"		0-5	0-15	40-70	85-100		20-55		10-30	100
4			0-5	0-15	10-30	0-10	0-10	0-5	0-5	95-100
8				0-5	0-10		0-5			
16					0-5					45-80
50										10-30
100										2-10

*From CDOT Specifications Section 703. Additional primary grading may be permitted, when produced on the project, provided the theoretical combination meets the specifications for combine aggregate sizes. Size No.357 is combination of No.3 and No.57. Size No.467 is a combination of No.4 and No.67.

DIVISION 7 THERMAL AND MOISTURE PROTECTION

07.100.180 TRAFFIC COATINGS

180.1 Thermoplastic Marking Materials

The thermoplastic material shall be homogeneously composed of pigment, filler, resins and glass beads. The thermoplastic material shall be available in white, yellow, and black colors.

The solid resin shall be either a synthetic hydrocarbon or maleic modified glycerol ester resin. For glass beads, the pre-mix beads shall be unquoted and conform to AASHTO M247-81 (1986) Type 1. The drop-on beads shall be moisture resistant coated. A maximum of 5 percent shall pass the 80 percent screen: glass spheres shall have a minimum of 70 percent true spheres on each sieve and 80 percent true spheres overall.

180.2 Requirements of the Thermoplastic Mixture

180.2. 1 The pigment, beads, and filler shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt, and foreign objects.

Luminosity

White - daylight reflectance at 45 degrees, 0 degrees - 75% minimum
Yellow - daylight reflectance at 45 degrees, 0 degrees - 45% minimum.

For highway use, the colors shall match Federal Highway Administration yellow and white color specifications. For airport use, the color shall comply with the requirements established by the Federal Aviation Administration.

180.2.2 The material shall be applied by one of the following methods:

1. The screed/extrusion method wherein one side of the shaping die is the pavement and the other three sides are contained by, or a part of, suitable equipment or heating and controlling the flow of material.
2. A suspended extrusion die having a 4 sided control of the flow and shape of the materials.
3. The spray method at a uniform minimum rate of 10 pounds of glass spheres every 100 square feet of markings.

180.3 Plastic Pavement Marking Materials

The performed marking materials shall consist of white or yellow films with pigments selected and blended to provide the appropriate highway colors for traffic markings. Glass or ceramic beads shall be incorporated to provide immediate and continuing retroreflection. The size, quality and refractive index of the beads shall be such that the performance requirements of this specification shall be met.

The edges of the preformed material shall be clean cut and true. The preformed plastic material may be supplied complete with a pre-coated, factory applied adhesive for immediate pavement application without the use

of heat, solvent, or other types of adhesive operations or it may be furnished with separate adhesives as recommended by the manufacturer.

180.4 Requirements of the Plastic Pavement Marking Material

Pigments shall be selected and blended to conform to standard highway colors throughout the expected life of the material. The white shall be no darker than Color Number 37778 of Federal Standard Number 595 and the yellow shall conform to Color Number 33538 of Federal Standard Number 595 (Highway Yellow Color PR#1)

The preformed plastic material shall be capable of application to non-defective pavement surfaces that are dry and free from dirt or other foreign matter. For normal application the pavement temperature should be at least 60 degree F and rising. Plastic pavement marking materials shall only be applied to surfaces with temperatures within the range specified by the manufacturer for optimum adhesion.