

SECTION #02700
TECHNICAL SPECIFICATIONS

FOR CONSTRUCTION OF

SANITARY SEWER EXTENSION

TO SERVE

**ANDALE HIGH SCHOOL
UNIFIED SCHOOL DISTRICT 267**

CITY OF ANDALE

SEDGWICK COUNTY, KANSAS

Prepared by

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TECHNICAL SPECIFICATIONS FOR SANITARY SEWER CONSTRUCTION

Section I. Materials

1. **General.** - All materials, of whatever nature required for the construction of the work embraced in this contract, shall be furnished by the Contractor and subject to the inspection and approval of the Engineer. All rejected material shall be immediately removed from the project site. The Engineer shall at all times have full and complete authority to inspect all material and work and to reject such as is not suitable for the proposed use and/or does not conform to the plans and specifications. The Contractor shall at all times provide ample facilities for the inspection of the work and testing of all material. Such inspection or non-inspection shall not release the Contractor from complying in every respect with the requirements of the plans and specifications up to the final completion and acceptance of the work.
2. **Concrete.** - Cement used in concrete for sanitary sewer manholes shall be Type II. Cement used in all other concrete shall be Type I. All cement shall comply with the requirements of the latest revisions of A.S.T.M. Designation C-150.

The Engineer shall have the authority to instruct the Contractor to substitute high early strength (Type III) cement for Type I cement. In this event, The Contractor will be allowed as an extra the difference in cost between standard Portland cement and high early strength (Type III) cement.
3. **Reinforcing Steel.** - Reinforcing steel shall conform to the requirements as specified in the project specifications for "Concrete".
4. **Manhole Castings.** - Manhole castings shall be made of good quality gray iron, free from cracks, holes, swells and cold shuts. Manhole castings shall be manufactured to conform to the shape and dimensions and other requirements as shown on standard manhole detail. Manhole castings shall conform to Class 30 of A.S.T.M. Designation A-48. Castings for manholes shall be a standard design approved by the City Engineer.
5. **Pipe Bedding Material.** - Type 1 Pipe Bedding Material shall be crushed rock conforming to A.S.T.M. C-33, Gradation No. 67 meeting the quality requirements of the concrete coarse aggregate. Type 2 Pipe Bedding Material shall be a sand-gravel mix conforming to Kansas Department of Transportation Specifications for Type UD-1 under drain aggregate. Type 2 Pipe Bedding Material may be used for the portion of the bedding below the bottom of the pipe only if the trenches are dry and stable and de-watering is not required. If the trenches are wet or unstable or de-watering is required, then Type 1 Pipe Bedding Material shall be used for the portion of the bedding below the bottom of the pipe and the depth of the bedding material shall be extended to a minimum depth of 12 inches below the bottom of the pipe. Bedding material shall be compacted to 90% ASTM D-698 to spring line of pipe. Fill sand or other approved bedding material shall be placed to 12" above top of pipe.

6. **Polyvinyl Chloride Pipe.** - Polyvinyl Chloride (P.V.C.) Pipe having diameters of eight inches (8") or greater shall have elastomeric gasketed joints and shall conform to the latest revision of A.S.T.M. Designation D-3034 for 15-inch and smaller pipe, and to A.S.T.M. Designation F-679 for 18-inch and larger pipe, and shall be rated for S.D.R.-35. All P.V.C. pipe shall be installed in accordance with manufacturer's recommendations. Waterstop gaskets around the pipe shall be installed in all manhole walls. P.V.C. pipe shall be installed with an improved bedding in accordance with the standard detail.

P.V.C. pipe meeting the requirements of the latest revision of A.S.T.M. Designation F-789 unless otherwise noted on the plans. Such pipe shall have a Certificate of Compliance executed by an accredited independent testing laboratory. Pipe joints shall be elastomeric gaskets meeting the requirements of the latest revision of A.S.T.M. Designation D-3212. Such pipe shall be installed in conformance with the applicable requirements specified for P.V.C. pipe in the preceding paragraph. Approved waterstop gaskets shall be furnished and installed on the pipe in all manhole walls.

Section II. Construction Requirements.

1. **Excavation.** - All excavation shall be done by open cut from the surface except where necessary to tunnel under existing sewers or other underground utilities and in such other locations where tunneling is expressly permitted or directed by the Engineer.

The Contractor shall strip and save the top six inches (6") of topsoil in unpaved areas when construction occurs on developed property, so that after the sewer is installed the topsoil can be replaced in its original location by the Contractor, in a condition suitable for replanting grass. The trench width from the bottom of the trench to one foot (1') above the top of the pipe shall be a minimum of six inches (6") and a maximum of eight inches (8") wider on each side of the pipe than the outside diameter of the pipe unless otherwise authorized by the Engineer. The excavated soil shall be placed compactly along the side of the trench such as to be of the least inconvenience as possible to the traveling public and adjoining tenants. Trenches shall not be opened more than two hundred feet (200') in advance of the laying of pipe unless otherwise authorized by the Engineer, with maximum open at end of day of 50 feet. The Contractor will maintain the trenches such that they will be free of water and in no circumstances will pipe be laid in water. The control of ground water shall be such that softening of the bottom of excavations, or formation of "quick" conditions or "boils" during excavation shall be prevented. Well point de-watering systems shall remain in operation until trench has been backfilled. The Contractor shall not obstruct the gutter along pavement or any other watercourse. Any watercourses disturbed or damaged by the Contractor shall be replaced by the Contractor at his expense.

Sewers will be constructed along the line and to elevations as shown by the plans. The Contractor shall provide offset line and grade stakes as necessary to facilitate the construction. The Contractor shall furnish all other labor and material to properly locate the alignment and elevation of the trench excavation.

No additional payment will be made when encountering rock, wet or unusual soil conditions and/or groundwater.

Surplus excavated trench material shall be disposed of by the Contractor as directed or approved by the Engineer. The cost of disposing of the excess excavated material, including loading and hauling, shall be included in the price bid. The Contractor shall dump and spread the excess excavated material as directed by the Engineer.

2. **Trench Stabilization.** - The Engineer may direct that trench stabilization be installed when groundwater or unstable soil conditions are encountered. Trench stabilization shall consist of over excavation and placement of additional compacted pipe bedding material in accordance with the standard drawing for trench stabilization. Any trench stabilization required as a result of surface water entering into the trench, or to correct inadvertent over depth trenching, shall be installed at the Contractor's expense.
3. **Installation of Pipe.** - Sewer pipe shall be installed true to line and grade and to bear uniformly along the length of the pipe barrel with notches excavated where necessary to accommodate pipe bells.

Care shall be exercised in joining sewer pipes such that the pipe ends butt against each other without undue gaps. The sewer pipe shall be laid up grade beginning at the point of connection with the existing sewer or lowest flow elevation, unless otherwise approved by the Engineer. The sewer pipe shall be installed with the bell end forward or upstream, unless approved otherwise by the Engineer. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with an approved temporary plug.

Maximum allowable gaps measured at the widest point and maximum allowable offsets in the flowline between butting ends of pipe shall be as indicated in the following table. Joint gaps requirements shown in the following table shall be applicable only to those types of pipes with joints where the bell socket is designed with an inner face which would normally seat with the butt end of the pipe installed into the bell socket for such pipe such as clay pipe, Armco Truss Pipe, concrete pipe and other such pipe types.

Pipe Size	Joint Gap	Flowline Offset
8"	1/2"	3/16"
10"	1/2"	3/16"
12"	9/16"	1/4"
15"	11/16"	1/4"
18"	11/16"	1/4"
21"	7/8"	3/8"
24"	7/8"	3/8"
27"	15/16"	1/2"
30"	15/16"	1/2"
36" or larger	1"	1/2"

Any sewer lines having flow elevations which deviate by more than one inch (1") from a straight line, as determined by the flow line of the two ends of pipe of any one line between structures, shall be reconstructed by the Contractor at his expense such that the flow elevations will not deviate by more than one inch (1") from the straight line previously described.

4. **Improved Bedding.** - Improved bedding shall be defined as the initial pipe backfill to a depth of twelve inches (12") above the top of the pipe. All pipe bedding shall be improved bedding and shall be hand placed and tamped under the haunches and around the pipe in uniform, maximum six inch (6") lifts. The improved bedding shall be worked simultaneously on each side of the pipe to ensure equal fill heights at all times. Particular care shall be taken to obtain uniform bearing along the length of pipe without causing joint damage or displacement.

Type 1 Pipe Bedding Material shall be crushed rock conforming to A.S.T.M. C-33, Gradation No. 67. Type 2 Pipe Bedding Material shall be a sand-gravel mix conforming to Kansas Department of Transportation Specifications for Type UD-1 under drain aggregate.

All bedding shall be brought to proper moisture content and compacted to not less than ninety percent (90%) of maximum dry density as determined by AASHTO Method T99.

A. **Improved bedding for flexible pipe** (P.V.C.) shall consist of Type 1 or 2 Pipe Bedding Material under the barrel of the pipe to the springline. Fill sand to be placed extending up to a level twelve inches (12") above the top of the pipe.

B. **Improved bedding for rigid pipe** (P.V.C.) shall consist of Type 1 or 2 Pipe Bedding Material under the barrel of the pipe to 1/6th the outside pipe diameter. Fill sand to be placed extending up to a level twelve inches (12") above the top of the pipe.

5. **Backfilling.** - All trenches and excavations shall be backfilled immediately after the installation of improved bedding. Trench backfill, beginning twelve inches (12") above the top of the pipe, shall be as described herein. Care must be taken during the tamping process so as not to injure or disturb the pipe.

Trenches shall be backfilled with excavated material mechanically compacted to a density equal to or greater than ninety percent (90%) of standard density. The top two feet (2') of trenches within alley or street right-of-way shall be backfilled with excavated material mechanically compacted to a density equal to or greater than ninety-five percent (95%) of standard density. Contractor will be required to furnish other approved backfill material suitable for mechanical compaction when laboratory tests indicate that the Contractor is not able to obtain the required density by mechanical compaction of the material excavated from the trench.

Trenches to be consolidated by flushing shall be sand backfilled when the excavated material is not suitable for backfill material as determined by the Engineer. The top one foot of trenches to be flushed shall be earth backfill compacted to a density equal to or greater than the existing adjacent undisturbed material. Backfill material to be flushed shall be placed in six foot maximum lifts when the trench is within alley or street right-of-way, and in twelve foot (12') maximum lifts when the trench is outside of alley or street right-of-way. Each lift shall be thoroughly consolidated by using water jets and vibrators. Consolidation of backfill by flushing and vibrating shall result in a final density which equals or exceeds ninety percent (90%) of the standard density. Water shall be applied so that effective settlement is obtained with a minimum amount of water. Trenches shall not be permitted to overflow. Special care must be taken during backfilling, flushing and

compacting operations to prevent pipe from floating. Water shall be introduced into the layer being flushed through a long pipe nozzle and in such a manner that the granular fill, tamped material or the previously placed layer will not be disturbed, and in no case shall the nozzle end be inserted closer than three feet (3') above the top of the pipe.

The backfill shall be compacted to maximum density by using mechanical vibrating equipment after the backfill material has been flushed with water. Backfill material shall be added as required in the top lift to compensate for settlement. Sand used for backfill material shall be relatively clean with one hundred percent (100%) passing the three-fourths inch (3/4") sieve, not more than twenty-five percent (25%) retained on a No. 4 sieve, and not more than ten percent (10%) passing a No. 200 sieve.

6. **Use of Explosives.** - When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property, including new work. The Contractor shall be responsible for any required permits and all damage resulting from the use of explosives. The use of explosives will not be permitted unless specifically approved by the Engineer.

All explosives shall be stored in a secure manner, in compliance with all laws and ordinances, and all such storage places shall be clearly marked. When no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than one thousand feet (1000') from the road or from any building or camping area or place of human occupancy. O.S.H.A. requirements shall be adhered to.

In advance of doing any blasting work involving the use of blasting caps within two hundred feet (200') of any railroad's tracks or structures, the Contractor shall notify the railroad of the location, date, time and approximate duration of such blasting operations.

Where electric blasting caps are being used close to a public highway, the Contractor shall erect warning signs in accordance with the latest edition of the Manual of Uniform Traffic Control Devices. The signs shall be furnished and installed by the Contractor at his own expense.

The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use the explosives, and such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

Any Contractor desiring to use explosives within the city limits must first obtain a permit to do so from the City Fire Department.

7. **Pipeline and Manhole Testing** - All sanitary sewer piping and manhole construction will be tested as described herein as part of the acceptance procedures.

- 7a. **Pipeline Testing and Inspection.** - All eight inch (8") and larger sanitary sewers constructed under this contract shall be air tested by the Contractor and observed by the Engineer's representative. The City may conduct exfiltration tests on sanitary sewers larger than twenty-four inch (24"). T.V. inspection will be conducted on all installed sewer lines. The Contractor shall furnish logs and video records of such inspections to the City. Any defects indicated by the visual inspection, air testing and/or exfiltration testing shall be corrected by the Contractor without additional compensation prior to acceptance of the project by the City. The lines shall be re-tested and re-inspected, after repairs are made by the Contractor.

Table 1 Minimum Specified Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated for Q = 0.0015
 Note 1- See Practice UNI-8-6-90.

Note 2-Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 in. in diameter.

Pipe Diameter in.	Min. Time min:s	Length for Min. Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, Min:s									
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft		
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24		
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24		
10	14:10	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48		
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38		
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04		
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:18	57:41		
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31		
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33		
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48		
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15		
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53		
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46		

Table 2 Minimum Specified Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated for Q = 0.0015
 Note 2-Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 in. in diameter.

Pipe Diameter in.	Min. Time min:s	Length for Min. Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, Min:s									
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft		
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12		
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42		
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54		
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50		
15	7:05	155	2.571 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02		
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51		
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16		
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17		
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54		
30	14:10	50	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07		
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57		
36	17:00	86	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23		

P.V.C. pipe and any other flexible pipe shall be subject to testing for deflection after it has been installed and backfilled. Deflection may be tested by a mandrel or by direct measurement of the vertical diameter of the pipe. Pipe that has deflected more than five percent (5%) of its nominal vertical dimension shall be reconstructed by the Contractor at his expense. The reconstructed pipe shall also be tested for deflection. Testing of pipe with a diameter of thirty-six inches (36") or less shall be by mandrel. The Contractor shall furnish all equipment and labor necessary to complete the testing. Testing of pipe with a diameter greater than thirty-six inches (36") shall be by direct measurement by the Engineer's representative.

- 7b. **Manhole Testing and Inspection** - All manholes shall be tested by vacuum testing. The manhole shall not be backfilled prior to testing.

Vacuum Testing of Manholes:

Each manhole shall be vacuum tested for leaks prior to backfill. Tests, sealing, and acceptance shall be according to the procedures described in this section.

Materials Required:

1. Air-tight pipe plugs for each pipe into the manhole, with brace posts.
2. Test plate fitted to top opening of manhole.
3. Air pump and base.
4. Vacuum gauge: range zero to 20 inches Hg. vacuum.
5. Non-shrink grout.

Procedure:

Prior to testing, all lifting holes and exterior joints shall be filled and pointed with an approved non-shrinking mortar well in advance of testing so it will have time to cure to its maximum strength. The completed manhole shall not be backfilled prior to testing. Manholes which have been backfilled shall be excavated and cleaned to expose the entire exterior, prior to vacuum testing.

All pipes and other openings into the manhole shall be plugged. All plugs shall be securely braced to prevent the plugs from being drawn into the manhole.

A plate with an inflatable rubber ring the size of the top of the manhole shall be installed by inflating the ring with air to pressure adequate to prevent leakage of air between the rubber ring and manhole wall.

Air shall then be pumped out of the manhole through an opening in the plate until a vacuum is created inside of the manhole equal to 10 inches of mercury on an approved vacuum gage. The removal of air shall then be stopped and the test time began.

The vacuum must not drop to below 9 inches of mercury within a 2-minute test period. If more than 1 inch drop in vacuum occurs within the 2-minute test period the manhole has failed the test and shall be repaired or reconstructed, and re-tested.

Following satisfactory test results, the manhole may be backfilled.

NOTE: Make sure the test plugs in the pipes are securely braced so that the vacuum will not displace them. If a general porosity leak is present the use of smoke will be helpful in locating the leaks. Caution: Do not allow anyone in the manhole during testing.

8. **Manhole Top Elevation.** - The intent of this specification is to ensure that tops of manholes will be constructed to match proposed finished grade in areas of new development and existing finished grade in areas which have already developed. The intent is to construct sanitary sewer manholes outside of paved or unpaved street, driveway, and/or parking lot traveled ways to an elevation of 0.4' higher than the proposed

finished grade or the existing finished grade. Tops of manholes constructed in proposed or existing paved traveled ways shall be set flush with the proposed or existing pavement.

Plans for sewer construction in new developing areas may indicate specific elevations for tops of manholes when the finished grade has been determined prior to completion of the plans. The Contractor and the Engineer must understand that tops of manhole elevations specified on any sewer plan were set according the best information available at the time the plans were prepared, and the actual top of manhole elevations shall be based on the best information available at the time the manhole is actually constructed in conformance with the requirements in this specification as further approved by the Engineer.

When the plans do not indicate top of manhole elevations, the manhole top elevation shall be ascertained at the time of construction using the best information available in conformance with the requirements of this specification as further approved by the Engineer.

9. **Structure Excavation and Backfill.** - Excavation for structures, backfill for structures and compaction of such backfill shall conform to the applicable requirements as specified for sewer pipe trenches.
10. **Pre-cast Concrete Manholes** – Pre-cast Reinforced Concrete Manholes shall be constructed as detailed by standard detail sheet in conformance with the latest revision of A.S.T.M. C-478 except for the following modifications:
 - (a) Cement, shall be revised to read: Cement used in construction of precast reinforced concrete manholes shall conform to the requirements of the Standard Specifications for Portland Cement (A.S.T.M. Designation: C-150). Minimum 28-day compressive strength shall be not less than 4000 p.s.i.
 - (b) Thickness of precast sections shall be at least one-twelfth of the internal shell diameter plus (1) inch, or five (5) inches total, whichever is greater. The minimum internal diameter of manholes shall be four (4) feet.
 - (c) Joints between precast reinforced concrete sections shall provide for the use of mastics or rubber gaskets (natural or synthetic) to prevent leakage or infiltration.
 - (d) Pre-cast sections shall be adequately reinforced with steel to withstand erection and temperature stresses.
 - (e) The Contractor must submit certified test results showing that a random number of pre-cast sections have been sampled and tested in accordance with A.S.T.M. C-478 for compressive strength and absorption prior to moving recast sections to the job site.
 - (f) The concrete bases of all manholes may be pre-cast. A-LOK gaskets shall be used on all pipe connections and pipe connections at manholes shall have crushed rock encasement.
 - (g) Adapting collar to connect the standard cone section to 5.0' inside diameter manhole shall be positioned near the top of the manhole at the base of the cone section.
 - (h) Pre-cast reinforced concrete manholes shall conform to the dimensions and requirements of the standard details.

- (i) All interior surfaces of pre-cast concrete manholes to be connected to sewer pipe shall receive a trowelled or broomed grout finish to fill air holes and irregularities prior to applying the epoxy coatings. The interior surfaces shall be painted with two coats of Tnemec Series 66 Hi-Build epoxy or other approved equal. When the paint coating is applied by the manufacturer, surfaces which are to be grouted or patched shall not be painted until after assembly of the manholes. The Contractor shall apply epoxy to touch up damaged surfaces, and cover patches or grouted areas. Each application of epoxy coating shall have a minimum dry film thickness of 4 mils.
 - (j) The floors of the manholes shall be shaped and smoothed so that flow channels will be formed such that the manhole will be self-cleaning and free of areas where solids may be deposited as sewage flows through the manhole from all inlet pipes to the outlet pipe. The floors shall have slopes of three inches (3") per foot on areas outside of the flow channels.
 - (k) All grout used to close openings around waterstop gaskets and sewer pipes shall contain approved non-metallic shrinkage correcting aggregate.
11. **Mortar Grout.** - All grout used to close openings in manhole walls around waterstop gaskets and/or sewer pipes shall contain non-metallic shrinkage correcting aggregate.
12. **Concrete Work.** - Concrete mixing, handling, placing, jointing, finishing, curing, protection and testing shall conform to the Project Specifications for concrete except as modified herein. Air entraining admixture shall not be used in concrete work which is not exposed to freezing and thawing.

Section III. Separation of Potable Water Lines and Sanitary Sewers

1. When potable water lines and sanitary sewers are installed parallel to each other, the horizontal distance between them shall not be less than 10 feet. Parallel water lines and sanitary sewers shall be in separate trenches with undisturbed earth between them.
2. When a water line and a sanitary sewer cross and the sewer is two feet or more (clear space) below the water line, no extra protection to the latter is needed. At all other crossings, the sewer is to be constructed of approved plastic pipe with bonded joints, or concrete encased for a distance of 10 feet in either direction from the crossing. Joints are not to be in the immediate vicinity of the water line and as far from it as practical. Where water lines are installed across or through an area where there are existing sanitary sewers and the extra protection is needed, the existing sewers may be encased in concrete with a minimum of 6 inches thickness for the required distance on each side of the crossing.
3. The same horizontal separation requirements as listed above apply to water service lines and building sewers. The same vertical distance separations and the extra protections as required above for potable water lines and sanitary sewers apply in the same manner to water service pipes and building sewers.
4. There shall be no physical connection between any parts of the potable water system with building sewers, sanitary sewers, or wastewater treatment facilities by means of which it would be possible for sewage, even under exceptional circumstances, to reach the wells, storage reservoirs, or distribution system.

Section V. Incidental Construction.

1. **Manholes Removed.** - Manholes designated for removal shall be completely removed. All abandoned pipes, which remain after the manhole has been removed, shall be plugged. The excavation shall be backfilled in accordance with the requirements as specified for sewer trench backfill.
2. **Observation Holes Removed.** - Observation holes designated to be removed shall be completely removed for the full depth to the top of the tee fitting in the sanitary sewer, unless otherwise indicated by the plans. The opening left by removing the observation hole shall be plugged with concrete as approved by the Engineer. The top half of the sewer pipe shall be encased with a minimum thickness of six inches (6") of un-reinforced concrete encasement for a minimum distance of eighteen inches (18") in both directions from the centerline of the original observation hole.
3. **Manholes Adjusted.** - Manholes designated for adjustment shall be raised or lowered as necessary such that the casting shall conform to the required elevation. Construction and material requirements shall conform to the same requirements as specified for new manhole construction. An approved type of flat concrete slab shall be used to support the manhole ring where it is necessary to lower manholes or brick stacks having corbels more than twelve inches (12"). Flat concrete slab manhole tops shall conform to the requirements of A.S.T.M. C-478 in addition to the following requirements. All surfaces of the flat concrete slabs which would be exposed to sewer gas shall be protected by an epoxy coating. The epoxy coating shall conform to the same requirements as specified for Pre-cast Concrete Manholes. A minimum six inch (6") brick collar conforming to the same type of construction as specified for brick manholes shall be installed between the manhole ring and the flat concrete slab to facilitate minor adjustments for elevation unless approved otherwise by the Engineer. All contact surfaces between brick masonry, flat concrete slab and cast iron ring shall be sealed with a layer of mortar. Manholes having corbels which must be raised more than twelve inches (12") will require removing the draw section completely to facilitate reconstruction of a standard draw section. When it is necessary to adjust a reinforced concrete manhole, this work shall conform to the requirements and details as shown by the plans.
4. **Manholes Abandoned.** - Manholes designated to be abandoned shall have the top four feet (4') removed and the remaining portion of the manhole shall be filled with sand, flushed and vibrated. All pipes in the manhole, which are to be abandoned, shall be plugged prior to filling the manhole with sand. The top four feet (4') of the excavation shall be filled with material similar to the adjacent surface and compacted to a density of ninety percent (90%) of the standard density.
5. **Connection to Existing Manholes.** - When it is necessary to connect a new sewer to an existing manhole which does not have a stub to facilitate this connection, the Contractor shall break into the manhole carefully such that the structural integrity of the manhole will not be impaired. All repair work necessary to close the opening made to facilitate the installation of the new pipe shall conform to the requirements for new

construction as specified in these specifications for the type of manhole involved. Waterstop gaskets shall be used when connecting P.V.C. Composite or P.V.C. Pipe to existing manholes to prevent leakage. The floor of the manhole shall be modified such that smooth channels will be formed from all inlet pipes to the outlet pipe such that the manhole will be self-cleaning and free of areas where solids could be deposited as sewage flows through the structure.

6. **Pipe Abandoned in Place.** - Both ends of all pipes to be abandoned in place shall be plugged. Pipes abandoned in place having diameters greater than fifteen inches (15") shall be filled with sand and plugged.
7. **Pipe Plugs.** - Pipe plugs shall be constructed of brick masonry. Pipes having a diameter of eighteen inches (18") or smaller shall be plugged with masonry plugs eight inches (8") thick. Pipes having diameters of greater than eighteen inches (18") shall be plugged with masonry plugs twelve inches (12") thick. Construction requirements and materials for brick masonry plugs shall conform to the same requirements as specified for brick manholes.

Temporary pipe plugs on the ends of lines which are to be extended shall be prefabricated by the manufacturer of the pipe, unless approved otherwise by the Engineer. Temporary plugs shall be of such construction that the plug will prevent entrance of any extraneous material into the sewer and such that will facilitate easy removal without undue damage to the sewer pipe when the sewer is extended.

8. **Pavement Removal and Replacement.** - The boundary lines of all pavement repair shall either terminate at existing pavement joints or at sawed cuts as directed by the Engineer. All lines of pavement removal shall be either perpendicular to or parallel with the centerline of the street or alley pavement. All pavement or driveway repair shall extend a minimum of one foot (1') beyond the edge of the sewer trench. No. 6 deformed reinforcing steel bars shall be placed across the sewer ditch on two foot (2') centers with the bars extending a minimum of eleven inches (11") past the trench. Two No. 6 longitudinal reinforcing steel bars shall be placed parallel with the centerline of the trench for the full width of the pavement. All bar crossing shall be securely fastened using wire ties. The pavement repair shall be two inches (2") thicker than the original pavement in the area of one foot (1') beyond either side of the sewer trench.
9. **Septic Tank System Removal.** - If in the prosecution of the construction of any sanitary sewer it becomes necessary to remove a portion of or a complete septic tank, the inspector shall notify the Field Engineer and the Contractor or his representative, that if a portion of the tank is removed, the entire tank shall be removed and a temporary connection established. A change order must be executed for this extra work before the Contractor can proceed with the removal of the septic tank.

The Contractor shall notify the tenant or property owner that the septic system is removed and a temporary connection established and also inform the tenant or property owner that the City shall be notified and requested to make an approved inspection of all plumbing in the building or residence. With this approval the connection will become permanent. All of the aforementioned shall be in accordance with local code.

In the event the lead line or the laterals from the septic system are encountered in the construction of the sewer, the Contractor shall make all necessary repairs for which no additional payment shall be made.

The inspector shall record on the plans the location of the temporary connection as measured from a reference manhole and the side of the sewer where the temporary connection is made.

10. **Tunnel Liner Installation.** - Tunnel liner plates shall be used where specified by the plans. The cross section of the tunnel shall be circular and of the size indicated. Alternate sizes and shapes may be submitted for approval subject to it being best suited for proposed method of excavation and lining, the clear cross-sectional area shall not be less than the clear area of the circular section specified by the plans, and the invert shall be at a grade consistent with adjoining open cut construction.

Steel liner plates, bolts, and nuts shall be galvanized and conform to the material and fabrication requirements of the American Railway Engineering Association Manual Recommendations. Liner plates shall be as manufactured by Commercial Shearing, Armco, or other approved equal. The design and shape of the tunnel liner plates shall be such that assembly can take place entirely from within the tunnel liner. The minimum outside diameter shall be four feet (4') and the minimum wall thickness shall be United States Standard Gauge 12(0.1046 inches). Sufficient sections shall be provided with one and one-half inches (1 1/2") or larger grouting holes located near the center of the section so that when the plates are installed there will be one line of holes on either side of the tunnel and one at the crown. The holes in each lines shall not be more than nine inches (9") apart and shall be staggered unless approved otherwise. Bolts and nuts shall conform to the applicable portions of A.S.T.M. Designation A-153, A-307, A-325 and A-449.

Excavation of the tunnel shall be by approved methods consistent with the material encountered. The sewer in the area to be tunneled shall be completed before the construction of adjacent portions of the same sewer so minor adjustments can be made in the adjacent sewer to compensate for slight discrepancies in alignment or grade which may occur in the tunnel construction. The liner plates shall be installed and assembled as the tunnel is excavated. The liner plates shall be installed such that the longitudinal joints in adjacent rings will be staggered. Longitudinal joints and circumferential joints shall all be bolted joints. The excavation shall be accomplished in such a way that will prevent disturbing overlying material. Care shall be taken to maintain alignment grade and circular shape of the tunnel when the liner plates are installed. All voids between liner plates and surrounding earth shall be filled with grout forced in under pressure. The grout shall consist of two parts of sand to one part of Portland Cement mixed with sufficient water to maintain a freely pouring consistency. Grouting holes shall be plugged as soon as the voids are filled in that section to prevent the grout from flowing back out. The lining shall be cleaned of all debris after its installation is complete, and all leaks which allow water to flow or seep into the tunnel shall be plugged. Redwood or other approved preservative treated wood skids shall be secured to the barrel of the sewer pipe with metal bands in such a manner to support the weight of the pipe along its full barrel length on the wood skids without any of the weight supported by the pipe bell and in such manner as required to properly position the sewer to the specified elevations and alignment. The annular space between the sewer pipe and the tunnel liner shall be filled with sand from end seal to end seal after the sewer pipe has been permanently placed in the tunnel, tested and approved, in such a manner such as not to disturb the alignment or grade of the sewer pipe. Brick masonry end seals eight inches (8") in thickness shall be constructed on each end of the tunnel after the sewer pipe has been installed, tested and approved. Brick, mortar, and construction requirements shall conform to the same requirements as specified for brick manholes.

11. **Sewer Installation by Boring and Jacking Methods.** - Steel casing or sewer pipes shall be installed by boring and jacking methods where specified by the plans. Steel casing for bored and jacked construction shall be steel pipe conforming to A.S.T.M. Designation A-139 with a minimum diameter as shown on the plans. Steel shall be Grade B under railroads and Grade A on all other uses. Steel pipe shall have welded joints in accordance with A.W.W.A. C-206 and shall have minimum wall thickness as indicated in the following table:

Diameter of Casing - inches	Nominal Wall Thickness - inches	
	Under Railroads	All Other Uses
16	0.282	0.188
18	0.312	0.250
20	0.344	0.250
22	0.375	0.250
24	0.406	0.281
26	0.438	0.281
28	0.469	0.312
30	0.469	0.312
32	0.500	0.312
34	0.531	0.312
36	0.531	0.344
38	0.563	0.375

Excavation shall be completed by approved methods applicable to the materials encountered. The sewer in the area to be bored and jacked shall be completed before the construction of adjacent portions of the same sewer so minor adjustments can be made in the adjacent sewer to compensate for slight discrepancies in alignment or grade which may occur in the boring and jacking process. Boring and jacking operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. The casing or pipe shall be jacked as the boring proceeds. Boring without simultaneous jacking of the casing or pipe will not be permitted.

The steel casing or sewer pipe shall be cleaned of all debris after its installation is complete. Redwood or other approved preservative treated wood skids shall be secured to the barrel of the sewer pipe with metal bands in such a manner to support the weight of the pipe along its full barrel length on the wood skids without any of the weight supported by the pipe bell and in such manner as required to properly position the sewer pipe to the specified elevations and alignment. Other types of casing spacers may be submitted for approval by the engineer. The annular space between the steel casing and the sewer pipe shall be filled with sand from end seal to end seal after the sewer pipe has been permanently placed in the casing, tested and approved, in such a manner such as not to disturb the alignment or grade of the sewer pipe. Brick masonry end seals eight inches (8") in thickness shall be constructed on each end of the casing after the sewer pipe has been installed, tested and approved. Brick, mortar and construction requirements shall conform to the same requirements as specified for brick manholes.

12. **Reinforced Concrete Encasement.** - Reinforced concrete encasement shall be constructed to conform to detail drawings. Concrete and reinforcing steel used in the construction of reinforced concrete encasement shall conform to the requirements as specified in the project specifications for "Concrete". Reinforced concrete encasement

constructed on clay pipe shall begin and/or terminate at joints in the pipe when the encasement does not start or stop at a manhole. The encasement shall start or terminate in such a manner as will maintain the flexibility of the joint in the clay pipe.

13. **Building Sewer Lines.** - Any work involved with building sewer lines shall be completed in conformance with the applicable sections of the City Code. Permits must be taken out for any work on building sewer lines. Such permits are obtained from City Hall.

The Contractor will be required to pay normal fees for sewer taps.

14. **Pipe Stub-Outs.** - Pipe stubs with temporary pipe plugs shall be installed in manholes when shown by the plans or when directed by the Engineer to facilitate connection of building service lines. Stubs shall be Schedule 40 P.V.C. pipe meeting ASTM D178S. All joints shall be elastomeric. Gasketed caps shall be used with seals that meet ASTM D3212.
15. **Pipe Removal.** - All concrete and corrugated metal pipe shall be removed by such methods that damage to the pipe during removal operations shall be prevented. Salvageable pipe shall be transported and stored at City material yards as directed by the Engineer. The trenches from removing pipe shall be backfilled and compacted to the specified density. Pipe having no salvage value shall be disposed of by the Contractor without additional cost to the City.
16. **Clearing Right-Of-Way.** - When clearing of right-of-way is a part of the contract as shown by plans or contract bid items, the bid price shall include all costs of removing obstructions; clearing trees, shrubs, vegetation and rubble; and all other necessary work to prepare the project site for new construction regardless of whether or not the work is specifically shown on the plans. The Contractor shall obtain the Engineer's approval prior to removing any trees. No other payment shall be made for any necessary removal and clearing work to prepare the project site for new construction, unless provisions have been made for additional payment.
17. **Fence Removed and Replaced.** - Existing fences shall be removed at locations as shown by plans. Existing fence shall be replaced and/or relocated at locations as shown by plans or as ordered by the Engineer. Existing fence unsuitable for re-use shall be replaced with new fence of the same type. All fences shall be replaced in a condition at least equivalent to the existing fence prior to removal. .
18. **Hedge and Tree Removal.** - Hedge and trees designated for removal or located within the limits of construction shall be removed and disposed of as directed by the Engineer. All roots two inches (2") or larger in diameter shall be removed to a depth of two feet (2') below the bottom of structures, slabs and pavements; one foot (1') below the finished elevation of graded areas. Hedge and trees not directly interfering with construction or grading shall be carefully preserved insofar as is possible.
19. **Fertilizing and Seeding.** - This work shall consist of furnishing and distributing fertilizer and furnishing and planting grass seed. The work shall also include the preparation of the ground for planting. Fescue K-31 grass seed shall have a germination period of fourteen (14) days, a purity of ninety percent (90%) with eighty-five percent (85%) germination, and seventy-six and five tenths percent (76.5%) sproutable seed. Fertilizer shall contain a minimum of twelve percent (12%) Nitrogen, twenty-four percent (24%) Phosphorous, and twelve percent (12%) Potassium unless indicated otherwise by the Plans or Proposal.

Fescue K-31 grass seed shall be planted at a minimum rate of two hundred fifty (250) pounds per acre unless indicated otherwise by the plans. The seed supplier shall furnish a certified statement for the seed furnished stating the purity percent, germination percent

and the sproutable seed percent. Sproutable seed is the product of the percentage of purity and the percentage of germination.

The seed shall be new crop seed complying with and labeled in accordance with U.S. Department of Agriculture rules and regulations under the Federal Seed Act in effect at the time of purchase. All seed shall be furnished in standard containers. Seed which has become moldy, wet or otherwise damaged in transit or storage will not be accepted. Seed shall be stored in a cool dry place.

Fertilizer shall be distributed at a minimum rate of three hundred fifty (350) pounds per acre unless indicated otherwise by the plans. Fertilizer shall be of commercial grade uniform in composition, free flowing and suitable for application with approved equipment. Fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable State Fertilizer Laws, and bearing the same trade name or trade mark, analysis and warranty of the producer.

All grassed areas disturbed by the construction of the improvements under this contract shall be replanted with grass, except where otherwise indicated by the plans or contract. The Engineer may designate local areas of desirable native perennial grasses not to be replanted. Areas of annual grasses such as cheat, crab grass, tripleawn, etc., shall be destroyed by thorough disking and then replanted using the specified seed.

The areas to be planted shall be prepared for planting by cultivation, removal of all objectionable material and filling of gullies or depressions. The soil preparation shall be accomplished by disking, harrowing and firming. The minimum depth of the soil preparation shall be three inches (3"). Existing weed stubble, small weeds and grass which can be disked, shall be cut by the disk and completely incorporated into the soil. Several diskings and harrowings may be required on some areas to provide a satisfactory seed bed. Areas inaccessible for disking and harrowing shall be prepared by hand methods. The minimum depth of preparation for the seed bed where hand methods must be employed shall be two inches (2").

Fertilizer shall be distributed uniformly over the area to be seeded. The fertilizer shall be incorporated into the soil to a depth of at least two inches (2") by disking and harrowing. Fertilizer may be distributed by means of an approved seed drill which is equipped to sow seed and distribute fertilizer in one operation.

The two general seeding seasons shall be (1) Spring Seeding, February 15 to April 20, and (2) Fall Seeding Season, August 15 to September 30. The permissible seeding periods for various seeds may be extended to a few days in special cases when mulching is specified to follow the drilling of seeds and fertilizer.

The Engineer reserves the right to delay the drilling or seeding of seeds or to vary the permissible seeding season listed above due to weather or soil conditions or for other causes.

Seeds shall be uniformly distributed with acceptable drills, hydraulic-slurry, or other equipment approved by the Engineer. Broadcasting with a standard grass seeder will be required on areas where it is impossible to operate a drill and this method may also be required for certain small seeds.

When a standard drill with fertilizer attachment is used, certain mixed seeds may be placed in the seed box and the fertilizer placed in the fertilizer compartment. Both may be applied during one (1) operation, unless notes on the Plans required separate applications. Fertilizer may be drilled into the soil or applied by hydraulic-slurry. Broadcasting fertilizer is permissible on rough, rocky slopes where drills cannot operate.

All drills shall be fully adjustable so that they will deliver the seeds and fertilizer at the rates specified on the Plans or ordered by the Engineer. Drills that are in poor repair or that do not deliver the seeds and fertilizer uniformly in each drill furrow, shall not be used. Drills shall be adjustable so that the seeds can be planted and covered not to exceed one-half inches (1/2") deep.

Most of the seed should be drilled about one-half inch (1/2") deep in a well-prepared and firm seedbed. When the fertilizing and seeding operations start on an area, that area shall be completed as soon as possible. No seeding shall be done during windy weather or when the ground is wet or otherwise non-tillable. The grass seed shall then be covered, using a flexible toothed weeder or other suitable equipment.

As soon as this covering operation has been completed, the seeded area shall be rolled again with the Culti-packer, the Culti-packer being run over the area only once parallel with the contours of the ground.

The grassed area shall be protected against traffic or other uses immediately after planting. The Contractor shall be responsible for the proper care of the grassed area until all work on the entire Contract has been completed and accepted, or a minimum period of thirty (30) days, whichever is the longest duration.

If planting is the last item of work that can be done during the current season, but items of work in the same Contract are to be done during the following planting season, the Contractor will be relieved of maintaining the accepted areas after completing all work in connection with seeding as shown on the Plans or required in these Specifications. All planted areas shall be growing when accepted.

20. **Mulching.** - This item shall consist of the furnishing and placing of hay mulch, the purpose of which is to retard erosion on slope areas and to improve the physical condition of the soil so that plant growth will become established more readily.

The materials for this item shall be either Prairie Hay or Bromegrass Hay, or other materials approved by the Engineer. Prairie hay shall consist chiefly of the Bluestem grasses. Switchgrass, Indian grass and other desirable native perennial grasses which are normally growing in Bluestem pastures. Mulching material shall be free of field bindweed, Johnson Grass, Hoary Cress or Russian Knapweed. Areas to be mulched shall be as indicated on the plans or as ordered by the Engineer.

Machines for distributing hay mulch shall be approved by the Engineer prior to use and shall be maintained in good operating condition. Distributing machines for hay mulch shall be constructed for this purpose and shall include a blower for the hay. Sufficient power shall be provided on the machine to operate the hay blower in such a manner that the hay can be distributed over the designated areas at the required rate with a single pass of the machine. The machine shall be provided with an operating platform large enough to accommodate an operator and a supply of hay. Hay blowing distributing machines shall not be used in areas where blowing hay dust would be objectionable to adjacent properties. Such areas shall be mulched using hand methods as prescribed for small areas and/or steep slopes.

The mulching material as specified or permitted shall be placed over the designated areas after seeding and fertilizing has been completed. The mulching material shall be spread

uniformly over the areas to the thickness of approximately one and one-half inch (1-1/2") loose measurement. This application rate normally will require approximately two (2) tons of hay per acre. The mulching material shall be disked or punched into the soil so that it is partially covered. The disking operation shall be performed longitudinally with a mulching tiller. Several trips over the mulched areas will be necessary to work part of the hay into the soil, especially if heavy weights are not used on the tiller. Care should be exercised to obtain a reasonably even distribution of hay partly incorporated into the soil.

Hay mulch shall be "patted" with forks as it is placed in areas which require mulching by hand because the areas are too small or the slopes are too steep for disking. Soil from these areas shall be placed on top of the mulch to reduce loss due to wind. Cloddy soil shall be placed over these areas on an average of approximately one shovelful of soil to each twenty-five (25) square feet of area.

The stem length of the hay mulch material is important in order for the mulch to intertwine and bind together. Short-stemmed mulching material is much more vulnerable to wind action than long-stemmed mulching material. When hay mulch is applied with a blower, it may be necessary to remove some of the cutting knives to prevent cutting the mulch stems too short.

The Contractor shall arrange his work so that the mulch can be placed and disked immediately after each area is seeded. Mulching operations shall not lag behind seeding operations more than twenty-four (24) hours during clear weather. When rain is threatening, the Contractor shall make every effort to mulch areas the same day on which they are seeded. Mulch shall be replaced before seeds germinate in remulching wind or rain-damaged areas.

21. **Removal and Replacement Work General Requirements.** - Natural obstructions and publicly owned existing facilities and improvements encountered during construction shall be removed, relocated, reconstructed or worked around as herein specified, regardless of whether or not their existence or location is shown or noted on the plans. Care shall be used while excavating, trenching or performing other work adjacent to any facilities intended to remain in place and, except as otherwise specified, the Contractor shall be responsible for any damage to publicly and privately owned items. Any repairs required shall be promptly made at the Contractor's expense. All work done in connection with removal and relocation shall be carefully done in accordance with accepted practices so as to result in the maximum salvage of materials for re-use. All salvaged materials shall be disposed of by the Contractor without additional cost to the City. Waste materials shall be disposed of in a satisfactory manner at approved locations without additional cost to the City. No separate or additional payment will be made for any work in connection with removal, relocation or restoration of obstructions and existing facilities unless provided otherwise by contract or plans. All pavement, curb and gutter, sidewalks and other surface obstructions within the site boundaries shall be removed when and as directed by the Engineer.
22. **Public and Private Utility General Requirements.** - The locations of all utilities shown on plans represent the best information available but such locations are not guaranteed by the City or the property owner. The Contractor shall make every reasonable effort to ascertain locations of public and private utilities. The Contractor shall notify the affected parties so that proper arrangements can be made for the prompt repair and restoration of service when any utilities are unexpectedly encountered and damaged. Public and private utility facilities which interfere with construction shall be bypassed or worked around by hand excavating, tunneling or other approved methods. Where it is not practicable to bypass or work around the facility, the Contractor shall notify the affected utility owner so

that provisions for the removal or relocation of such facilities can be made. The Contractor shall notify all affected utility companies in advance of construction operations in areas where public or private utilities may be encountered.

Section VI. Concrete Mix Design

1. **Cement** - Cement shall meet the requirements of the Standard Specification for Portland Cement, A.S.T.M. Designation C150, except that the total Alkalies ($\text{Na}_2 + (0.658 \times \text{K}_2\text{O})$) shall not exceed 0.60 percent, the 28 days compressive strength shall not be less than 3,500 pounds per square inch, the time of set shall be determined by the Gilmore test, and the maximum value of fineness as tested by the air permeability test shall not exceed 3,700 square centimeters per gram.

Type I cement may be used for all cement work. Cement of different types shall not be mixed during storage or used alternately in any one part of a structure. Cement shall be stored in railroad cars or in other suitable moisture-proof storage. Caked or reclaimed cement shall not be used. The cement supplier and the concrete producer shall certify in writing that the cement used conforms to the required chemical and physical properties. The City reserves the right to sample the cement at the concrete production site and to test it to verify the certification.

2. **Fine Aggregate** - Fine aggregate to be used in concrete shall consist of natural sand resulting from the disintegration of siliceous and/or calcareous rocks and manufactured sand produced by crushing predominantly siliceous materials and shall be uniformly graded from coarse to fine. This type of aggregate shall be free from injurious amounts of organic impurities and from injurious amounts of alkali. Other deleterious substances shall not exceed the following percentages by weight:

Material passing No. 200 sieve	2.0
Shale, lignite, coal, soft, or flaky fragments	1.0
Sticks (wet)	0.1
Clay lumps (wet, on No.4 sieve)	0.25

Fine aggregate shall meet the following gradation requirements when tested as specified by A.S.T.M. Method C 136:

Retained on 3/8 inch sieve	0%
Retained on No. 4 sieve	0% - 5%
Retained on No. 8 sieve	0% -20%
Retained on No. 16 sieve	15%-50%
Retained on No. 30 sieve	40%-75%
Retained on No. 50 sieve	70%-95%
Retained on No. 100 sieve	90%-100%

The fine aggregate shall have a fineness modulus of not less than 2.50 or more than 3.40 and the percent retained between any two consecutive sieves shall not be exceed 25%.

Fine aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 24 hours before using to produce concrete. The City reserves the right to sample fine aggregate at the concrete production site and to conduct tests to verify that the aggregate meets the specified requirements.

3. **Coarse Aggregate** - Coarse aggregate to be used in concrete shall consist of gravel, crushed gravel, crushed stone or a combination thereof conforming to the requirements prescribed in A.S.T.M. C-33, or the latest revision thereof, except that the percentage of wear shall not exceed forty percent (40%) as tested by the Los Angeles Abrasion Test Method and the loss shall not be more than eighteen percent (18%) as tested for soundness by the magnesium sulfate method. Coarse aggregates used in concrete mixes shall have maximum absorption of three and five tenths percent (3.5%).

Grading requirements shall be size No.67, 3/4" to No.4

Retained on 1" mesh sieve	0%
Retained on 3/4" mesh sieve	0% to 10%
Retained on 3/8" mesh sieve	45% to 80%
Retained on No. 4 mesh sieve	90% to 100%
Retained on No. 8 mesh sieve	95% to 100%

Aggregate shall be placed in stock pile not less than 48 hours in advance of being used in the concrete mixtures. Moisture shall be controlled in stockpiled coarse aggregate during the Summer such that the coarse aggregate will contain a uniform amount of free moisture. Materials shall be accurately weighed into separate trucks or into separate batch compartments in a truck. Batch compartments shall be so constructed or protected that cement will not blow off the truck while being transported to the mixer in the street and so that none of the materials in the batch remaining in the truck shall be allowed to spill over into the first batch being discharged from the truck. The City reserves the right to sample the coarse aggregate at the concrete production site and to conduct tests to verify that the aggregate meets the specified requirements.

4. **Proportions** - Concrete to be used in the construction of concrete base course shall contain six and six-tenths (6.6) sacks of cement per cubic yard of concrete minimum; a maximum water content, including surface moisture, but excluding water of absorption of the aggregates of five and five-tenths (5.5) gallons per sack of cement. Fine and coarse aggregate shall be combined in such proportions that the limits of the total aggregate retained on the No. 4 mesh sieve will be a minimum of thirty percent (30%) and a maximum of fifty percent (50%). The maximum permissible slump shall be three and one-half inches (3-1/2"). Concrete to be used for concrete base course construction shall not contain air-entraining admixtures.

The Contractor shall be responsible for the design and the proper combinations of aggregates, cement, and water within the limits of these specifications to produce the best possible mix. The Contractor or cement producer shall furnish to the Engineer in writing all criteria used in the mix design for each type of concrete including, but not limited to, to saturated and surface dry specific gravity of the individual aggregates, the dry and rodded unit weights of the individual aggregates, the percent by volume of the individual aggregates, the fineness modulus of the individual aggregates, the type of mix, the water content, the design slump, the theoretical weight per cubic foot of the concrete, the

gradation of the individual aggregates, the percent by volume of entrapped and/or entrained air, the design moisture condition of the individual aggregates, the quantity of air entraining admixture per cubic yard to produce the design air entraining, the gallons of water to be added per cubic yard of mixed concrete, and the batch weights of aggregate and cement per cubic yard of mixed concrete. The batch weights of the aggregates and the quantity of water in the design mix shall be adjusted to correspond with the moisture condition of the aggregates at the time the concrete is produced. The Engineer shall require the Contractor or concrete producer to redesign any concrete mix when the fineness modulus of the aggregates varies plus or minus 0.20 from the fineness modulus of the aggregates used in the original mix design.

- 5. Mixing** - All proportioning shall be done at a central proportioning plant in which measurements is by weight. If bulk cement is used, 376 pounds shall be used as equivalent to one barrel. The ingredients of the concrete shall be thoroughly mixed and the consistency of concrete shall be determined by the Standard Method of Slump Test for Consistency of Portland Cement Concrete, A.S.T.M. C-143-58. The concrete shall be mixed in quantities required for immediate use. Concrete shall not be used which has developed initial set or is not in place one-half (1/2) hour after the water has been added. Retempering concrete by adding water or by other means will not be permitted. The maximum desired slump shall be three inches to be used in concrete base construction, and the maximum slump shall be three and one-half inches.

The concrete shall be mixed not less than sixty (60) seconds. When double compartment mixers are used, the minimum mixing time in the first compartment shall be thirty (30) seconds and the total mixing time, including transfer time, shall not be less than sixty-five (65) seconds.

The concrete may be mixed by a paving mixer into which the material, including the water, can be precisely and regularly proportioned, and which will produce a concrete of uniform consistency in order and the materials thoroughly and uniformly mixed.

The paving mixer shall be equipped with a batch meter and automatic locking timing device. The water tank shall be equipped with a scale graduated in gallons and fractions thereof. The water measuring device shall be capable of accurate measurement to within one (1) percent of the required amount. The paving mixer shall be equipped with a boom and bucket, full power controlled, which shall be so operated that the batches may be uniformly distributed on the subgrade.

All equipment used to produce, mix and transport concrete shall conform to the applicable portions of Section 401 of the 1990 Kansas State Department of Transportation Standard Specifications. Transit mixed concrete may be used for all work in lieu of a paving mixer. Concrete mixed in transit shall conform to the applicable requirements of sub-section 402.07 of the 1990 Kansas State Department of Transportation Standard Specifications.

Concrete used in base course construction shall develop a compressive strength of not less than three thousand five hundred (3,500) pounds per square inch in twenty-eight (28) days. Flexural strength shall be determined according to the Standard Method of test for Flexural Strength of Concrete A.S.T.M. Designation C78-57. Conversion factor used in estimating compressive strength based on results of flexural tests shall be determined by the Engineer consistent with materials used.