CITY OF JENKS

DESIGN CRITERIA
AND
TECHNICAL SPECIFICATIONS

for

Streets, Drainage, Detention,
Earth Change, Sanitary Sewer, Water Systems
Jenks, Oklahoma

2009

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RESOLUTION NO. 45

RESOLUTION TO ADOPT DESIGN CRITERIA AND
TECHNICAL SPECIFICATIONS FOR STREETS, DRAINAGE,
SANITARY SEWERS, AND WATERWORKS FOR THE CITY OF
JENKS, OKLAHOMA.

WHEREAS, the Jenks City Council on August 20, 1973 did adopt Design Criteria for Paving and Drainage Projects; and

WHEREAS, the Jenks City Council on August 23, 1973 did adopt Design Criteria for Sanitary Sewerage and Waterworks; and

WHEREAS, the Jenks City Council on June 2, 1975 did adopt Pavement, Storm Sewer and Open Ditches and Sidewalk and Driveway Specifications;

WHEREAS, there exists a need to revise the above Design Criteria and Specifications; to regulate the improvement in subdivisions of land in the City of Jenks; and

WHEREAS, the City Engineer of the City of Jenks has submitted for adoption Design Criteria and Technical Specifications for Streets, Drainage, Sanitary ***Sewer*** and Water Systems;

NOW, THEREFORE, BE IT RESOLVED by the Jenks City Council that Design Criteria and Technical Specifications for Streets, Drainage, Sanitary Sewer, and Water Systems be adopted as amended to regulate subdivision improvements in the City of Jenks, Oklahoma.

BE IT FURTHER RESOLVED that former Design Criteria for Sanitary Sewer and Waterworks and Pavement, Storm Sewer, and Open Ditches and Sidewalk and Drainage Specifications of the City of Jenks are hereby repealed and these regulations shall take effect this 16th day of June, 1980, provided that all plats now pending approval shall be processed under the former Design Criteria and Specifications.

APPROVED BY THE CITY COUNCIL OF THE CITY OF JENKS, OKLAHOMA, THIS 16TH DAY OF JUNE 1980.

R.E. O'Donley
Mayor

Attest:
Bernice Foster
City Clerk

John Gerkin
City Attorney

CITY OF JENKS

DESIGN CRITERIA

AND

TECHNICAL SPECIFICATIONS

FOR

STREETS
DRAINAGE
DETENTION
EARTH CHANGE
SANITARY SEWER
WATER SYSTEMS

1.0 DESIGN CBITERIA FOR DRAINAGE, DETENTION, STREETS AND EARTH CHANGE

1.1 General:

1. Where, on a particular tract, the standards and specifications set forth herein are not necessary or applicable by reason of topography, soils or other conditions peculiar to such tract, other standards may be used with the prior approval of the City Engineer.
2. For any item of work not covered by the adopted standards and specifications of the City of Jenks, the Consulting Engineer shall include two copies of design, specifications and/or special provision with his first submittal for review and approval by the City Engineer.
3. Approval of the plans by the City Engineer does not release the Consulting Engineer from his responsibility to meet the planning and design of the project as required by the City Engineer and/or other departments of the City, the safety and welfare of the public or regulations of State of Oklahoma and the Federal Government.
4. All of the plan sheets and the cover sheet of the calculation report shall be signed, sealed and dated by a Professional Engineer, registered in the State of Oklahoma, prior to submitting the plans to the City Engineer for review.
5. Directly above the title block and signature of the Professional Engineer, registered in the State of Oklahoma, the first sheet of the plans shall contain the following statement:
   "I hereby certify that I am familiar with the adopted ordinances and regulations of the City of Jenks governing drainage, streets, detention and flood plains; that these plans have been prepared under my direct supervision; the above and foregoing drainage plans comply with all governing ordinances and the adopted standards of the City of Jenks pertaining to drainage, detention and earth change to the best of my knowledge, information, and belief."
6. All developments with private streets and drainage facilities shall contain the following statement on the first sheet of the plans directly above the title block and signature of the Professional Engineer, registered in the State of Oklahoma. "These plans comply with all governing ordinances and the adopted criteria of the City of Jenks pertaining to drainage, streets, detention and earth change to the best of my knowledge, information and belief."

1.2 Drafting:

1. Construction plans shall be drawn with black India ink on a transparent reproducible medium (paper velum, linen or Mylar, matte both sides).
2. Sheets shall be 34" wide by 22" high having a margin of 1½" along the left border and ½" along the top, bottom, and right border.
3. North shall be oriented to the top or right hand side of all sheets.
4. A Title Block shall be located in the lower right hand corner of each sheet. Each Title Block shall contain the following information: City of Jenks, Oklahoma, Subdivision Name, Sheet Title, Sheet Number of Total sheets, Consulting Engineer's name and address.
5. All line work shall be of sufficient density to be reproducible by current reproduction processes. Any line work which does not reproduce satisfactorily may be cause for the rejection of the plans by the City Engineer.
6. Freehand lettering shall be no smaller than the No. 4 setting on the Ames lettering guide (0.12" minimum height). Mechanical lettering shall be at least comparable to the 100 Leroy guide (0.10" minimum height) except mechanical lettering on plats or records reproduced in the plans may be comparable to the 80 Leroy guide (0.08" minimum height). Typing shall be at least 0.10" minimum height. Adhesive or transfer lettering shall have a minimum height of 0.10". These lettering sizes are minimum. Sizes greater than these are desirable and suggested.
7. "Record" drawings shall be either India ink or linen, 3 mil Mylar, or paper velum, or black line auto-positive reversed matte both sides. (Diazo processes will be acceptable). "Stick-on" will not be acceptable.

8. The sheets shall be arranged in the following order:
    a. The front sheet shall contain topography (maximum 2' contour intervals), Title Block, north arrow, scale, index to sheets, street layout, lot layout, off site adjacent structures, location map, description, symbol legend, owner's and consulting engineer's name, address, & telephone number, bench mark, Professional Engineer's PE seal and signature and certified statement.
    b. Preliminary clearing, leveling and grading plan identifying areas where erosion and sediment control is needed.
    c. Soils map, type of erosion and sediment control measures needed, a timing schedule indicating the anticipated starting and completion dates and the developments construction sequence.
    d. Drainage areas for inlet design with flow arrows indicating areas, Q100, Q15 and time of concentration. Summation tabular column of drainage areas and flows to respective inlet.
    e. Layout of streets with stations, cul-de-sacs, elbows, and intersections numbered with cross reference to plan details.
    f. Storm sewer layout (may be included with paving plans).
    g. Final grading plan showing final grades and minimum pad elevations for lots close to sump areas, for areas where pad is lower than the curb, and for lots adjacent to floodplain areas, permanent erosion and sediment control practices.
    h. Large scale drawing of cul-de-sacs, intersections, elbows showing drainage system.
    i. Detention pond(s) showing existing and proposed topography cross sections through the pond including 5 and 100 year water levels, details of inlet and outlet structures, a back water profile for the existing and proposed topography if located in a floodplain area subject to mapping and indicate if privately or publicly maintained.
    j. Details of structures, both standard and special.
    k. Drawings of all dam structures.

1.3 Bench Marks:

1. All elevations shown on the plans shall be based on USGS or USC&GS datum.
2. The permanent bench mark location and description used to extend level datum to the projects shall be noted on the front sheet of the plans.
3. All temporary bench marks used for control of the project shall be designated on the plans stating elevation, location and description. The nearest such bench mark shall be shown on each sheet.
4. Prior to commencement of construction, a permanent bench mark shall be established on the project. This permanent bench mark will be a brass cap set in concrete. The location, description and elevation of the permanent bench mark shall be shown on the front sheet of the plans.
5. Level notes shall be provided to the City Engineer for all permanent and temporary bench marks. All level notes shall be of closed loop survey.

1.4 Typical Sections:

1. Typical sections shall be drawn with the horizontal and vertical scale noted for each.
2. Typical sections shall show dimensions, type of materials, layer details, reserve topsoil, temporary and permanent erosion control, compacted thickness, etc.
3. All typical sections or notes that are necessary to clearly reflect the design shall be included.

1.5 Cross Sections:

1. Cross sections may be required by the City Engineer as a part of the construction plans when necessary to reflect more clearly the intent of the design.
2. All cross sections for street rights-of-way shall be drawn to scale showing existing ground and proposed construction from building line to building line.
3. Typical cross sections shall be shown for each street if' the slope to the property line exceeds one quarter inch per foot.
4. Each section shall be stationed clearly.

5. The beginning and ending points of a project shall be stationed and cross sections for both the stations shall be drawn.
6. Maximum distance between cross section stations shall be 100' when ¼" per foot of slope to the right-of-way is exceeded.
7. Sufficient information shall be furnished to show that water is not ponded behind curbs or in ditches.
8. Scale for cross sections shall not be less than:

   Channels 1" = 10' Horizontal 1" = 5' Vertical

   Streets 1" = 5' Horizontal 1" = 5' Vertical
9. Cross section will be required on plans at center line of each lot when the slope to the right- of-way exceeds twelve (12) percent.

1.6 Plan Sheets and Profiles:

1. All property lines shall be shown, dimensioned and locations referenced thereto. This includes rights-of-way, easements, building lines, etc.
2. All intersections, cul-de-sacs, and other critical locations shall be shown in large plan detail, including direction of drainage, top of curb elevation at PC's, PT's and high or low points. All curve information shall be shown in detail.
3. All drainage areas shall be clearly marked on the drainage area plan sheet; showing acreage, runoff and offsite pickup points.
4. A site plan showing proposed locations and elevations of all sanitary sewer and water system improvements shall accompany the street and storm sewer plans.
5. The profile may be either three separate profiles or one single profile.
   a. Three separate profiles: When using three separate profiles, the top and bottom shall show existing property line and proposed top of curb. The middle profile shall show only existing center line profile. Stationing shall be along center line.
   b. One single profile: When using one single profile both property lines shall be shown along with the proposed top of curb. The center line profile shall not be shown. Stationing shall be along center line.
6. All fill areas within the street right-of-way and beneath storm drainage structures, shall be cross hatched on the profile and notation shall be made that the fill area shall be compacted to a minimum of 95% standard proctor density.
7. A list of construction pay items and estimate of quantities shall be shown on the plans.
8. Curb returns with elevation shall be clearly labeled on profile.
9. Vertical curves in profile shall give the top of curb elevation at the PC, PI, PT and high or low point, and all other curb elevations at a minimum of 50' intervals.
10. All structures (manholes, junction boxes, inlets, headwall, etc.) shall be numbered and labeled both in plan and in profile and detailed on plans.
11. Scale shall not be less than 1"- 50' horizontal, and 1"- 5' vertical on profile sheets. Minimum scales shall be 1"- 100' on plan sheets.
12. Storm sewer lines shall be identified on both plan and profile sheets by letter or number.

1.7 Streets:

1. The centerline of paving shall be the centerline of right-of-way where dedicated. All other cases shall be determined by the City Engineer.
2. The minimum grade set along the curb shall be .5%. The maximum desirable grade for non-arterial streets shall be limited to 8%. For situations where the topography is unusually hilly, grades will be permitted up to a maximum of 15% providing they do not exceed 500-feet in length from PT to PC.
3. The grade of the curb returns will continue for the full arc on all intersections where a midway opposing break is not provided.
4. Sag vertical curves shall be designed according to ASSHTO Specifications using the criteria of headlight site distance and drainage control. Crest vertical curves shall be designed according to the current

ASSHTO Specifications using the criteria of safe stopping sight distances.

5. Vertical curves shall be the minimum length available for the two grades entering into a sump area as defined by the ASSHTO publication titled, "A POLICY ON DESIGN OF URBAN HIGHWAYS AND ARTERIAL STREETS".
6. Design speed shall be 25 miles per hour on all residential streets and 40 miles per hour on all collector streets.
7. The minimum centerline radius on street alignment shall be 125 feet for minor residential and 300 feet for collector residential.
8. The minimum radius on returns at residential intersections shall be 25 feet. At intersections of a residential and arterial street the minimum radius on returns shall be 30 feet. The minimum radius on the returns for industrial districts shall be 40 ft.
9. Soil tests will be required for all areas to be paved. Soil tests will be submitted to the City Engineer for approval. If soil tests indicate that the soil has a plasticity index of 10 or greater, a minimum of 6" of subgrade shall be modified with a minimum of 5% lime by weight. If the soil tests indicate that the soil is granular and unstable, the method of stabilization shall be approved by the City Engineer. If desired, subgrade may be built of an approved borrow material.
10. The maximum grade of a residential street when intersecting an arterial shall be 2% for a minimum of 100 feet from the curb line of the arterial. No vertical curve shall begin any closer than 50 feet from the curb line of the arterial. The maximum grade of residential streets at intersections shall be 4%.
11. Industrial pavement sections shall be a minimum of 10 inch asphaltic concrete or 8 inch PC Concrete. Residential pavement sections shall be a minimum of 6½ inch asphaltic concrete or 6 inch PC Concrete.
12. A proposed and existing profile shall be shown beyond the end of all dead end streets for a minimum of 200 feet to determine a satisfactory grade for future development.
13. Cross slope may be ¼ inch or 3/8 inch however, crown will be flattened off so never exceeds curb height.
14. All paving shall have concrete curbs unless approved otherwise by the City Engineer.

1.8 Structures and Specific Details:

1. All special structures will be detailed.
2. When standards are used, standard sheets shall be included as part of the project plans.
3. Special structures shall be drawn to scale unless noted otherwise.
4. Sufficient details, dimension and related notes shall be provided for all structures.
5. All structures subject to vehicular traffic shall be designed for H-20 loading.
6. All bridge design shall meet the requirements in the latest edition of Standard Specifications for Highway Bridges prepared by AASHTO.

1.9 Easement and Right-of-Way:

1. Easements and rights-of-way shall be clearly dimensioned on the plans.
2. All overland drainage easements will be shown on the "Plans" and "Final Plat", as well as described in the conditions and restrictions of the plat.
3. Additional overland drainage easements may require "Separate Instruments".
4. An unimproved drainageway left in a natural state shall be dedicated to the public either by title or easement, and platted with a minimum width equal to the floodplain width required to pass the 100 year flood. Dedicated drainageway shall be provided with adequate vehicular ingress and egress for maintenance purposes. If said drainageway width is less than 150' the minimum width required will be the floodplain plus an additional width of 15' on each side of the floodplain. A permanently visible monument shall be set on each property line at its intersection with the easement or right-of-way line to identify the limits of the drainageway. Said monuments to conform to adopted City Standards. Said dedication may have an ownerhsip reverter provision.
5. City may accept dedication of the entire floodplain area for an unimproved channel.
6. Adequate restrictive easements for dedicated right-of-way must be provided for access and maintenance.

7. The minimum width for all storm sewer easements shall be the outside diameter of pipe plus 10'. The pipe shall be laid in the center of easement.

1.10 Drainage:

1. All stormwater runoff shall be subject to review and approval by the City Engineer with regard to analysis, design, and construction of drainageway facilities and the appropriate public authority shall have the right to maintain or cause to be maintained the drainageway system for its intended purposes. Drainageway facilities, both public and private, shall consist of all elements necessary to convey stormwater runoff from its initial contact with the earth to its disposition in either the Arkansas River or Polecat Creek. The drainageway system, both public and private, shall consist of storm sewers (which are closed conduits); improved channels constructed in conformity with adopted City Standards; unimproved drainageways left in their natural condition; the areas covered by restricted drainageway easements for the purpose of providing overland flow; and all appurtenances to the above including inlets, manholes, junction boxes, headwalls, dissipators, culverts, etc. All portions of the drainageway system that exist on dedicated right-of-way or restricted drainageway easements shall be owned and maintained by the City of Jenks.
2. The stormwater collector system shall be designed to pass the runoff from a 100-year frequency rainstorm with full urbanization by one of the following methods:
   Pass minimum of 15-year frequency storm in a pipe network with overland flow capacities so that the combination of the two will pass the runoff from a 100-year frequency rainstorm under full urbanized conditions. Or to pass the entire 100-year flood in the pipe network. The overland flow portion of the collector system shall be confined to dedicated right-of-way, or restricted drainage easements to assure that stormwater can pass through the development without inundating the lowest level of any building, dwelling or structure.
3. The stormwater drainageway system shall be designed to pass the runoff from a 100 year frequency rainstorm under full urbanization. The entire flow shall be confined within the said stormwater drainageway system.
4. The "Rational Method of runoff analysis shall be used for the design of the closed pipe networks of the storm sewer system up to discharges of 400 cfs. For discharges over 400 cfs, a hydrograph method will be used.
5. Rainfall Intensity Curves prepared from TP-40 and National Weather Service HYDRO-35 (June 1977) shall be used for design when using the rational method.
6. The Oklahoma Department of Transportation Technical Manual dated April, 1970, shall be used for determining the basic "C" values. A weighted "C" value shall be determined with minimum values of .45 for residential, .65 for multifamily and .90 for industrial and commercial areas. Unplatted areas within 300' either side of arterial shall be either considered commercial or shall be in accordance with the comprehensive plan in estimating runoff coefficients.
7. The time of concentration (Tc) shall be determined by first reading the velocity from an approved slope-velocity graph and computing by the formula:

$$Tc = \frac{\text{Length of Reach (ft.)}}{\text{Velocity (ft./sec)}} \text{ divided by } 60 = \text{Minutes}$$

8. A maximum time of concentration of 10 minutes to the first inlet shall be used for single and multifamily residential areas.
9. A maximum time of concentration of 5 minutes to the first inlet shall be used for commercial and industrial areas.
10. The distance between inlets shall be determined so that gutter flow for the 15 year storm will not exceed a width of 5 feet per side. The water depth in the street on slopes shall not be deeper than the curb of the street for the 100 year design rainfall. Distance between inlets shall not exceed 600 feet. The water depth at sump locations shall not exceed more than 1' above the top of curb for the 100 year design rainfall.
11. Inlets at intersections shall be located in such a manner that no part of the inlet will encroach upon the

return. The flowline and top of curb elevations shall be on all inlets. Inlets shall not be placed on main storm sewer lines.

12. Where possible, runoff from large areas outside the roadway shall be collected before it reaches the roadway. Parking lots shall have internal drainage systems so as to reduce concentrated flow into streets.
13. Drainage areas and the 15 year and 100 year flows to the respective inlets shall be summarized and tabulated on the plans. The summary table shall also be a part of the calculations.
14. Grates and curb inlets shall be sized in accordance with Oklahoma Department of Transportation methods, or other methods approved by the City Engineer.
15. Gutter flow shall be computed by using the "Nomograph for flow in triangular channels", as published in the Hydraulic Engineering Circular No. 12, Federal Highway Administration.
16. Calculations for inlets, pipes and gutter flow shall be summarized.
17. Borrow ditches along arterial streets shall not exceed 3 feet in depth. Culverts shall be sized to handle the 15 year or larger storm.
18. All off roadway inlets up to 24" will be of the standard drop inlet design. The standard inlets larger than 24" may be used upon special review and approval by the City Engineer.
19. Manholes and catch basins shall be stationed on plan sheet using centerline of street stationing with left or right offset dimensions. Inlets with grates shall be stationed at the centerline of the grated section. Inlets without grates shall be stationed at the centerline of the throats.
20. Storm sewer systems shall be closed conduit up to 60" diameter pipe or its hydraulic equivalent. Stormwater drainageway systems that must carry a flow greater than the capabilities of a 60" closed conduit system may be a closed system, an improved channel constructed in accordance with adopted City Standards and adopted floodplain policies, or in accordance with adopted floodplain zoning ordinances.
21. Roughness coefficient for drainage design will be as listed in Tables 5-5 and 5-6, Figure 5-5, pages 109 through 123, of "Open Channel Hydraulics" by Ven Te Chow, published by McGraw-Hill Book Company, 1959.
22. Minimum Velocity in a drainageway system, having a roughness coefficient less than or equal to 0.015, shall be 2.5 fps to avoid sedimentation.
23. Pipes shall be sized using either Kutters or Mannings charts for the design flow. The slope used for design shall be the slope of the invert of the pipe.
24. No pipe shall be installed downstream having a diameter smaller than the pipe from which it is receiving water.
25. Concrete pipe shall not be less than C-76 Class III. Corrugated metal pipes shall meet Oklahoma State Highway Department gauge requirements for fill heights.
26. Junctions between different pipe sizes shall be made with the top inside of the downstream pipe no higher than the top inside of the upstream pipe.
27. A manhole or junction box shall be required at all changes of grade, changes in alignment, and junctions between two or more different size pipes.
28. The horizontal clear distance between pipes being placed in the same trench shall be a minimum of 2' or one-third the diameter of the largest pipe, whichever is greater. This would include multiple pipe crossings for culvert purposes.
29. Radius pipes will not be used on storm sewers.
30. Manholes of 4'inside diameter shall be used whenever possible. If the diameter of the manhole exceeds 4', junction boxes will be used. Junction boxes must be used whenever manholes cannot be used. The rim elevation shall be indicated on all manholes and junction boxes. Manhole and junction boxes may be masonry precast or cast in place.
31. Drainage pipes shall not enter manholes within the Corbel (neckdown) section. The size of pipe entering or leaving a 4' diameter manhole shall not exceed 24".
32. A minimum of 6" cover shall be provided over pipes and box culverts to the bottom of the sub-grade beneath streets except when box culverts are built with the top at grade and structurally designed to withstand H-2O loading.

33. All storm sewers shall be shown in profile, showing flowline, size, type, grade and design discharge. Profiles shall show the natural and proposed ground line at the center line of the storm sewer.
34. The critical depth of flow in culverts shall not be exceeded.
35. Box culverts and bridges shall have adequate capacity to pass 100 year fully urbanized flows with 1' freeboard. Backwater analysis shall be provided by the consulting engineer to illustrate compliance with this requirement.
36. All headwalls shall be broken back design except for culverts under roadway embankment where purpose of headwall is primarily to retain earth.
37. Pipes discharging at a steep gradient into drainageways and detention facilities shall be provided with a slope wall.
38. All open channels shall conform to the City of Jenks standards. The centerline radius of a curve on an improved channel shall be a minimum of 3 times the maximum top width at the design flow depth.
39. All improved channels shall be provided with a minimum of 1' of freeboard.
40. When storm sewers are constructed all materials in fill areas shall to a 95% standard proctor density laying of the pipe.
41. Maximum spacing between manholes or boxes shall not exceed 300'.

1.11 Detention Facilities:

1. Detention is required for all residential developments of 10 acres or more and for all other developments of 2 acres or more. Peak release rates from the developments should not exceed the natural runoff that occurred before developments for all storms up to and including 100 year storm.
2. Residential development less than 10 acres and all other developments less than 2 acres may also be required by the City Engineer to have detention if the location of the developmental site with respect to the watershed and its inherent flooding problems warrants.
3. Detention will not be required for a developmental site that has 100 year full urbanization drainageway capacity to either the Arkansas River or Polecat Creek.
4. The detention storage requirements shall be that excess runoff generated due to urbanization resulting in less impervious area and alteration of times of concentration due to storm sewering of the area, overland flows on rights-of-way and alteration of the drainage patterns as a result of earth change, etc., for a 100 year frequency storm.
5. Snyder Synthetic unit hydrograph method, the Soil Conservation Service derivative thereof, the Storm Water Management Model, the Stanford Watershed Model, or Massachusetts Institute of Technology Catchment Model shall be used for the design of all detention facilities.
6. U.S. Weather Bureau Technical Paper No. 40 and National Weather Service HYDRO-35 (June, 1977) shall be used for rainfall information.
7. The duration of the storm used for design shall not be less than two times the time of concentration. The time of concentration is defined as the time for runoff to travel from the furthermost point in the watershed to the point in question.
8. The time increment used in developing the rainfall distribution and in reading off the ordinates of the unit hydrograph may be rounded off to the nearest whole time interval or to the nearest time increment.
9. The rainfall excess shall be critically arranged in such a way that the largest increment is located one time interval past the center of the duration of the rainfall excess.
10. The loss rates in determining the runoff hydrograph shall be an initial loss of .50 inches and a uniform loss of .08 inches/hr. for the subsequent hours once the initial losses are satisfied.
11. To determine peak release rate a minimum of 5 and 100 year storm frequencies under natural site conditions shall be investigated.
12. All calculations for detention facilities shall be submitted for review by the City Engineer to include hydrographs, outflow structures and a time phase analysis through the facility.
13. Floodplain areas and detention pond locations shall be identified at the preliminary plat stage to illustrate how these areas will be managed during and after construction.
14. If a tract of land under development has a floodplain area within Its boundary, the information that must

be furnished before the final plat is filed, shall include:

a. A backwater analysis on the existing drainageway system.
b. A backwater analysis on the proposed drainageway system.

15. Detention facilities should not be located in undesirable non-reusable areas that would demand continued high maintenance costs to the City of Jenks. Each facility shall incorporate methods to minimize erosion and other maintenance reducing designs.
16. Detention facilities located in non-reusable locations where soil or other conditions exist that would require continued high maintenance costs after the facility may no longer be needed will be required to have a dual storm sewer system.
17. A dual storm sewer system will not be required for a detention facility. However, the developer should carefully consider any advantages to him that would result from the immediate installation of a dual storm sewer system which would be realized by him upon reversion of ownership.
18. Detention facilities may be located in the Floodplain area or Floodway area when the elimination of the facility could be easily accomplished, thereby returning the site to its natural state.
19. Additional detention storage, in excess of the required storage for a drainage area, can be provided to satisfy the detention requirements for a tract of land downstream of the detention facility, providing the detention facility is constructed prior to the development of the downstream tract.
20. All detention facilities will be designed "dry" unless a special maintenance agreement in writing has been negotiated with the City of Jenks.
21. A minimum number of detention facilities is encouraged for each development.
22. If runoff has a natural tendency to drain in several directions for a given developmental tract of land where detention is required, then detention storage shall be provided for the biggest drainage area. Additional detention storage may be provided, at the same facility, to satisfy detention requirements for a separate drainage area on the same development, provided that:
    a. The whole developmental tract of land is in the same watershed.
    b. The smaller drainage area(s) that, has/have been compensated for does/does not, either singly or in combination, adversely impact the health, welfare and safety of the general public downstream.
23. If a tract of land being developed is located in more than one watershed, grading work to divert flows from one watershed to another will not be permitted and compensatory storage will not be permitted in one watershed for that required in another.
24. Detention facilities may be used for compensatory storage when encroaching into the Floodplain area provided that the overall drainageway system does not:
    a. Cause a rise in the water surface elevation beyond the extent of the development tract of land.
    b. Adversely impact adjacent properties by an increase in velocity.
25. All dikes and spillways on detention facilities will show typical cross sections on plans.
26. Access road, with a grade of 10% or less, shall be provided to the detention areas for maintenance purposes.
27. Side slopes on detention facilities shall not be steeper than 3:1.
28. Detention facilities shall be provided with a concrete trickle channel from the inlet to the outlet structure to transmit low flows. The trickle channel shall be constructed in accordance with City Standards.
29. Storm sewer outlets in the slope of the detention pond shall be protected by a Standard Slopewall.
30. Erosion and sediment control practices in and around detention facilities shall be in conformance with the earth change criteria.
31. The detention area shall be identified as a separate area within the plat; it may consist of one or more platted lots, a separate block, or it may be identified as a reserve area.
32. Dedication of the detention facility shall not appear among the plat's restrictive covenants: the format of the dedication shall be consistent with the dedication of public streets.
33. Every plat dedication shall contain an ownership reverter provision. Whether the reverter shall run in favor of the subdivider, an identified third party, or to a designated abutting property shall be determined as follows:
    a. If the detention area meets all applicable subdivision subdivision regulation/zoning requirements

b. If the detention area fails to meet all applicable subdivision regulation/zoning requirements and appropriate variances/special exceptions are not approved by the Jenks Planning Commission/Jenks Board of Adjustment which would permit its proper redevelopment upon reverter of ownership, reverter shall run only in favor of an identified abutting property or properties; if all deficiencies receive variance/special exception approval, reverter shall be governed by paragraph 33a (above).

34. Every plat shall provide an accesswav at least 20 feet wide to any required detention area. Access may be provided by frontage on a dedicated public street to the detention area.
35. If the detention facility is approved by the City to serve areas outside the subdivision in which it is located, such additional areas shall be specifically identified in the dedication.
36. In designing the dams for detention facilities, the book titled "DESIGN OF SMALL DAMS" by U.S. Department of the Interior, Bureau of Reclamation shall be used. An analysis shall be furnished of any proposed earthen dam construction soil. Foundation boring for the earthen dam may be requested.
37. The ownership and maintenance responsibility for detention facilities shall remain with the private sector if the facility is an integral usable part of the development. In all other cases, the detention facility will be dedicated to the public and the public will be responsible for the maintenance thereof. In the event the detention facility, as a result of drainageway improvements, becomes unnecessary, the facility by action of the City of Jenks shall revert to the person firm or corporation making such dedication or his heirs, successor or assignees.

1.12 <u>Earth Change, Soil Erosion and Sedimentation:</u>

1. Introduction

   The principles of erosion and sedimentation control can be successfully formulated and implemented by understanding the basic processes of soil erosion and sedimentation. There is a certain amount of erosion and sedimentation that occurs in nature. The process of natural erosion and sedimentation is greatly accelerated due to construction activity. If the accelerated process is not accounted for at the time of construction the adverse effects, possibly are:

   a. A large increase in area exposed to storm water runoff and soil erosion.
   b. Increased volumes of storm runoff, accelerated soil erosion and sediment yield and higher peak flows caused by:
      1. Removal of protective vegetative cover.
      2. Exposure of underlying soil or geologic formations less pervious and/or more erodible than original soil surface.
      3. Reduce capacity of exposed soils to absorb rainfall due to compaction caused by heavy equipment.
      4. Enlarged drainage areas caused by grading operations, diversions and street construction.
      5. Shortened times of concentration of surface runoff caused by altering steepness, distance and surface roughness and installation of improved storm drainage facilities.
      6. Increased impervious surfaces associated with the construction of streets, buildings, sidewalks and paved driveways and parking lots.
   c. Alteration of the groundwater regime that may adversely affect drainage systems, slope stability and survival of existing and/or newly established vegetation.
   d. Creation of exposures facing south and west that may hinder plant growth due to adverse temperature and moisture conditions.
   e. Exposure of subsurface materials that are rocky, acidic, droughty or otherwise unfavorable to the establishment of vegetation.
   f. Adverse alteration of surface runoff' patterns by construction and development.

2. General Applicability:

Earth change permit applications shall be required for areas shown in the 100 year flood plain on the most recently adopted "FEMA flood maps".

3. Minimum Approval Requirements:
   The plans and specifications accompanying the permit application shall contain the following data as deemed applicable by the City Engineer:
   a. A vicinity sketch at the scale of 1 inch to 200 feet indicating the site location as well as the adjacent properties within 500 feet of the site boundaries.
   b. A boundary line survey of the site on which the work is to be performed.
   c. A plan of the site at a minimum scale of 1 inch to 100 feet showing:
      1. Name, address and telephone number of the legal land owner, developer and petitioner.
      2. A timing schedule indicating the anticipated starting and completion dates of the development's construction sequence and the time of exposure of each area prior to the completion of effective erosion and sediment control measures.
      3. Estimate of the quantity of excavation and fill involved.
      4. Existing topography at a maximum of 2 foot contour intervals.
      5. Proposed topography at a maximum of 2 foot contour intervals.
      6. Location of any structure or natural feature on the site.
      7. Location of any structure or natural feature on the land adjacent to the site and within 50 feet of the site boundary line.
      8. Location of any proposed additional structures or development on site.
      9. Plans of all drainage provisions, retaining walls, cribbing, planting erosion control measure, or other temporary or permanent soil erosion control measures, to be constructed in connection with, or as a part of the proposed work together with a map showing the drainage area of land tributary to the site and estimated runoff of the area served by any drains.
   d. The estimated total cost of the required temporary and permanent soil erosion control measures shall be provided.
   e. Other information or data that may be required by the City Engineer such as a soil investigation report which shall include but not be limited to, data regarding the nature, distribution and supporting ability of existing soils and rock on the site.
4. Principles of Applying Erosion and Sediment Control Criteria.
   a. Plan the development to fit the particular topography, soils, waterways and natural vegetation at a site.
   b. Expose the smallest practical area of land for the shortest possible time.
   c. Apply "soil erosion" control practices as a first line of defense against on-site damage.
   d. Apply "sediment" control practices as a perimeter protection to prevent off-site damage.
   e. Implement a thorough maintenance and follow up operation.
5. Temporary Structural Practices
   a. Dikes:
      1. Diversion dike.
      2. Interceptor dike.
      3. Perimeter dike.
   b. The design drainage area for dikes shall not exceed 5 acres.
   c. The minimum dimensions shall be in accordance with the adopted standards.
   d. Swales:
      1. Interceptor swale.
      2. Perimeter swale.
   e. The design drainage area for swales shall not exceed 5 acres.
   f. The minimum dimensions shall be in accordance with the adopted standards.
   g. Straw Bale Dike:
      Where no other practice is feasible a temporary barrier with a life expectancy of three months or less can be installed across the toe of a slope for contributing drainage areas less than half' acre,

in accordance with the adopted standards.

h. A stabilized construction entrance shall be built in accordance with the adopted standards to reduce or eliminate the tracking or flowing of sediment onto public rights-of-way.

i. A stone outlet shall be constructed in areas where the entire drainage area to the structure is not stabilized or where there is a need to dispose runoff' at a protected outlet or where concentrated flow for the duration of the period of construction needs to be disffused. The structure shall be in accordance with adopted standards.

j. A grade stabilization structure in the form of a paved chute or flume shall be constructed to prevent erosion, where concentrated flow of surface runoff is to be conveyed down a slope, in accordance with the adopted standards. The maximum allowable drainage area upstream of such a structure shall not exceed 110 acres.

k. A grade stabilization structure in the form of a pipe slope drain shall be constructed to prevent erosion, where concentrated flow of surface runoff is to be conveyed down a slope, in accordance with the adopted standards. The maximum allowable drainage area upstream of such a structure shall not exceed 5 acres.

l. Storm water detention facilities may be used temporarily as sediment basins. A temporary outlet structure for the storm water detention facility to work as a sediment pond shall be constructed. At the end of the construction activity, the developer shall make sure that the outlet structure shall meet the design requirements of a storm water detention facility.

m. Condition of the detention facility that is used as a sediment pond during construction, shall meet the following requirements at the time of acceptance:
   1. It shall be completely cleaned by the developer and be rid of any immediate maintenance.
   2. It shall meet all design standards.

6. Permanent Structural Practices
   a. Depending on the development layout, a diversion shall be constructed across a slope more than 15% to:
      1. Prevent runoff from higher areas that have a potential for causing erosion and interference with the establishment of vegetation on lower areas.
      2. Reduce the length of slopes to minimize soil loss.
   b. Diversions need to be constructed only below stabilized or protected areas in conformance with standards.
   c. Outlets from diversions shall be constructed to discharge in such a manner as not to cause erosion.
   d. Outlets shall be constructed and stabilized prior to the operation of diversion.
   e. Storm drain outlet protection shall be provided when converting pipe flow to channel flow. The reduction in velocity shall be consistent with the roughness coefficient of the receiving waterway. The reduction in velocity may be accomplished by:
      1. Providing mortared riprap stabilization;
      2. Providing energy dissipators;
      3. Providing permanent vegetation; depending on the site specific needs.

7. Vegetative Practices

   Vegetative practices can be applied very effectively to control erosion. The practices can be either temporary or permanent depending on the site specific needs. The specifications for establishing vegetation both temporary and permanent are briefly outlined below.

   a. Temporary Practices

      Small grains like oats, rye and wheat, and sudans and sorghums are the most feasible temporary vegetation to control erosion for the Jenks area. This practice is effective for areas where soil is left exposed for a period of 6 to 12 months. The time period may be shorter during periods of erosion rainfall.

      1. Prior to seeding, needed erosion control practices such as diversions, grade stabilization structures, berms, dikes, etc. shall be installed.

2. Temporary vegetative practice is usually applied prior to the completion of final grading of the site.
3. If the area to be seeded has been recently loosened to the extent that an adequate seedbed exists, no additional treatment is required. However, if the area to be seeded is packed, crusted and hard, the top layer of soil shall be loosened by suitable means.
4. Fertilizer shall be applied at a rate of 600 pounds per acre or 15 pounds per 1000 square foot using 10—20—10 or equivalent.
5. Soils known to be highly acidic shall be lime treated.
6. Seeding requirements shall be as specified in the following:

PLANT	PER ACRE	PER 1000 SQ FT.	PLANTING DATE	DEPTH OF SEEDING
Annual Ryegrass	40 Lbs.	0.9 Lbs.	9/15 – 11/30	¼ Inch
Elbon Rye	2 Bu.	3.0 Lbs.	8/15 – 11/30	2 Inches
Wheat	2 Bu.	3.0 Lbs.	8/15 – 11/30	2 Inches
Oats	3 Bu.	2.5 Lbs.	8/15 – 11/30	2 Inches
Sorghum	60 Lbs.	1.4 Lbs.	3/1 – 9/15	2 Inches
Sudan Grass	40 Lbs.	0.9 Lbs.	4/1 – 9/15	2 Inches

7. Seeds shall be drilled uniformly.
8. Seeding implements should be used at right angles to the general slope to minimize erosion.
9. After 2 to 3 months of planting the seeded site shall be dressed with 8 pounds per 1000 square feet or 350 pounds per acre of 33-0-0.
10. Areas that are not well covered shall be replanted.
11. The seeded area shall be watered when feasible and needed.

b. Permanent Practices

Bermuda grass, Kentucky 31 Tall Fescue and Weeping Lovegrass are some of the types of permanent vegetation that could be effectively used to control erosion.

1. Prior to seeding, needed erosion control practices such as dikes, swales, diversions, etc. shall be installed.
2. The subgrade shall be loosened evenly to a depth of 2 to 3 inches and 10-20-10 fertilizer (10 pounds per 1000 square feet or 450 pounds per acre) shall be mixed with the loosened surface soil by discing or other suitable means.
3. Soils known to be high acidic shall be lime treated.
4. Planting rate requirements shall be as specified in the following table:

PLANT	PER ACRE	PER 1000 SQ. FT.	PLANTING DATE	DEPTH OF OF SEEDING
Bermuda Grass	10 Lbs.	0.25 Lbs.	4/1 - 8/15	0-1/2 Inch
Fescue	40 Lbs.	0.90 Lbs.	9/1 - 11/1	0-1/2 Inch
Lovegrass	5 Lbs.	0.10 Lbs.	4/1 - 6/30	0-1/2 Inch

5. Seeds shall be drilled uniformly.
6. Seeding implements should be used at right angles to the general slope to minimize erosion.
7. Mulch will be used where needed.
8. The area shall be watered daily or as often as necessary to maintain adequate soil moisture until the plants grow about ½ - 1 inch.

1.13 Floodplain Area Maps:

1. Initial Maps

a. The City Council shall adopt initial flood plain area maps, developed by the City Engineer, identifying lands subject to flooding hazards and periodic inundation, based on the best available information.

b. Sources of available information include but are not limited to:
   1. Federal Insurance Administration (FIA) Zone A designated areas with and without flood elevation.
   2. High water marks from previous floods;
   3. Engineering studies; and
   4. Flood prone soils maps.

2. Map Revisions
   a. As new information becomes available, maps will be updated by the City Engineer and adopted by the City Commission.
   b. The regulatory flood will be used in Engineering analysis to determine the floodplain area. Analyses will also include delineation of the floodway.
   c. The regulatory flood will be computed based upon full potential urbanization of the contributing watershed, considering the Comprehensive Plan, adopted Floodplain Management Policies and the Watershed Drainage Plan where adopted.
   d. In calculations of the degrees of watershed urbanization to be considered in flood flow routing:
      1. Natural floodplains and those which can be reasonably expected to remain unaltered by man-made changes may be considered as remaining in their natural states.
      2. Floodplains altered by existing or anticipated man-made changes shall be considered as having the natural channel eliminated.
      3. Where an adopted Watershed Drainage Plan exists, the effects of urbanization shall be determined in accordance with that plan's floodplain development guidelines.
   e. Floodplain area maps shall be limited to delineating those floodplains where the contributing drainage area is approximately 40 acres or more.
   f. Mapping of Floodway Zoning Districts shall be limited to delineating those floodplains where the contributing drainage area is approximately 640 acres or more.

1.14 <u>Determination of Floodway:</u>

1. The floodway is comprised of the channel of a watercourse plus those portions of the adjoining floodplain which are reasonably required to carry and discharge the regulatory flood.
2. A floodplain has two basic functions:
   a. Carrying and discharging the flood flows (floodway);
   b. Temporarily storing flood water (floodplain).
3. Any appreciable change in either function of the floodplain can result in an increase in flood heights and/or an increase in velocity.
4. Floodway boundaries shall be determined so that:
   a. Sufficient area is reserved to carry the regulatory flood.
   b. Existing floodplain storage capacity is maintained.
   c. No measurable increase occurs in flood flows, flood heights or potential flood damage and danger to off-site properties.

2.0 DESIGN CRITERIA FOR SANITARY SEWERS AND WATER SYSTEM IMPROVEMENTS

2.1 <u>General:</u>

1. Where on a particular tract, the standards and specifications set forth herein are not necessary or applicable by reason of topography, soils or other conditions peculiar to such tract, other standards may be used with the prior approval of the City Engineer.
2. For any item of work not covered by the adopted standards and specifications of the City of .Jenks, the Consulting Engineer shall include two copies of the design, specifications and/or special provisions with his first submittal for review and approval by the City Engineer.

3. Approval of the plans by the City Engineer does not release the Consulting Engineer from his responsibility to meet the planning and design of the project as required by the City Engineer and/or other departments of the City.
4. All of the plan sheets and the cover sheet of the calculation report shall be signed, sealed, and dated by a Professional Engineer, registered in the State of Oklahoma, prior to submitting the plans to the City Engineer for review.
5. Directly above the title block and signature of the Professional Engineers registered in the State of Oklahoma, the first sheet of the plans shall contain the following statement:
   "I hereby certify that I am familiar with the adopted ordinances and regulations of the City of Jenks governing sanitary sewers and water system improvements; that these plans have been prepared under my direct supervision; the above and foregoing plans comply with all governing ordinances and the adopted standards of the City of Jenks, to the best of my knowledge, information and belief."
6. All developments with private sanitary sewer and water systems shall contain the following statement on the first sheet of the plans directly above the title block and signature of the Professional Engineer, registered in the State of Oklahoma:
   "These plans comply with all governing ordinances and the adopted criteria of the City of Jenks pertaining to sanitary sewers and water systems to the best of my knowledge, information and belief."
7. All design and construction shall be in accordance with or in excess of the minimum standards and specifications required by the Subdivision Regulations of the City of Jenks and the regulations of the Oklahoma State Department of Health. The City Engineer shall have the authority to require design information as he may deem necessary to check any and all proposed systems and shall have authority to require greater than the minimum design standards as set forth herein if in his opinion the safety and welfare of the public is threatened.

2.2 <u>Drafting:</u>

1. Construction plans shall be drawn with black India ink on a transparent reproducible medium (paper velum, linen or Mylar, matte both sides.)
2. Sheets shall be 34" wide by 22" high having a margin of 1-1/2" along the left border and 1/2" along the top, bottom, and right border.
3. North shall be oriented to the top or right hand side of all sheets.
4. A Title Block shall be located in the lower right hand corner of each sheet. Each title block shall contain the following information: City of Jenks, Oklahoma, Subdivision Name, Sheet Title, Sheet Number of Total Sheets, Consulting Engineer's Name and Address.
5. All line work shall be of sufficient density to be reproducible by current reproduction processes. Any line work which does not reproduce satisfactorily may be cause for rejection of the plans by the City Engineer.
6. Freehand lettering shall be no smaller than the No. 4 setting on the Ames lettering guide (1.12" minimum height). Mechanical lettering shall be at least comparable to the 100 Leroy guide (0.10" minimum height) except mechanical lettering on plats or records reproduced in the plans may be comparable to the 80 Leroy guide (0.08" minimum height). Typing shall be at least 0.10" minimum height. Adhesive or transfer lettering shall have a minimum height of 0.10". These lettering sizes are minimum. Sizes greater than these are desirable and suggested.
7. "Record" drawings shall be either India ink or linen, 3 mil Mylar or paper velum, or base black line autopositive matte both sides reversed. (Diazo processes will be acceptable. "Stick-on" will not be acceptable.
8. The sheets shall be arranged in the following order:
   a. The front sheet shall contain existing topography (maximum 2' contour intervals), title block, north arrow, scale index to sheets, street layout, lot layout, off site adjacent structures, location map, description, symbol legend, owner's and engineer's name, address and telephone number, bench mark, Professional Engineer's seal and signature and certified statement.

b. Layout of sanitary sewer system with individual line and structure identifications, line sizes and stations.
c. Profile of sanitary sewer system with individual line and structure identifications, line sizes and slopes expressed in feet per foot, stations and all existing and proposed subsurface structures.
d. Miscellaneous special sanitary sewer details.
e. Layout of water system improvements with individual line identification sizes, valves, bends, fire hydrants, encasements and stations.
f. Profile of water system improvements with individual line identification, sizes, bends, valves, fire hydrants, encasements, stations and all existing and proposed subsurface structures.
g. Miscellaneous special water system improvement details.

2.3 Bench Marks:

1. All elevations shown on the plans shall be based on USGS or USC&GS datum.
2. The permanent bench mark location and description used to extend level datum to the projects shall be noted on the front sheet of the plans.
3. All temporary bench marks used for control of the project shall be designated on the plans starting elevation, location and description. The nearest such bench mark shall be shown on each sheet.
4. Prior to commencement of construction, a permanent bench mark shall be established on the project. This permanent bench mark will be a brass cap set in concrete. The location, description and elevation of the permanent bench mark shall be shown on the front sheet of the plans.
5. Level notes shall be provided to the City Engineer for all permanent and temporary bench marks. All level notes shall be of closed loop survey.

2.4 Plan Sheets and Profiles:

1. All property lines shall be shown, dimensioned and locations referenced thereto. This includes right-of-way, easements, building lines, etc.
2. A site plan showing all proposed locations and proposed elevations, at crossings only, of all paving and drainage improvements shall accompany the sanitary sewer and water system plans.
3. The scale shall not be less than 1” – 10’ plan:
   1” – 100’ horizontal and 1” – 10’ vertical profile.
4. Profiles shall be shown as specified herein:
   a. Sanitary Sewer:
      A land surface profile shall be shown and labeled at the following locations: centerline of construction, center of building pads and the flowline of a paralleling drainage channel.
   b. Water System Improvements:
      A land surface profile shall be shown and labeled at the following locations: top of curb or centerline of construction, if the water line doesn’t parallel a street, and at the building or setback line. Both top of curb and centerline of construction shall be shown if greater than 1/2” per foot slope exists between the curb and the property line.

      If the proposed utility is at a location that requires more than one foot of cut or fill for final grading, both proposed and existing land surface profiles will be shown and labeled. All fill areas shall be denoted with a cross-hatch symbol and shall be labeled “Compact to 95% standard proctor density.”

      All subsurface structures, both existing and proposed, including paving, shall be shown and labeled with an elevation noted.
5. A list of construction quantities shall be shown on plans.
6. All structures (manholes, lampholes, fire hydrants, valves, tees, etc.) shall be labeled both in plan and profile and on detailed plans, if any. Manholes and lampholes shall be numbered in addition to the above.

7. Sanitary sewer stationing shall start at the downstream end of that particular line and shall proceed upstream. Water system stationing shall be done in an accepted manner.

2.5 Sanitary Sewer

1. No sanitary sewer or appurtenance thereto shall be installed without dedication of right-of-way or appropriate easements.
2. Lines shall be in the south or west 1/2 of joint easement, 5.0' off the easement line. Total easement width is 15' minimum. Lines shall be in the rear of lots if topographically possible. If not, they shall be in an easement adjacent to street right-of-way.
3. Lines shall project a minimum of 15' into property served. If all utilities are to be underground, this may be reduced to 10' for manholes and 7.5' for lampholes. No property shall be platted if it cannot be served by sanitary sewers in accordance with these specifications.
4. Alignment, size and grade of lines shall be subject to approval.
5. Manhole spacing shall be 400' maximum unless otherwise approved. Lamphole spacing shall be 100' maximum.
6. Manholes shall be 4' deep minimum. Top shall be above the 100 year flood high water level. Invert difference in drop manholes shall be a minimum of 2'. Exact manhole rim elevations shall be shown on profile and staked in field.
7. Encasement shall be required where the depth of cut from the original ground elevation to the flow line of pipe is four (4) feet or less; cradle were 16' or more.
8. Cover over line at creek crossings shall be 3' minimum.
9. Maximum permissible depth for service to property is 12'.
10. Design shall be based on service line stubbout 1 1/2' below surface, 2.08% minimum grade and 1 1/2' drop into sewer (1.04% grade for cast iron pipe service line.)
11. A 4" riser consisting of the same material as the main line shall extend to within 3' of the finished land surface and shall be marked with Lineguard Type II detectable mylar marking tape or equal (labeled "Caution- Sewer Line Below"). The location of the riser shall be shown in feet upstream from the nearest downstream manhole on the As-built plans. The riser shall be connected to the main line with a lateral wye.
12. All pipe 6" to 12" shall be PVC-SDR-35 type with gasket joints and shall be bedded with 6" of clean river sand on both sides, top and bottom. The sand bed shall be prepared before the pipe is lowered into the trench. No rocks shall be used for the first one foot of backfill above the sand bedding. The trench backfill may be completed using material on site providing that no rocks larger than one foot measured in any direction shall be used. Pipes larger than 12" shall be reviewed on an individual basis.
13. No sewer shall be less than eight inches in diameter except that the use of six inch diameter sewer may be permitted in situations where it cannot be extended and where not more than 400 feet will be installed in any one place.
14. All sanitary sewers shall be designed and constructed with hydraulic slopes sufficient to give mean velocities, when flowing full, of not less than 2.0 feet per second. The following are the minimum slopes which should be provided:

SEWER SIZE	MINIMUM SLOPE IN FEET PER 100 FEET
6"	0.50
8"	0.40
10"	0.29
12"	0.22

15. Sanitary sewers must be designed deep enough to drain wastes from houses on both sides of the sewer and to prevent frost damage. The sewer depth should be great enough to permit extension of the sewer where such extension is possible or practical. Where, for specific reasons, shallow depths are necessary

and can be justified, the sewer must be protected to prevent its being damaged. All sewers shall be designed to prevent cracking due to superimposed loads and weight of backfill materials.

16. When sewers are increased in size, or when a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevations.
17. Sewers should be laid in straight alignment and shall be laid with uniform grade between manholes. In no case shall horizontal or vertical curves be permitted.
18. In the case of sanitary sewers where the slope and volume are such that velocities exceeding 10 feet per second will be realized at average flow, drop manholes shall be used.
19. In determining the required capacities of sanitary sewers, the following factors should be considered:
    a. Maximum hourly quantity of domestic sewage;
    b. Additional maximum sewage or waste from industrial plants or high use businesses;
    c. Ground water infiltration; and
    d. Future upstream development of the basin. Sanitary sewage systems shall be designed on the basis of an average daily per capita flow of domestic sewage of not less than 100 gallons per day. Lateral and submain sewers should be designed with capacities when running full, of not less than 400 gallons per capita per day, and main, trunk, interceptor, and outfall sewers should have capacities under the same conditions of not less than 250 gallons per capita per day with due allowance in each case for any additional sewage or waste from industrial plants, commercial developments and territory for future development. The 100 g.c.d. figure is assumed to cover normal infiltration, but an additional allowance should be made where conditions are especially unfavorable. Laterals should be designed on a house count for full development.
20. Manholes should be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet. Lampholes may be used only for special conditions and shall not be substituted for manholes nor installed at the end of 6” laterals greater than 100 feet in length. The minimum diameter of a manhole shall be 4 feet and shall extend from top to bottom at full diameter when the manhole is less than 4.5’ deep.
21. A drop manhole should be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solids deposition.
22. The flow channels through manholes should be made to conform to hydraulic requirements. A minimum of 0.2 feet fall should be used across the manhole.
23. Special structures and equipment shall be reviewed on an individual basis and shall conform to the requirements of the Oklahoma State Health Department and/or these specifications, whichever is greater.
24. The “Standards for Water Pollution Control Facilities” published by the Environmental Health Services Division of Sanitary Engineering, Oklahoma Department of Health (O.D.H. Engineering Bulletin No. 0587) and revisions or additions thereto are hereby incorporated by reference.

2.6 <u>Water System Improvements:</u>

1. No water system or appurtenance thereto shall be installed without dedication of right-of-way or appropriate easement.
2. The maximum permissible depth shall be 6 feet and the minimum cover shall be 3 feet. In unusual cases, a variance may be approved by the City Engineer.
3. All fire hydrants shall be equipped with a gate valve and box and shall have a maximum spacing of 500 feet. Each fire hydrant shall be located with respect to property lines and the finished land surface elevation shall be shown on the plans.
4. Water lines shall be located on the South or East side of the right-of-way, 8 feet off the property line, unless otherwise approved. The minimum radius bend shall be 200 feet.
5. The distribution system including but not limited to mains, valves, fittings, fire hydrants, consumer service pipes and meters, and all other appurtenances shall be A.W.W.A. approved. The system shall be

designed to provide an adequate supply of water as well as fire protection at all times. Whenever plastic pipe is used, it shall bear the seal of the National Sanitation Foundation and meet the appropriate commercial standard.

6. A minimum main size of 6 inches in a residential area or 8 inches in a high-value district shall be used where cross-connecting mains are not more than 600 feet apart. A 4 inch main shall be permitted on cul-de-sacs shorter than 300 feet in length providing fire protection is provided from a 6 inch or larger main. On collector streets and for long lines cross-connected at intervals exceeding 600 feet, 8 inch or larger mains are required. Principal streets such as section lines shall have 12 inch or larger mains. Upon request, a pipe networm analysis by the Hardy-Cross method or other acceptable methods shall be furnished to the City Engineer.
7. Gate valves should be located so that a single break in the line will require no more than 500 feet of pipe to be disconnected from service in high-value areas, nor more than 800 feet in other sections, nor shall require the shutting down of an artery. Valves should be located at street intersections in position so that they can be readily operated in case of main failure. All small distribution lines branching from larger mains should be valved. Valves should be arranged so each block can be isolated in case of a main break. Each branch at large pipe intersections should be valved, with large supply lines gated at about one-half mile intervals. Air valves should be located at high points and blow-offs at low points in large mains. Hydrants should be located at street Intersections accessible from four directions, or spaced so that hose lines need not exceed 500 feet in length. In high-value districts, hydrants shall be spaced at 300 feet maximum. Fire Hydrants shall have a 4 1/2 Inch pumper outlet, not less than two 2-1/2 inch hose outlets, and be connected to the main with pipe not smaller than six inches. The pumper should be able to connect to the hydrant with a single 10 foot length of suction hose, set so the center of the lowest outlet is not less than 18 inches above the surrounding gate. The hydrant operating nut should be not over four feet above grade. Drains from hydrant barrels on distribution systems shall not be connected to sanitary sewer or storm drains. Where practicable, hydrant barrels should be drained to the ground surface, or to dry wells provided exclusively for that purpose.
8. The distribution system shall be designed so that negative pressure will not occur under any conditions of draft on the system. The minimum pressures in a system shall be designed to have between 45 to 75 pounds per square inch.
9. Pipe lines that extend beyond the grid system must be laid out with the plan of eventually connecting them to other mains to provide circulation of the water. Dead ends should be held to a minimum. The dead end of a main should have a fire hydrant, flushing hydrant, or blow-off for flushing purposes. No flushing device shall be connected directly at any sewer.
10. All water system improvements shall be cleaned and disinfected before use. Water with 50 to 100 parts per million of chlorine shall be allowed to stand 24 hours, and develop a residual of at least 10 parts per million of chlorine. The spent solution should be drained and replaced with potable water. As an alternate, either of the methods listed in the latest American Water Works Association specifications may be used.
11. Unless a variance is approved by the City Engineer, all distribution systems shall be “PSI” 160 or larger polyvinyl chloride pipe (P.V.C.) with gasket joints conforming to A.W.W.A. C-900 specification. All fittings shall be cast iron conforming to applicable A.W.W.A. specifications and shall be thrust blocked. All P.V.C. pipe shall be bedded with 4” of clean river sand. The sand bed shall be prepared before the pipe is lowered into the trench.
12. Special structures and equipment shall be reviewed on an individual basis and shall conform to the requirements of the Oklahoma State Health Department and/or these specifications, whichever is greater.
13. The “Standards for Public Water Supply Facilities” published by the Environmental Health Services Water Quality Control Division, Oklahoma State Department of Health (ODH Engineering Bulletin No. 0589) and revisions or additions thereto are hereby incorporated by reference.

SECTION 3

TECHNICAL SPECIFICATIONS

FOR

PAVING AND DRAINAGE

3.0 TECHNICAL SPECIFICATIONS FOR PAVING AND DRAINAGE

3.1 Excavation for Pavements:

1. Description. Excavation shall consist of all the work, as described herein which is necessary for the preparation and construction of the roadbed, embankments, subgrade, shoulders, parking, curb trenches, drainage ditches, cross street and alley approaches, sidewalks, driveways, private entrances, etc., in conformity with the lines, grades and cross-sections shown on the plans, or called for in these specifications. Excavation shall include the removal and satisfactory disposal of all trees, brush, stumps, posts, fences, weeds, rock, concrete, existing pavement, gravel or macadam, sidewalks, curbs, pipes, culverts, sewer manholes and inlets where required, and all other structures, materials or debris; the stripping and removing of the top soil or sod to be piled separately from other materials and later restored to its original place when backfilling is completed, the removal of all excess or unsuitable materials encountered; the replacement of any such unsuitable materials with satisfactory materials; the doing of all necessary backfilling, tamping, compacting, and refilling, the restoring of all streets, alleys, right-of-way or other lands, either public or private, damaged or occupied by the Contractor in the performance of the contract, to as good condition as they were prior to the beginning of the work.
2. Classification. There will be no classification of any of the above described excavation material, save structures, broken concrete pavement, sidewalk and driveway materials, and these items shall be classified only when so listed and classified as contract pay items. All excavated materials and structures other than those which are separately classified shall be considered as "UNCLASSIFIED EXCAVATION."
3. Construction Methods. Excavating and grading equipment shall be of approved types and designs, and shall be maintained in first class condition. Equipment used for, disposing of excavated materials outside of the limits of the work shall be such as will avoid scattering or wasting material along the line of haul. The Contractor shall immediately clean up all material as wasted or scattered.

   All grass or weeds or other vegetation shall be cut and properly disposed of in a satisfactory manner before the ground is broken for grading and excavation. All existing structures, such as manhole and sewer inlets, which are to remain in place shall he adjusted or rebuilt to grade as provided in Section 3.19, Adjustment of Existing Structures; and care shall be taken not to damage existing structures during grading or construction operations.

   Existing pavements, driveways, sidewalks, curbs, gutters, etc., to be removed shall be broken up and disposed of as provided herein. Construction methods involved shall conform to Section 3.22.

   After the site of the work has been properly cleared and cleaned, excavation and grading of the roadway shall proceed in conformity with the plans and these specifications.

   Rock, boulders or existing structures which are abandoned, shall be removed to a depth of not less than six inches (6") below the subgrade elevation. Soft, spongy or other unsuitable foundation material shall be removed to such a depth as may be necessary to permit the preparation of an acceptable subgrade. All excavation below subgrade elevation shall be backfilled with approved select materials, placed in layers not exceeding six inches (6") in thickness. These layers shall be rolled or tamped, or both to a density of 95% Standard Proctor, in such a manner as to secure proper compaction. Layers of backfill material shall be moistened before being rolled or tamped, when the desired degree of compaction cannot otherwise be obtained.

   Care shall be taken not to disturb the ground below the required finish subgrade elevation except for necessary structures, and where provision is made for uniformly scarifying or loosening the ground below subgrade as provided in Section 3.3. Excavation outside the curb lines, or beyond the slab edges shall not be made wider than necessary to permit proper placing of the forms. The finish grade, slopes

and edges of the excavation on all parking, cross street or private driveway approaches, etc., shall be backfilled where necessary, using approved material thoroughly compacted in layers and dressed off uniformly in a neat and workmanlike manner. Slab edges shall be backfilled for a width of not less than two feet (2'), measured at the level of the top of slab. Ample provision will be made at all times for completely and readily draining the subgrade and all excavations.

4. Structures Removed and Surplus Excavated Material. All structures removed, such as manhole frames and covers, sewer inlet frames and gratings, and all pipes, culverts, bricks, etc., salvaged from the project, which may, in the opinion of the Engineer, be suitable for use by the city shall be property of the city. If so directed, these items will be stockpiled on the project, in a neat manner, for movement to an appropriate storage site by the city. If not directed to stockpile any such items, said items and any surplus excavation shall be removed from the project and disposed of by the Contractor at no cost to the city.
5. Removal and Replacement of Sod. Where sod or grass is removed in making an excavation, such areas as are backfilled shall have the same sod or grass replacement in good condition, or other sod or grass of the same kind and in good condition placed in its stead. The sod shall be removed in squares cut out with a sharpened spade, and of such sizes that they may be handled conveniently without unduly breaking. The sod shall be removed in one layer not less than four inches (4") in depth, shall be carefully stored where it will be protected from injury, and shall be kept continuously in a good condition by sprinkling with water as required. During hot, dry weather the stored sod shall be protected by covering with canvas or burlap. When backfilling is completed, the sod shall be carefully replaced to cover the entire area and shall be thoroughly wet down.

   The removal and replacement of sod will not be required unless shown on the plans or required by the Special Provisions.
6. For City Contracts. All unclassified excavated material shall be measured in its original position in the street or borrowed pit, and the volume computed by the method of average end areas. In determining the volume of unclassified excavation, vertical measurements will be taken from the original surface to the subgrade elevations shown on the plans and to the finish grade on all parking, cross street or private drive approaches, etc., provided as follows:
   a. Where rock or existing structures, not separately classified, are excavated or removed below subgrade elevation in accordance with these specifications, vertical measurements will be taken to the bottom of the excavation.
   b. Where soft spongy material is removed below subgrade elevation, and where the presence of such soft or spongy material is not the result of the Contractor's failure to make provision for adequate drainage, vertical measurements will be taken to the bottom of the excavation. Horizontal measurements will be taken at right angles to the center line of the street. The width of the excavation for pavement will be measured to a point twelve inches (12") back of the curb or edge of the pavement for sections having no curb. Width of excavation for the parking will be measured to the edge of the excavation, provided the excavation is entirely within the limits of the street or right-of-way. Horizontal and vertical measurements will be taken at intervals not more than fifty feet (50') apart and as much closer as necessary to include all substantial variations in the depth of the excavation. When the excavation or removal of structures, pavements, driveways, sidewalks, etc., appears as items in the proposal, such materials will be measured in their original position in units as classified. When the removal of trees is classified separately for payment, according to sizes, the measurement of the diameter will be taken at a point three feet (3') above the general ground surface elevation and shall be the average diameter of the main trunk.
7. For City Contracts. Excavation will be paid for at the contract-unit price for the items classified for payment. Such price or prices shall be full compensation for all items of work specified under the general heading "EARTHWORK", for which no separate unit prices are included in the contract, including all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and these specifications.

8. Testing. The following is the test schedule required to be accomplished for each project constructed under these specifications:

Test Schedule

Description	Method of Test	Quantity of Item Represented by One Test
1. Standard Proctor Density	AASHO T-99	2400 Sq yd of subgrade
2. Field Density		
a. Subgrade	AASHO T-191 or T-205	1200 Sq yd of subgrade
b. Trench under paving	AASHO T-191 or T-205	200 L.F. of trench or at any transverse crossing
c. Embankment	AASHO T-191 or T-205	Each 6" layer, over 1200 Sq yd

3.2 Embankment for Pavements:

1. Construction Method. All grass, weeds, trees, stumps and existing structures shall be removed in a satisfactory manner from the entire area to be occupied by the embankment.

   All embankments shall be formed of good sound earth, gravel or other acceptable materials, and shall be built to sufficient heights and width that after full shrinkage, they will conform to the lines, grades and cross sections shown on the plans, or called for in the specifications. Rocks and boulders may be placed in embankment provided they are not placed in piles, arid provided no rock larger than one-half (1/2) cubic foot in volume is placed nearer the finish grade than six (6) inches. No sticks, weeds, trash or other vegetable matter, or any other unsuitable materials shall be placed in embankments.

   Material in embankments shall be placed in layers not exceeding six (6) inches in depth measured when loose, and extending the entire width and length of the embankment. Each succeeding layer shall be uniformly spread over the surface then thoroughly compacted by rolling with a sheepsfoot roller in the manner prescribed in Section 3.3. Areas inaccessible to the roller shall be thoroughly hand tamped until the degree of compaction is equivalent to that of the rolled area. Hand tampers shall have a tamping surface not exceeding twenty-five (25) square inches, shall weigh not less than one (1) pound per square inch, and shall be of a design approved by the Engineer.

   Shoulders and parking area shall be brought to the required finish grade after the pavement slab and curbs are constructed, and shall be compacted by rolling or tamping with or without wetting as required above.
2. For City Contracts. Embankment will not be paid for directly as such but the cost of constructing complete any required embankment shall be included in the price bid for "UNCLASSIFIED EXCAVATION", which price shall be in full compensation for all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and these specifications.
3. Testing. The following is the test scheduled required to be accomplished for each project constructed under these specifications:

   The party, developer, consulting engineer or Contractor, who shall be responsible for paying the cost of the testing as outlined herein, shall be established prior to construction for each project constructed under these specifications.

TEST SCHEDULE

Description	Method of Test	Quantity of Item Represented by One Test
1. Standard Proctor Density	AASHO T-99	2400 Sq yd of subgrade
2. Field Density		
a. Subgrade	AASHO T-191 or T-205	1200 Sq yd of subgrade
b. Trench under paving	AASHO T-191 or T-205	200 L.F. of trench or at any transverse crossing

c. Embankment	AASHO T-191 or T-205	Each 6" layer, over 1200 Sq yd

3.3 Subgrade:

1. Description. This work shall consist of preparing the subgrade for the immediate construction of subbase, base, and sand cushion, pavement or surface.

   The subgrade shall be constructed in accordance with one of the methods specified herein and as required in the specifications for the type of new construction proposed, or by the method indicated on the plans and in the proposal for the work.
2. Testing. The following is the test schedule required to be accomplished for each project constructed under these specifications:

   The party, developer, consulting engineer or contractor, who shall be responsible for paying the cost of the testing as outlined herein, shall be established prior to construction for each project constructed under these specifications.

TEST SCHEDULE

Description	Method of Test	Quantity of Item Represented by One Test
1. Soil Classification		1200 Sq yd of Subgrade
a. Preparation of Soil Mechanical Analysis	AASHO T-87	
b. Mechanical Analysis of Soils	AASHO T-88	
c. Liquid Limit of Soil	AASHO T-89	
d. Plastic Limit and Plastic Index	AASHO T-90	
e. Soil Classification	AASHO M-145	
2. Standard Proctor Density	AASHO T-99	2400 Sq yd of Subgrade
3. Field Density		
a. Subgrade	AASHO T-191 or T-205	1200 Sq yd of Subgrade
b. Trench under paving	AASHO T-191 or T-205	200 L.F. of trench or at any transverse crossing
c. Embankment	AASHO T-191 or T-205	Each 6" layer, over 1200 Sq yd

3. Method A Construction Methods. (Traffic Bound Surface Course) shall be as follows: The full width of the existing roadbed shall be shaped and crowned with a grader to the approximate grade and section required. Unless otherwise indicated the completed sectional shall have a crown of at least 1/4 inch per foot. All exposed rock larger than 3 inches and any unstable soil shall be removed and replaced with acceptable material. The finished roadbed shall be smooth and uniform and be maintained in this condition until surfacing aggregate is placed.
4. Method B Construction Methods. (All Other Subbases, Bases, Pavement or Surface) shall be as follows: When an item under Section 3.4 is not included in the contract, any asphalt surfacing shall be removed and disposed of by the Contractor. The aggregate in place shall be used on or incorporated in the full width of the subgrade to provide a uniform subgrade as specified.

   The subgrade shall be scarified or otherwise processed to permit uniform dispersion of moisture to a depth of approximately 6 inches. Areas of the subgrade through rock cuts that cannot be scarified or otherwise processed shall be shaped with soil meeting the requirements of Section 3.2, unless otherwise specified, to conform to the planned profile and cross section. When the loosened soil has been pulverized, it shall be thoroughly and uniformly compacted with suitable equipment to at least 95 percent of Standard Density for a depth of approximately 6 inches.

Test rolling will not be required on the preparation of subgrade, Method B, unless specifically designated on the plans. Areas of the subgrade which are not accessible to rolling equipment shall be compacted to the required density with approved mechanical tampers.

The surface of the finished subgrade will be tested by the Engineer using a 10-foot straight edge at selected locations. The variation of the surface from the testing edge of the straight edge between any two contacts with the surface shall at no point exceed 1/2 inch. Unless otherwise provided, points closer than 50 feet shall not vary more than 1/2 inch from the approved grade in place. All humps or depressions exceeding the specified tolerance shall be corrected in an acceptable manner.

Tests of the subgrade in place shall be made immediately in advance of placing the subsequent course and shall not vary more than the tolerances heretofore specified and any deficiency shall be corrected before material is placed for the subsequent course.

When the condition of the subsurface materials in excess of 12 inches below subgrade elevation prevents the satisfactory construction of the subgrade, all of the excavation required to remove the unstable material for an area and to a depth designated by the Engineer and then backfilled with acceptable material to subgrade elevation shall be done in accordance with Section 3.2.

Material unsuitable for backfill shall be wasted and the backfill made with acceptable material in accordance with Section 3.2.

Instability due to excess moisture in the top 12 inches will not be recognized as justification for removal of unstable material, and no payment is to be made for manipulation and aeration of materials in place, necessary to establish a satisfactory subgrade.

5. For City Contracts the subgrade will be measured by the square yard along the center line of the roadbed.
6. For City Contracts the accepted subgrade, measured as provided above, will be paid for at the contract unit price per square yard for:

(A)	Subgrade, Method A	Square Yard
(B)	Subgrade, Method B	Square Yard

which shall be full compensation for furnishing materials, equipment, tools, labor and incidentals necessary to complete the work as specified.

3.4 <u>Processing Existing Base and Surface:</u>

1. This work shall consist of the removal, processing, reuse or disposal of existing aggregate surface course, or base course and asphalt surface. This work shall be done in accordance with one of the following methods as specified for the type of new construction proposed, the method shown on the plans, or as indicated by a pay item on the plans and in the proposal.
2. General construction methods shall be as follows: The aggregate or other course in place shall be loosened by scarifying or other suitable method to its full depth and width. All loosened aggregate or asphalt shall be processed and broken into pieces which will pass a 3 inch sieve. The materials shall be windrowed on the subgrade or shoulder as the case may require. Care shall be exercised in loosening and removing, processing and storage of aggregate to avoid addition of excess amounts of soil or other foreign material which would render it unsuitable for the use hereafter specified. Damaged material resulting from carelessness of the Contractor will not be paid for.

   <u>Method A.</u> (For Salvage and Stockpiling) The processed materials shall not contain detrimental amounts of subgrade or soil or other foreign material. The processed aggregate shall be loaded and hauled to storage locations indicated on the plans. All materials shall be stored in a neat and workmanlike manner. All grass, weeds and other rubbish shall be removed from storage area prior to stockpiling material.

   <u>Method B.</u> (For Use in Subgrade) The processed materials shall be windrowed on the shoulders during

the shaping and conditioning of the subgrade. The materials shall then be spread uniformly over the full width of the section and compacted and completed with the subgrade in accordance with the method specified.

Method C. (For Use as Subbase) The processed materials shall be spread evenly on the previously completed and compacted subgrade and then compacted to the requirements specified for the method of subgrade preparation.

Method D. (For Use in New Base Courses, Shoulders, or Ramps) The processed materials may be placed on the completed subgrade as a base course, shoulders or ramps, or it may be blended uniformly with new aggregate for any course. The suitability of the removed materials shall be determined by the Engineer and materials used as authorized.

These materials shall be compacted to not less than 95 per cent of Standard Density for shoulders, ramps and base courses.

3. For City Contracts, processing existing base and surface will be measured by the Square Yard along the center line of the road bed.
4. For City Contracts, the accepted quantities for processing Existing Base and Surface, measured as provided above, will be paid for at the contract unit price for:

(A)	Processing Existing Base and Surface, Method A	Sq Yd
(B)	Processing Existing Base and Surface, Method B	Sq Yd
(C)	Processing Existing Base and Surface, Method C	Sq Yd
(D)	Processing Existing Base and Surface, Method D	Sq Yd

which shall be full compensation for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

3.5 Lime Treatment of the Subgrade:

1. Description. This item shall consist of treatment of subgrade materials by mixing them with lime and compacting the mixture and shaping to conform to the lines, grades and depths shown on the Plans.
2. Materials.
   a. SOIL. The soil shall consist of soil in-place at the completion of the grading operations and suitable for lime modification. Soil shall be free of roots, sticks, sod tufts, and other deleterious concentrations of organic matter.
   b. LIME. The material shall consist essentially of calcium oxide or calcium hydroxide.

Chemical Composition - when tested under appropriate section of ASTM C-25:

Minimum available lime, percentage by weight (rapid sugar method), reported as CaO:		90.0%
Maximum carbon dioxide (as rec'd basis):		7.0%
Physical Size		
Hydrated Lime		
Retained on No. 6 sieve	Max.	0.0%
Retained on No. 10 sieve	Max.	1.0%
Retained on No. 30 sieve	Max.	2.5%

the Contractor to regulate sequence of his work, to use the amount of lime to render the soil suitable, maintain the work, and work the course as necessary to meet requirements of these specifications.

a) Weather Limitations. No lime shall be applied unless the temperature is at least 40 degrees F. in the shade and rising. The Contractor shall be responsible for the protection and the quality of the soil-lime mixture under any weather conditions.
b) Application of Lime.
   (1) Dry Method. The lime shall be applied at a uniform rate to assure equal distribution. Dry lime shall not be applied when wind conditions are such that blowing lime shall be objectionable to traffic or adjacent property owners. Lime shall be placed only on that area

where the first mixing operation can be completed during the same working day.

(2) Slurry Method. The lime shall be mixed in a central mixing tank. Agitation shall be accomplished through integral paddles, recirculating pumps, or a combination of these devices. The distributor truck shall be equipped with a pump and the slurry will be applied through the spray bars under pressure to assure a uniform flow and distribution.

The slurry shall consist of a minimum mixture of approximately one (1) ton of lime to each 500 gallons of water (about 30% solution) and shall not contain Quicklime

ASTM C-51-47 Quicklime Sizes

c) Ground, Screened or Granular -1/4" and smaller

c. WATER. Water shall be reasonably clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

3. Proportioning. The amount of lime applied to the subgrade shall be sufficient to produce modification of the soil to the extent expressed by the Engineer or shown on the plans. Rate of application will be stated by weight per square yard or subgrade for the depth to be modified.
4. Equipment. Equipment necessary for the proper construction of the work shall be on the job, in first class working condition, before construction operations commence. The Engineer shall have the right to reject any equipment which is not capable of producing desired results. R ejected equipment shall be replaced with approved equipment.
5. Construction Methods. It is the primary requirement of this specification to secure a completed course of treated material containing a uniform mixture of soil and lime.

The treated material shall be free from loose and segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing the subsequent courses. It shall be the responsibility of more than one (1) ton of lime to each 25 gallons of water (about 5O% solution).

c. First Mixing. The materials shall be mixed until a homogenous friable mixture of soil and lime is obtained, free from lumps or clods in excess of 2-1/2" in diameter. Proper moisture shall be maintained to allow uniform mixing of the materials. When the first mixing operation is completed, the moisture content shall be brought to not less than optimum and left to cure a minimum of three days or as otherwise directed by the Engineer, it shall be permissible to seal the surface of the modified area with a pneumatic roller to the extent that it will repel water and retain the moisture below. The moisture content of the mixture shall be maintained at optimum moisture during the curing period by sprinkling.

d. Final Mixing. After the required curing time, the material shall be uniformly remixed. At this time all material shall be pulverized to the extent that when all non-slacking aggregates retained on the No. 4 sieve are removed, the remainder of the material will meet the following requirements when tested dry by laboratory sieves:

Minimum passing 1-1/2" sieve	100%
Minimum passing No. 4 sieve	60%

e. Compaction. Compaction of the material shall be completed as soon as possible after final mixing, preferably the same day. Compaction shall be such that the modified material will be of uniform density for the full depth and area. The density shall not be less than 100% of Standard Proctor Density.

In addition to the requirements for density, the material shall be compacted to the extent that it will remain firm and stable under construction equipment. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these specifications. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface, upon completion, shall be smooth and in conformance with established lines, grades, and depths shown on the Plans. Should the material, due to any reason or cause, lose the required stability, density or finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense

of the Contractor.

6. For City Contracts. Lime Stabilized Subgrade will be measured by the square yard of the dimensions shown on the plans.
7. For City Contracts. Lime Stabilized Subgrade will be paid for at the contract unit price bid per square yard for "LIME STABILIZED SUBGRADE" completed in place and accepted. Such payment shall be full compensation for all materials, tools, labor, manipulation, and other incidentals necessary to complete the work as specified.

3.6 Sand Cushion Subbase:

1. This work shall consist of furnishing and placing a course of sandy material as a foundation for concrete pavement in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the Engineer.
2. Materials shall meet the requirements specified in Section 3.27.

3.7 Fine Aggregate – Bituminous Base

1. Description. This work shall consist of mineral aggregate, sand, stone screenings, gravel or a combination of those mixed with bituminous material in a central plant, spread and compacted in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the plans established by the Engineer.
2. Materials. Materials shall meet the requirements specified in Subsection 2 of Section 3.28, Materials: Bituminous plant mix shall be composed of a mixture of aggregate, filler, if required, and bituminous material. The several aggregate fractions shall be sized uniformly, graded and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula. When materials from two sources are used they will be independently controlled by the cold feed.

   Prior to use samples of all materials proposed to be used under these specifications shall be submitted to an approved laboratory for test and for the preparation of trial mixtures to determine the initial job-mix formula. Testing cost to be borne by the Contractor. After the plant is in operation a satisfactory job-mix formula will be determined.

   The job-mix formula with the allowable tolerances shall be within the master range specified. The job-mix formula for each mixture shall be in effect until modified in writing by the Engineer. The job-mix formula 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 delivered at the point of discharge. After the job-mix formula is established, all mixtures furnished for the project shall conform thereto within the following ranges of tolerances:

Passing No. 200	± 5%
Asphalt Cement	± 0.5%

   Should a change in source of material be made a new job-mix formula will be established before the new material is used.
3. Equipment. The equipment used for' producing, heating, mixing, hauling, spreading, compaction and finishing bituminous base shall meet the requirements of Section 411 of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission.
4. Construction Methods shall be as follows:
   a. Weather Limitations. No asphalt base shall be laid when there is frost in the foundation course. When conditions are such that the material becomes chilled to an extent which prevents proper leveling and thorough consolidation, the Engineer shall stop the laying of the asphalt base.
   b. Heating Bituminous Material. The bituminous material for the base mixture shall be heated at the mixing plant to a temperature of 250° F. to 325° F.
   c. Preparation of Mineral Aggregates. Mineral aggregates shall be dried and heated at the paving plant so that when delivered to the mixer they shall be at as low a temperature as is consistent with

proper mixing. The minimum temperature shall be such that the average moisture content of the aggregate in the plant bins does not exceed 1%. In no case shall the temperature exceed 325° F. All effort will be exerted to ensure a uniform heat of the dried aggregate.

d. Preparation of Bituminous Mixtures. The hot aggregate prepared as prescribed above shall be accurately measured and conveyed into the mixer in the proportionate amounts of each aggregate required to meet the specified grading. When batch type mixers are used, wet mixing time shall be determined by the Engineer for each plant and for each type of aggregate used.

e. Loading and Transportation of Mixture. In discharging the bituminous mixture from the mixer to trucks, every precaution shall be taken to prevent segregation of materials. The mixture shall be transported from the paving plant to the work in tight vehicles with metal bottoms previously cleaned of foreign materials. The vehicles shall be provided with canvas or other suitable material as may be required to protect the mixture from adverse weather conditions. The inside surface of all vehicles used for hauling mixtures may be lightly lubricated with a thin oil or soap solution just before loading, but excess of lubricant will not be permitted. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight unless artificial light satisfactory to the Engineer is provided.

f. Prime Coat. Prime Coat, as required by the plans, shall be in accordance with Section 3.10.

g. Tack Coat. Tack coat shall be in accordance with Section 3.9.

h. Placing the Base Course. The asphalt mixture shall be laid at a temperature of 180° F. to 300° F. and only upon an approved base which is dry. The mixture shall be delivered on the job at a minimum workable temperature which will produce the density herein specified after final compaction. After the minimum workable temperature is determined, it shall not vary more than plus or minus 20° F.

   The alignment of one edge shall be established by a string or wire line in advance of placing of the asphalt.

   The asphalt mixture shall be spread by means of a mechanical self-powered paver capable of spreading the mixture reasonably true to the line, grade, and crown set by the Engineer.

   When the asphalt mixture is placed in a narrow strip along the edge of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated, when authorized by the Engineer, provided a satisfactory surface can be obtained by other approved methods.

   Immediately after any course is screeded, and before roller compaction is started, the surface shall be checked, any irregularities adjusted, all fat sandy accumulation from the screed removed by a rake or hoe, and all fat spots in any course removed and replaced with satisfactory “material, Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is rolled.

   Placing of asphalt mixture shall be as continuous as possible and the roller shall pass over the unprotected edge of the fresh-laid mixture only when the laying of this course is to be discontinued for such length of time as to permit the asphalt mixture to become chilled.

i. Joints. Longitudinal and transverse joints shall be staggered approximately 6 inches. Well bonded and sealed joints are required.

   Transverse or longitudinal joints accumulating mud, dust or other foreign matter shall be cleaned to the satisfaction of the Engineer.

j. Compaction. As soon after being spread as it will bear the rollers without undue displacement, the

asphalt mixture shall be thoroughly and uniformly compacted with the rollers.

Rolling shall be done in such a manner and sufficient number of complete passes made so that a surface will be obtained meeting the tolerances for smoothness and density requirements specified herein.

Along curbs, headers, and similar structures, and at all places not accessible to the roller, the mixture shall be thoroughly compacted by approved methods.

After final compaction, each course shall at no point have a density less than 95 per cent of laboratory density.

The Contractor shall cut test samples from the pavement by sawing or coring at locations directed by the Engineer.

k. Tolerances. Any deficiency in the thickness of Fine Aggregate Bituminous Base will be compensated for by an increase in thickness of subsequent Asphaltic concrete placed thereon.

5. Testing Schedule. Testing methods, schedules and payment therefor shall be in accordance with Section 3.12, Subsection 14, of these specifications. In addition to these requirements, stability test shall be performed for each 500 tons of mix.
6. For City Contracts the following method of measurement should be used:
   a. Bituminous Base, Fine Aggregate Type, shall be measured by the square yard of surface laid on the thickness in place and accepted.
   b. Prime Coat, when required, will be measured and paid for in accordance with Section 3.10.
   c. Tack Coat, will be measured and paid for in accordance with Section 3.9.
7. For City Contracts. The accepted quantities measured as provided above will be paid for at the contract unit price for:

   Bituminous Base Fine Aggregate Type Square Yard which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

3.8 Portland Cement Concrete Base:

1. Description. This work shall consist of constructing a course of Portland Cement concrete base, with or without reinforcement as specified, on a prepared surface in accordance with these specifications, in reasonably close conformity with the established lines, grade and typical cross sections shown on the plans or established by the Engineer.
2. Materials. Materials shall meet the requirements specified in the following sections and subsections:

ITEM	SECTION	SUBSECTION
Portland Cement	3.24	1
Air-Entraining Admixtures	3.24	2
Water	3.25	1
Fine Aggregate	3.26	1
Coarse Aggregate	3.26	2
Joint Seal	3.26	2
Joint Filler	3.37	5 – 8
Steel Reinforcement, Dowel Bars & Tie	3.37	2 & 3
Bars	3.38	2 & 3
Metal Caps for Dowel Bars	3.39	1
Metal or Bituminous Parting Strip	3.39	3
Curing Materials	3.40	1 – 10
Chemical Admixtures for Concrete	3.27	4

3. Proportioning. Proportioning shall meet the requirements of Section 3.13, Subsection 7.
4. Equipment. The equipment shall meet the requirements of Section 3.13, Subsection 10. The Contractor may use a slip-form paver for this construction in accordance with Section 3.3, Subsection 45.
5. Construction Requirements. The construction methods used shall meet the applicable requirements of Section 3.13.
6. Surface Finishing. The surface of the concrete shall be broomed and slightly roughened. The surface shall be finished so there will be no deviation of more than 1/4 inch between any two contact points when tested with a 10 foot straightedge placed parallel to the center line.
7. Tolerance in Base Thickness. The thickness of the base will be determined by average caliper measurement of cores tested in accordance with Section 3.11. Adjustment of pay quantities shall be in accordance with Subsection 9.
8. For City Contracts. Portland cement concrete base will be measured by the square yard complete in place. The width for measurement will be the width of the pavement shown on the plans and additional widening where called for, or as otherwise directed. The length will be measured horizontally along the center line of each roadway or ramp.
9. The Basis of Payment for City Contracts shall be as follows:
   a. General. The accepted quantities of Portland Cement concrete base will be paid for at the contract unit price per square yard for Portland Cement concrete base, which payment shall be full compensation for furnishing and placing all materials, including any reinforcing, dowels and joint material; provided, however, for any base found deficient in thickness by more than 0.2 inch, but not more than 1.0 inch, only the reduced price stipulated below will be paid.

      No additional payment over the unit contract bid price will be made for any base which has an average thickness in excess of that shown on the plans.

      Payment will be made under:

Pay Item	Per Unit
Portland Cement Concrete Base	Square Yard

   c. Price Adjustments. Where the average thickness of base is deficient in thickness by more than 0.2 inch, but not more than 1.0 inch, payment will be made at an adjusted price as specified in the following table:

Deficiency in Thickness as Determined by Cores Inches	Proportional Part of Contract Price Allowed
0.00 to 0.20	100 per cent
0.21 to 0.30	80 per cent
0.31 to 0.40	72 per cent
0.41 to 0.50	69 per cent
0.51 to 0.75	57 per cent
0.76 to 1.00	50 per cent

      Where the thickness of base is deficient by more than one inch and the judgment of the Engineer is that the area of such deficiency should not be removed and replaced, there will be no payment for the area retained.

      Note: Mesh reinforcing, reinforcing steel and transverse expansion and contraction joints, including all load transmission devices may be paid for as separate items.

3.9 Tack Coat:

1. Description. This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

2. Materials. Materials shall meet the requirements specified in Subsection 708 of Section 700, Materials of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission.

   Emulsified Asphalt SS-1 708.03

   The SS-1 will be diluted as specified or directed by the Engineer to insure the desired coverage of the old surface. For average conditions a blend of 25% SS-1 and 75% additional water will be used.
3. Equipment. Distributors, heating equipment and supply tanks shall meet the requirements of Section 401.02 of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission.
4. Construction Methods. The existing surface or course shall be dry and cleaned to the satisfaction of the Engineer before the tack coat is placed. The tack coat shall be applied as directed by the Engineer, with an approved distributor or spray equipment at the rate of not to exceed 0.10 gallons per square yard of surface. All contact surfaces of curbs and gutters, manholes, and other structures shall be painted with a thin uniform coating of the approved tack coat material.

   The tack coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material. Tack coat shall not be applied during wet or cold weather, after sunset, or to a wet surface. However, the surface may be damp. The quantity, rate of application, temperature and areas to be treated shall be approved prior to application.
5. For City Contracts. Tack Coat will be measured before dilution. It will be measured by the gallon in accordance with Section 407.05 of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission. Water used in dilution of emulsified asphalt will not be measured for payment, except that the maximum dilution for quantity of SS-1, for payment hereunder shall be one part SS-1 to five parts water.
6. For City Contracts. The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

   Tack Coat Gal.

   which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

3.10 Prime Coat:

1. Description. This work shall consist of preparing and treating an existing surface with bituminous material, and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.
2. Materials. Materials shall meet the requirements specified in the following subsections of Section 700, Materials, of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission.

   Prime Material MC-30 or MC-70 708.03
   Prime Material SS-1 (diluted) 708.03

   Blotter material, if required, shall meet the requirements of Section 402.04(g) of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission.
3. Equipment. Distributors, heating equipment and supply tanks shall meet the requirements of Section 400.03 of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission.
4. Construction Methods shall be as follows:
   a. Weather Limitations. Bituminous material shall not be applied when the temperature is below 50° F air temperature in the shade, unless otherwise provided, or when weather conditions would otherwise prevent the proper construction of the prime coat.
   b. Preparation of Surface. Before priming, the subgrade, subbase or base shall be cleaned of loose material and shall be in a condition that maximum penetration of the prime will be obtained.
   c. Priming Subgrades, subbases or bases that are non-cohesive. Subject to the approval of the Engineer, when friable or non-cohesive materials are encountered in the surface to be primed, the

bituminous material shown on the plans may be changed to an asphalt emulsion and sprinkling water with asphalt emulsion added may be used in the final operations of sprinkling, manipulation, shaping and rolling of the subgrade, subbase or base. Additional applications may be made if required to form a firm, bonded, working table.

d. Application of Bituminous Material. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread at the approximate rate of 0.1 to 0.4 gallon per square yard as directed by the Engineer. When traffic is maintained, not more than 1/2 of the width of the section shall be treated in one application. Care shall be taken that the application of bituminous material at the junctions of spreads if not in excess of the specified amount. Excess bituminous material shall be removed from the surface. Skipped areas or deficiencies shall be corrected.

   When traffic is maintained, one-way traffic shall be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portion and the remaining width of the section shall be primed.

   The quantities, rate of application, temperatures and areas to be treated shall be approved before application of the prime coat.

   Succeeding applications of bituminous materials or other courses shall not be applied until after sufficient time has elapsed to allow both proper penetration and hardening of the prime coat. Extreme care will be exercised to prevent the entrapment of volatiles in the prime materials.

d. Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate within the time specified and the roadway must be used for traffic, blotter material shall be spread in the amounts required to absorb any excess bituminous material.

5. For City Contracts. Bituminous material will be measured by the gallon in accordance with Section 408.05 of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission. If an asphalt emulsion is substituted for the bituminous material shown on the plans, measurement will be made before dilution with water on the project. Blotter material, if required, will not be measured for payment.
6. For City Contracts. The accepted quantities of prime coat, measured as provided above, will be paid for at the contract price for:

   Prime Coat Gal.

   which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

3.11 Tolerance in Pavement Thickness:

1. It is the intent of these specifications that all pavement shall be constructed in accordance with the details and to the thickness shown on the plans. After the street pavement is complete, should any question arise as to a possible deficiency in pavement thickness, at any location; then core specimens shall be cut from the completed pavement at these locations. If the average thickness of the pavement as determined by caliper measurements of the cores made in accordance with AASHO T-l48, shows the average pavement thickness to be equal to or greater than the specified thickness or not more than 5% less than the specified thickness; then the cost of coring shall be paid for by the City and the Contractor will receive full payment for the pavement in question; provided that, any core which shows a total pavement thickness equal to or greater than the specified thickness shall not be used in calculating the average pavement thickness. It being the intent of these specifications to reject any pavement which is more than 10% deficient in thickness.

   Should the average pavement thickness, determined as described above, be between 5% and 10% less

than the specified thickness, then the Contractor may accept reduced payment for the area represented by the cores made, in accordance with the following schedule:

Deficiency in Thickness Per Cent of Total	Reduction in Unit Contract Price
Less than 5%	None
5% to 6%	10%
6% to 7%	20%
7% to 8%	30%
8% to 9%	40%
9% to 10%	50%
More than 10%	No Payment*

* Portland Cement concrete pavement must be removed and replaced to specified thickness. Asphaltic concrete pavement may be brought to specified thickness by applying tack coat and an overlay of surface material in not less than one (1) inch increments providing the requirements of Section 3.12, Subsection 13.

The contractor shall pay for all cores which show the average total thickness to be more than 5% less than the specified thickness. The contractor may correct any pavement thickness between 5% and 10% deficiency, as provided above, after which he will receive full payment.

Each core taken will be assumed to represent the thickness of the pavement for a longitudinal distance of one hundred (100) feet, fifty (50) feet on each side of the core location and transversely for one-half (1/2) street width. The contractor may make and pay for additional cores to define any section of pavement which shows to be deficient in thickness, to within closer limits than set out above, if he so desires.

Core holes shall be filled with material matching the pavement from which the cores were cut, in an acceptable manner.

3.12 Asphalt Concrete:

1. Description. This item shall consist of one or more courses of compacted asphalt concrete leveling, binder and/or surface course. The mixtures shall be composed of a mineral aggregate uniformly coated with an approved asphalt cement and shall be laid under a previously compacted and approved subgrade or overlay of an existing street. Thickness of the various courses shall be as shown on the plans for each project constructed under these specifications.
2. Materials. Materials shall meet the requirements specified in Section 3.28, Subsection 1 of these specifications.

   The bituminous plant mix shall be composed of a mixture of aggregate, filler, if required, and bituminous material. Prior to use, samples of all materials proposed to be used under these specifications, shall be submitted to an approved laboratory for test and for preparation of trial mixtures to determine the initial job-mix 'formula. Asphalt shall be 85-100 penetration unless otherwise specified in the plans. A Certificate of Compliance with Subsection 708 of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission will be required for the asphalt. Local materials will be approved for use when they meet the gradation and other requirements specified herein, except for surface courses, as noted in Section 3.28, Subsection 1, of these specifications. Proportioning of the various materials entering into the asphalt mixture shall be as directed by the laboratory and in accordance with these specifications. The Engineer or his representative shall have access at any time to all parts of the paving plant. Satisfactory equipment and construction methods shall be used as hereinafter specified.

After the plant is in operation, a satisfactory job-mix formula will be determined. Any appreciable changes from the laboratory approved job-mix formula will be retested by the laboratory. The job-mix formula with the allowable tolerances shall be within the master range specified for the particular type of bituminous concrete. The job-mix formula for each mixture shall be in effect until modified in writing by the Engineer. The job-mix formula for each mixture shall establish a single percentage of bituminous material to be added to the aggregate, and a single temperature at which the mixture is to be delivered at the point of discharge.

After the job-mix formula is established, all mixtures furnished for the project shall conform thereto with the following ranges of tolerances:

Passing No. 4 and larger sieves	±5 per cent
Passing No. 8 to No. 100 sieves(incl.)	±4 per cent
Passing No. 200 sieve	±2 per cent
Bitumen 0.2 to	±0.4 per cent
Temperature of mixture	± 20 degrees F.

The above variations from the job-mix formula shall not permit the use of any mix which would be outside of the specification limits through the applications of the variations.

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 establish a new job-mix formula.

3. Equipment Requirements. All plants and equipment used by the contractor for the preparation, laying and compaction of materials under these specifications shall meet the requirements of the current Standard Specifications for Highway Construction of the Oklahoma State Highway Commission, except that, only batch type plants will be allowed.
4. Inspection and Control of Asphalt Mixing Plants shall be as follows:
   a. General. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mixes, the Engineer or his authorized representative will at all times have access to all portions of the mixing plant, aggregate plant, storage yards and other facilities for producing and processing the materials of construction. All sampling and testing of processed and unprocessed material shall be under the control and direction of the Engineer, and shall be accomplished in accordance with the provisions set forth in these specifications.
   b. Job-Mix Formula. The Engineer will make frequent gradation analyses of the hot aggregates and of the completed mix to be certain that the materials being used and produced are within the tolerances of the job-mix formula and the specifications of the mix number being used. if the mix is found to be outside of the job-mix formula tolerances, or outside of the specification limits, correction shall be made in quantities measured from the hot bins and adjustments made at the cold bin feeders.
   c. Sampling and Testing. Stockpiles and bins will be samples for gradation analysis and examined for dust coating and for other purposes, in compliance with stated requirements.

Gradation analyses of each hot bin will be performed and a combined analysis: computed at least twice a day- once in the forenoon, and once in the afternoon. A combined gradation analysis will be performed at least twice a day. If materials do not run uniform, more frequent tests will be made. When requested by the Engineer, the Contractor shall provide representative samples by taking aggregate from the discharge of the aggregate through each of the hot bin gates, or by drawing aggregate from each bin through the mixing chamber (without asphalt) into a truck or other receptacle. At least one sample shall be taken from each 300 tons of the mix being produced. Samples will be used to determine compliance with general and special requirements set forth in these specifications.

5. Preparation of Area to be Paved. The area to be paved shall be true to line and grade, and have a dry and properly prepared surface prior to the start of paving operations. It shall be free from all loose

screenings and other loose or foreign material. Where a base is rough or uneven, a leveling course shall be placed by use of paver or motor grader and shall be properly compacted before the placing of subsequent courses. When a leveling course is not required, all depressions and other irregularities shall be patched or corrected and the work approved by the Engineer before the paving operation begins. All fatty and unsuitable patches, excess crack or joint filler, and all surplus bituminous material shall be removed from the area to be paved. Blotting of excessive deposits of asphalt with sand or stone shall not be permitted. Where the area to be paved is a prepared soil or aggregate base, it shall be primed in accordance with Section 3.10 of these specifications. The prime coat shall consist of an application of the asphalt material indicated, and at the rate specified. The prime coat shall be allowed to cure properly before 'any further operations are permitted on the primed area. A tack coat shall be applied when the surface is to be paved is an existing Portland Cement concrete, brick or asphalt pavement. When a tack coat is required, it shall consist of an application of the asphalt material indicated, and at the rate specified in Section 3.9 of these specifications. The surface of curbs, gutters, vertical faces of existing pavement and all structures in actual contact with asphalt mixes shall be painted with a thin, complete coating of asphalt material to provide a closely bonded watertight joint.

6. Preparation of Paving Asphalt. The asphalt shall be heated at the paving plant to a temperature at which it can be uniformly distributed throughout the mix. It shall be delivered into the contractor's tank at a temperature not exceeding 350° F., and shall not be heated above this temperature for any operation of the paving plant.
7. Preparation of Handling of Aggregates. Coarse and fine aggregates shall be stored at the plant in such a manner that the separate sizes will not become intermixed. Cold aggregates shall be carefully fed to the plant in such proportions that surpluses and shortages in the hot bins will not cause breaks in the continuous operation. When loading aggregate into stockpiles and trucks the material shall be placed in such a manner as to prevent segregation of aggregate sizes. Coarse and fine aggregate may be sampled and tested upon arrival at the plant in accordance with the standard methods. Samples of coarse and fine aggregate shall be submitted to the Engineer for testing prior to the start of work, and as often thereafter as requested by the Engineer.

   When coarse aggregate grading is such that the material will tend to segregate during stockpiling or handling, it shall be supplied in two or more sizes. Each size of coarse aggregate required to produce the combined gradation specified shall be placed in individual stockpiles at the plant site and separated by bulkheads or other means approved by the Engineer. Likewise, when it is necessary to blend fine aggregates from one or more sources to produce the combined gradation, each source or size of fine aggregate shall also be placed in individual stockpiles. Aggregate from the individual stockpiles shall be fed through separate bins to the cold elevator feeders. They shall not be blended in the stockpile.
   a. Drying. The aggregate shall be thoroughly dried and heated to provide a paving mix temperature within a tolerance of ±20 degrees F., of that specified by the Engineer. The moisture content of the heated and dried aggregate shall not exceed 0.5 per cent. The quantity of material fed through the dryer shall in all cases be held to an amount which can be thoroughly dried and heated in accordance with that specified in "Proportioning and Mixing."
   b. Screening. Aggregates shall be screened into sizes such that they may be recombined into a gradation meeting the requirements of the job-mix formula.
   c. Hot Aggregate Storage. Hot screened aggregate storage shall be accomplished in such a manner as to minimize segregation and loss of temperature of the aggregate.
8. Proportioning and Mixing. To aid in determining the proper temperature of the completed batch, current asphalt viscosity data shall be provided and shall be available at the plant at all times. With information relative to the viscosity of the particular asphalt being used, the temperature of the completed mix at the plant and at the paver shall be designated by the Engineer after discussing with the Contractor the hauling and placing conditions. The asphalt shall be heated so that it can be distributed uniformly throughout the batch. For mixing applications, the specified temperature generally will be such that the asphalt viscosity is within the range of 150-300 centistokes (75-150 seconds, Saybolt Furol). The

material shall be sufficiently fluid to produce a complete coating on every particle of aggregate within the specified mixing time. The temperature of the aggregates and asphalt immediately prior to mixing shall be approximately that of the completed batch.

When the mix is produced in a batch-type plant, the aggregate shall be weighed accurately in the designated proportions to provide the specified batch weight. The temperature of the aggregate at the time of introduction into the mixer shall be as directed by the Engineer, with a tolerance of ± 20 degrees F. In no case, however, shall the temperature of the mixture exceed 350 degrees F.

9. Control of the Mixing Time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is the interval of time between the opening of the weigh box gate and the application of the asphalt. The wet mixing period is the interval of time between the application of all asphalt and the opening of the mixer gate for discharge. When it is applied by a spray system, the wet mixing time shall begin with the start of the asphalt spray.
   a. Batch Type Plants. The Engineer will designate the length of time of both the dry and wet mixing periods to insure a uniformly and completely coated mix. Mixing period time shall not be altered unless so ordered by the Engineer. A dry mixing period of not less than five seconds shall precede the addition of the asphalt to the mix. Excess wet mixing shall be avoided. Wet mixing shall continue as long as is necessary to obtain a thoroughly blended mix but shall not exceed 75 seconds nor be less than 30 seconds.
10. Transportation of Mix. The mix shall be transported to the job site in vehicles cleaned of all foreign material which may affect the mix. The truck beds shall be painted, or sprayed, with limewater, soap, or detergent solution, at least once a day or as often as required. After this operation, the truck bed shall be elevated and thoroughly drained; no excess solution shall be permitted. The dispatching of the vehicles shall be so scheduled that all material delivered may be placed in daylight; unless the Engineer approves artificial light. Delivery of material to the paver shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.
11. Spreading and Finishing. The minimum temperature of the bituminous mixes to be placed shall be 225 degrees F. Spreading and finishing shall be conducted in the following manner:

    a. Mechanical Pavers. The base and surface courses shall be spread and struck off with a mechanical paving machine meeting the requirements of these specifications. The paving machine shall be operated so that material does not accumulate and remain along the sides of the receiving hopper. Equipment which leaves tracks or indented areas which cannot be corrected in normal operation, or which produces flushing or other permanent blemishes or fails to produce a satisfactory surface, shall not be used.

       Longitudinal joints and edges shall be constructed to true line markings. Lines for the paver to follow in placing individual lanes will be established by the Engineer parallel to the center line of the proposed roadway. The paver shall be positioned and operated to follow closely the established line. When using pavers in echelon, the first paver shall follow the marks or lines, and the second paver shall follow the edge of the material placed by the first paver. In order to assure a hot joint and obtain proper compaction, the pavers shall work as close together as possible and in no case shall they be more than 100 feet apart. In backing trucks against the paver, care shall be taken not to jar it out of its proper alignment. As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediate1y suspended until the cause is determined and corrected. Transverse joints in succeeding courses shall be offset at least two feet. Longitudinal joints shall be offset at least six inches.

Any irregularities in alignment left by the paver shall he corrected by trimming directly behind the machine. Immediately after trimming, the edges of the course shall be thoroughly compacted by tamping. Distortion of the pavement during this operation shall be avoided. Edges against which additional pavement is to be placed shall be straight and approximately vertical. A lute or covered rake shall be used immediately behind the paver, when required, to obtain a true line and vertical edge. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material forming high spots shall be removed by a shovel or lute. Indented areas shall be filled with hot mix and smooted with the back of a shovel being pulled over the surface. Broadcasting of material over such areas shall not be permitted.

b. Motor Grader. When the Engineer permits the use of motor graders for the spreading of a leveling course, the material shall be placed on the roadbed in a windrow by a windrow-leveler, measuring device or by other methods approved by the Engineer so that the proper amount of material is available. The mix shall be spread to the required thickness, line and grade with a uniform surface texture while at a workable temperature. The Engineer will specify the length of the windrowed mix ahead of the spreading operations, based upon the workability of the mix, weather conditions and the time required for the spreading operation.

c. Hand Spreading. In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand, if so directed by the Engineer. Wood or steel forms, approved by the Engineer, rigidly supported to assure correct grade and cross-section, may be used. In such instances, measuring blocks arid intermediate strips shall be used to aid in obtaining the required cross-section. Placing by hand shall be performed carefully; the material shall be distributed uniformly to avoid segregation of the coarse and fine aggregate. Broadcasting of material shall not be permitted. During the spreading operation, all material shall be thoroughly loosened and uniformly distributed by lutes or covered rakes. Material that has formed into lumps and does not break down readily shall be rejected. Following placing and before rolling, the surface shall be checked with templates and straightedges and all irregularities corrected.

Heating equipment used for keeping hand tools free from asphalt shall be provided. Caution shall be exercised to prevent high heating temperatures which may burn the material. The temperature of the tools when used shall not be greater than the temperature of the mix being placed. Heat should be employed to clean hand tools, if petroleum oils or solvents are used extreme care must be exercised to not use excessive quantity or to contaminate the mix.

12. Compaction shall be in accordance with the following:

a. General. Rolling equipment for use in compacting mixes shall meet the requirements of the Standard Specifications for Highway Construction at the Oklahoma State Highway Commission. Except for small jobs, such as driveways, at least two rollers shall be required at all times, one of which shall be a self propelled pneumatic. As many additional roller shall be used as necessary to provide specified pavement density. During rolling the roller wheels shall be kept moist with only sufficient water to avoid picking up the material.

After the longitudinal joints and edges have been compacted, rolling shall start longitudinal at the sides and gradually progress toward the center of the pavement. This holds true except on super-elevated curves where the rolling ~shall begin on the low side and progress to the high sides, overlapping on successive trips by at least one-half the width of tandem rollers and uniformly lapping each preceding track or covering the entire surface with the rear wheels when three-wheeled rollers are used. The rollers shall move at a slow but uniform speed with the drive roll or wheel nearest the paver. The speed shall not exceed three m.p.h. for steel wheeled rollers or five m.p.h. for pneumatic-tired rollers.

The line of rolling shall not be changed suddenly or the direction of rolling reversed suddenly. If rolling causes displacement of the material, the affected areas shall be loosened at once with lutes or

shovels and restored to the original grade of the loose material before being rerolled. Heavy equipment or rollers shall not be permitted to stand on the finished surface before it has been compacted and has thoroughly cooled.

When paving in single width, the first lane placed shall be rolled in the following order:

1. Transverse joints;
2. Outside edge;
3. Initial or breakdown rolling, beginning on the low side and progressing toward the high side;
4. Second rolling same procedure as (3); and
5. Finish rolling.

When paving in echelon, or abutting a previously placed lane, the longitudinal joint rolling shall follow the transverse joint rolling.

When paving in echelon, two or three inches of the edge which the second paver is following shall be left unrolled, and rolled when the joint between the lanes is rolled. Edges shall not be exposed more than fifteen minutes without being rolled. Particular attention shall be given to the construction of transverse and longitudinal joints in all courses.

In laying a surface mix adjacent to any finished area, it shall be placed sufficiently high so that, when compacted, the finished surface will be true and uniform. When the wearing course is placed adjacent to curbs to form an asphalt gutter, it shall be sealed with asphalt for a distance of 12 inches from the curb. The seal shall be evenly applied to the surface by means of hot irons or squeeges so that the surface void are completely filled and no excess asphalt remains on the surface. When necessary to do this in areas carrying traffic, the Engineer may direct that the surface be lightly dusted. Where the grade is slight, gutters shall be checked with a straightedge and tested with running water to insure drainage to the desired outlet.

b. Transverse Joints. Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straightedged and stringlined to assure smoothness and true alignment. If the joint is formed with a bulkhead, such as a board, to provide a straight line and vertical face, it shall be checked with a straightedge before fresh material is placed against it to complete the joint. If a bulkhead is not used to form the joint and the roller is permitted to roll over the end of the new material, the line of joint shall be located back of the rounded edge a sufficient distance to provide a true surface and cross-section. If the joint has been distorted by traffic or by other means, it shall be trimmed to line. In either case, the joint face shall be painted with a thin coating of asphalt before the fresh material is placed against it.

To obtain thorough compaction of these joints, the material placed against the joint shall be tightly crowded against the vertical face of the joint. To accomplish this, the paving machine shall be positioned so that the material shall overlap the edge of the joint one inch to two inches. The depth of the overlapped material shall be kept uniform. The coarse aggregate in the overlapped material that has dislodged through raking or luting shall be <u>removed from the pavement surface and discarded</u>.

If a three-wheeled roller is used, it shall be placed on the previously compacted material transversely so that not more than six inches of the rear rolling wheel rides on the edge of the joint. The roller shall be operated to pinch and press the mix into place at the transverse joint. The roller shall continue to roll along this line, shifting its position gradually across the joint, in six-to-eight inch increments, until the joint has been rolled with the entire width of the roller wheel. Rolling shall be continued until a thoroughly compacted, neat joint is obtained. If only tandem rollers are available,

they shall be similarly operated to complete the joint. Transverse joint shall be held to a minimum. When paving single width and maintaining traffic, one lane shall be taken no farther than one-half of the total paving day. At the end of the paving day all lar.es shall be completed to approximately the same station. When paving in echelon, the lanes shall be as nearly even as practical.

c. Longitudinal Joints. Longitudinal joints shall be rolled directly behind the paving operation. The first lane placed shall be true to line and grade and have an approximately vertical face. The material being placed in the abutting lane shall then be tightly crowded against the face of the previously placed lane. The paver shall .then be positioned so that in spreading, the material overlaps the edge of the lane previously placed by one or two inches. The width and depth of the overlapped material shall be kept uniform at all times. The paver shall closely follow the line or markings placed along the joint for alignment purposes. Before rolling, the coarse aggregate in the material overlapping the joint shall be carefully removed with a rake or lute and discarded.

   When rolling is accomplished with a three-wheeled roller, it shall be shifted over onto the previously placed lane so that not more than six inches of the rear roller wheel rides on the edges of the fine material left by brooming. The rollers shall then be operated so as to pinch or press the fines gradually across the joint. If only tandem rollers are available, they shall be similarly operated to complete the joint. When the abutting lane is not placed in the same day, or the joint is distorted during the day's work by traffic or by other means the edge of the lane shall be carefully trimmed to line and painted with a very thin coating of asphalt before the abutting lane is placed.

d. Edges or Abutting Curbs and Gutter. The edges of the pavement shall be rolled concurrently with or immediately after rolling the longitudinal joint. Care shall be exercised in consolidating each course along the entire length of the edge. Before it is compacted, the material along the unsupported edges or surface shall be slightly elevated with a lute. This will permit the full weight of the roller wheel to bear on the material to the extreme edge of the mat and insure that the mix is above the gutter. In rolling pavement edges, roller wheels shall extend two inches to four inches beyond the pavement edge.

e. Breakdown. Breakdown rolling shall immediately follow the rolling of the longitudinal joint and edges. Rollers shall be operated as close to the paver as necessary to obtain adequate density without causing undue displacement. The breakdown roller shall be operated with the drive roll or wheel nearest the finishing machine. Exceptions may be made by the Engineer when working on a steep slope or super-elevated curve. When both three-wheeled rollers and tandem rollers are used, the three-wheeled rollers shall work directly behind the paver followed by the tandem rollers. Only experienced roller operators shall be used for this work.

f. Second Rolling. Self propelled pneumatic tired rollers shall be used for the second rolling. The second rolling shall follow the breakdown rolling as closely as possible and while the paving mix is still of a temperature that will result in maximum density from this operation. Pneumatic tired rolling shall be continuous (at least five complete coverages will be made) after the initial rolling until all of the mix placed has been thoroughly compacted. Turning of pneumatic tired rollers on the hot paving mix which causes undue displacement shall not be permitted.

g. Finish Rolling. The finish rolling shall be accomplished with two-axle tandems or three-axle tandems while, the material is still warm enough for the removal of Roller marks. To obtain the desired surface finish, pneumatic tired rollers shall be required. All rolling operations shall be conducted in close sequence. In places inaccessible for the operation of standard rollers as specified, compaction shall be performed by trench rollers. The trench roller shall be operated at the direction of the Engineer until the course is thoroughly compacted. Hand tamping, manual or mechanical, may be used in such areas if it is proved to the Engineer that such operations will give the desired density.

h. Shoulders. Where paved shoulders or curb and gutters are not used, the shoulder material shall not be placed against the edges of the pavement until the rolling of the surface course has been completed. Adequate precaution shall be taken to prevent distortion of the pavement edge from specified line grade. When shoulders are paved (except in conjunction with the travel way paving)

cold joint construction procedure shall be required to insure a tight bond at the joint.

13. Density Thickness and Surface Requirements. The completed pavement shall have a density equal to or greater than 95~ of a laboratory specimen prepared as specified and made from plant mix conforming to the job-mix formula. The final surface shall be of a uniform texture and shall conform to line and grade shown on the plans. Before final acceptance of the project, or during the progress of the work, the thickness of all courses will be determined by the Engineer. All unsatisfactory work shall be handled in accordance with Section 3.11. Both density and thickness shall be carefully controlled during the construction and shall be in full compliance with the plans and specifications. During construction, preliminary tests, as an aid for controlling the thickness, shall be made by inserting a flat blade, correctly graduated, through the material to the tops of the previously placed base; or by other means approved by the Engineer.

    In checking compacted depth or density, the cutting of the test holes, refilling with acceptable material, and proper compaction shall be done by the Contractor under the supervision of the Engineer. The tolerances allowable on the surface course will be as indicated by the table below, for the category of facility being constructed:

    a. Residential Street 1/4" in 10'
    b. Collectors 1/4" in 10'
    c. Arterial 1/8" in 10'

    The straightedge shall be held in successive position parallel to the street center line in contact with the surface, and the entire area checked from one side to the other. Corrective action, if required, will be in accordance with Section 3.11, or by a suitable method of grinding or cutting.

14. Testing Schedule. General. The following testing will be required on mixes produced under these specifications:
    a. Job-Mix Design. The Contractor shall provide the city with a complete Job-Mix Design performed by a laboratory, approved by the city. A design need not be performed for each project, but the design for each project must have been accomplished not longer than six months before the commencement of the project. The Contractor will be responsible for the cost of this testing, unless otherwise stated in the Special Provisions. A new Job-Mix design will be performed if materials sources are changed during the project.
    b. Aggregates. The Contractor shall provide the contracting agency with copies of the tests required by Section 3.28, Subsection 1, for each aggregate to be used on this project. If the contracting agency elects to have additional testing accomplished, they shall be responsible for the costs thereof.
    c. Asphalt. The Contractor shall obtain from his asphalt supplier, and furnish the contracting agency, with a Certificate of Analysis of each different type and grade of asphalt used on the project. All asphalt products will be required to meet the provisions of Section 715 – Bituminous Materials, of the latest edition of the Standard Specifications for Highway Construction of the Oklahoma Highway Commission. If the owner elects to have additional testing accomplished on the asphalt materials, he shall be responsible for the cost of same.
    d. Construction Control. In addition to the preliminary tests and trial mixes, the following tests from the completed asphalt pavement will be required:

Description	Method of Test	Quantity Represented One Test
Asphalt – Extraction and Gradation	AASHO-T-30 AASHO-T-58	250 tons or 952 sq yds asphaltic paving
Asphalt – Field Density	OHD – L-14	500 tons or 1904 sq yds asphaltic paving test
Stability Value – Vheem test	OHD – L-16	will be taken at discretion of Engineer

The party responsible for the cost of testing required in paragraph (d) above, developer, consulting engineer, or contractor, shall be established prior to construction.

15. Method of Measurement. For City Contracts, asphalt concrete pavement shall be measured by the square yard of the surface area of the specified types of courses and thicknesses in place and accepted. Asphalt concrete leveling course if required by the plans shall be measured by the ton (2000 lb) of material actually used in the completed and accepted work. Tack coat will be measured by the gallons of Asphalt Emulsion, before dilution. Prime, if specified, shall be measured by the gallons used, converted to 60 degrees F.
16. Basis of Payment. For City Contracts, the various items measured as provide above will be paid for at the contract unit price bid per square yard for asphalt concrete pavement, of the specified types of courses and specified thicknesses, at the unit price bid per ton for asphalt concrete leveling course and the contract unit price for tack coat and prime if included as a bid item in the proposal. Such payment shall be compensation in full for preliminary tests and for all additional tests required by the schedule set for tests required by these specifications, for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications. No payment will be made for tack coat material used in painting longitudinal construction joints, curbs, gutters, headers, manholes, etc.

3.13 Portland Cement Concrete Pavement:

1. Description. This work shall consist of a pavement composed of Portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.
2. Materials.
   a. Materials shall meet the requirements specified in the following sections and subsections:

ITEM	SECTION	SUBSECTION
Portland Cement	3.24	1
Air-Entraining Admixtures	3.24	2
Water	3.25	1
Fine Aggregate	3.26	1
Coarse Aggregate	3.26	2
Joint Seal	3.26	2
Joint Filler	3.37	5 – 8
Steel Reinforcement, Dowel Bars & Tie	3.37	2 & 3
Bars	3.38	2 & 3
Metal Caps for Dowel Bars	3.39	1
Metal or Bituminous Parting Strip	3.39	3
Curing Materials	3.40	1 – 10
Chemical Admixtures for Concrete	3.27	4

3. Subgrade Construction Requirements. The bottom of the excavation for the pavement or top of the fill shall be known as the pavement subgrade and shall conform to the lines, grade and cross-sections shown on the plans. If in the opinion of the Engineer, the existing subgrade material cannot be compacted to meet the requirements of Section 3.3, this material shall be considered unsuitable and shall be removed as directed and replaced with suitable material which shall be placed and compacted as specified in Section 3.3. The subgrade shall be brought to a firm and unyielding condition with a uniform density meeting the criteria established by the Engineer. It shall be compacted at or slightly above the optimum moisture content.

   All utility trenches and structure excavations shall be backfilled to natural or finished grade as soon as conditions permit. All backfill shall be made with clean, flushed river sand. All backfilled areas which function as subgrade as described above shall meet the subgrade requirements specified in this section.

The paving contractor shall be responsible for only the trenches he cuts under this contract. Immediately prior to placing the concrete, the subgrade shall be tested for conformity with the cross-section shown on the plans by means of an approved template riding on the side forms. If necessary, material shall be removed or added, .as required, to bring all portions of the subgrade to the correct elevation. It shall then be thoroughly compacted and again tested with the template. Concrete shall not be placed on any portion of the subgrade which has not been tested for correct elevation. The subgrade should also be cleared of any loose material which may have fallen upon it.

4. Protection of Subgrade. The finished subgrade shall be maintained in a smooth and compacted condition until the concrete has been placed. The mixer, ready-mix trucks, or other equipment shall not operate between the forms in the paving lane unless conditions of the job will not permit operation from the shoulder or outside the lane. Mixer or ready-mix trucks shall not be permitted to operate from previously paved lanes until the pavement is ready to open to traffic. If it is necessary to operate trucks between the forms and the trucks cause rutting or displacement of the subgrade material, either lighter trucks shall be used or suitable runways shall be provided. The contractor shall re-roll or hand-tamp the subgrade to correct any ruts or other objectionable irregularities which may have been caused by the trucking of materials. A berm shall be graded between the curb and sidewalk, or property line where there are no existing sidewalks, in a neat, workmanlike manner. All excess concrete and debris shall be removed from the excavation behind the curb line before backfilling.
5. Sand Cushion Sub-Base. After the subgrade has been properly prepared, a layer of clean durable sand may be placed thereon, if required by the plans; after which it shall be thoroughly wet down. The sand shall be completely saturated to settle the sand and to moisten the subgrade. Sand for sub-base shall conform to Section 3.27.
6. Batching. Measurement and batching of cement, fine and coarse aggregates shall be by weight on scales that are accurate to within 4/10 of one percent. One sack of cement shall be considered to weigh 94 lb. net. Bulk cement and cement from fractional sacks shall be weighed.
7. Composition of Concrete. The proportions of Portland Cement, fine aggregate, coarse aggregate and water shall be such as to produce a dense, plastic concrete with a slump of not less than one and one-half (1½) inches nor more than three (3) inches and which will have a minimum 28-day compressive strength of at least thirty-five hundred (3500) pounds per square inch when sampled and tested in accordance with A.S.T.M., C31 and C39 or AASHO, 123 and 122 respectively. The maximum size aggregate shall not exceed 30% of the pavement slab thickness. All concrete shall be air-entrained and the volume of air in the freshly mixed concrete shall be based on the following table:

Maximum Size of Course Aggregate	Air Content by Volume
1½", 5" and 2½"	4% to 6%
¾" to 1"	5% to 7%
3/8" to ½"	6½% to 8½%

The entrained air shall be obtained either by using air entraining cement or an air-entraining admixture that meets the applicable requirements of latest ASTM and AASHO specifications. When high-early-strength concrete for pavement is specified or used, it shall be in accordance with Section 3.13, Subsection 8. The use of admixtures for any purpose other than air-entrainment will be permitted only with the written permission of the City Engineer.

8. High Early Strength Concrete. General. When high early strength concrete pavement is specified, it shall be made with high early strength cement. In lieu of high early strength cement, and with written permission of the Engineer, the Contractor may use standard Portland Cement with a cement factor 25 per cent in excess of that specified for Portland Cement concrete pavement. No additional compensations will be allowed for the 25 per cent additional cement if standard Portland Cement is used. When 25 per cent of cement is added, the absolute volumes in the mix will be adjusted to compensate for the additional cement. All other requirements hereinbefore specified for concrete pavement shall be applicable subject to the following modifications.

Curing. When high early strength concrete pavements is specified or used, the pavement shall be cured in the same manner as is provided for regular pavement.

Opening to Traffic. Traffic shall be excluded from the newly constructed pavement for a period of not less than 24 hours and for 72 hours if necessary, unless test beams prepared in accordance with Subsection 46 meet strength requirements specified in Subsection 47 before 72 hours.

9. Consistency. Slump shall be determined using AASHO T-119 or ASTM-C143. The Contractor shall keep a standard slump cone on the job at all times. Should water need to be added at the job site to increase slump within limits, the cement must be increased at the same time so that the water per sack of cement does not exceed 5.5 gallon per sack, unless otherwise approved by the Engineer.
10. Equipment. Equipment necessary for the proper construction of the work shall be on the project in first class working condition, before construction operations begin, and shall be approved by the City Engineer as to design, capacity and mechanical condition. The City Engineer shall have the right to reject any equipment which is not capable of producing the specified results, or which cannot be properly calibrated or controlled. Rejected equipment shall be replaced with approved equipment.
11. Job Mixed Concrete. All handling, measuring and batching of materials; mixing of concrete and equipment used for job mixed concrete shall conform to the applicable subsections of Section 414 - Portland Cement Concrete Pavement of the latest edition of the Standard Specifications for Highway Construction published by the Oklahoma State Highway Commission.
12. Ready Mixed Concrete. Ready-mixed concrete shall be mixed and transported in accordance with the current AASHO Specifications for Ready-Mixed Concrete, Designation M-157. When concrete is hauled in truck mixers, no more than 60 minutes shall elapse from the time water is added to the mix until the concrete is deposited in place at the site of work. Retempering concrete by adding water or by other means shall not be permitted. When construction conditions are such that it is absolutely necessary for trucks hauling concrete to operate on the grade between forms they shall not back over previously deposited concrete.
13. Measuring Air Content. The air content of freshly mixed air-entrained concrete shall be checked at least twice daily. Concrete with air contents above or below the amount specified in Subsection 7 shall be corrected by adjusting in the mix design or quantities of air-entraining admixture being used. The air content shall be measured in accordance with ASTM Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method (Designation C-231) or ASTM Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method (Designation C-173).
14. Forms. Forms shall be made of metal and shall have a depth equal to or greater than the prescribed edge thickness of the pavement slab, except when curb form is added after machine finishing. They shall have a base width of not less than eight (8) inches for all forms eight (8) inches or more in height. All side forms less than eight (8) inches in height shall have a base width of not less than six (6) inches. The minimum length of each section of form used shall be ten (10) feet. Each section of form shall be straight, free from bends or warps.

    The maximum deviation of the top surface of any section shall not exceed one-fourth (1/4) inch, or the inside face not more than one-fourth (1/4) inch from a straight line. The method of connection between sections shall be such that the joint thus formed shall be free from movement in any direction. Forms shall be of such cross-section and strength and so secured as to resist the pressure of the concrete when placed, and the impact and vibration of any equipment which they support, without springing or settlement. Each ten (10) foot length of form shall have at least three (3) form braces and pin sockets which shall be spaced at intervals of not more than five (5) feet, having the end brace and socket not more than six (6) inches from the end of the form. Approved flexible forms shall be used for construction where the radius is 150 feet or less.
15. Setting Forms. Forms shall be set, as herein specified. The subgrade under the forms shall be compacted and cut to grade so that the form when set will be uniformly supported for its entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are free from play

or movement in any direction. The supply of forms shall be sufficient to permit their remaining in place for at least 12 hours after the concrete has been placed. All forms shall be cleaned and oiled each time they are used.

16. Grade and Alignment. The alignment and grade elevations of the forms shall be checked by the Contractor and the necessary corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any subgrade thereunder has become unstable, the form shall be reset and rechecked.
17. Placing, Consolidation and Finishing. General. The prepared subgrade shall be uniformly wet down by sprinkling with water in such a manner as to provide a damp surface at the time the concrete is to be placed on the subgrade. No concrete shall be placed unless the subgrade has been approved by the City Engineer. When sand subbase is required, it shall conform to Subsection 5. The sequence of operations shall be the placing, strike-off and consolidation, floating if necessary, straight-edging and final surface finishing.
18. Placing. Concrete shall be placed in such a manner as to prevent segregation of material, and in such a manner as to require as little rehandling as possible. Necessary hand spreading shall be done with shovels. Spreading of concrete with rakes *or* vibrators will not be allowed. Concrete shall be placed as uniformly as possible to the required depth and width of the construction lane in successive batches, and in a continuous operation between transverse joints without the use of intermediate bulkheads. When work is unavoidably suspended for a period longer than thirty (30) minutes after the placing of concrete has begun, or when the concrete has taken initial set, a transverse construction joint, in accordance with Subsection 32, shall be constructed and placing of concrete completed to this joint. Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained the strength specified for opening to traffic in accordance with Section 47. Concrete shall be placed as near to expansion and contraction joints as possible without disturbing them but shall not be dumped onto a joint assembly. In the distribution of the concrete, care shall be taken to place a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab. No concrete shall be placed around manholes or other structures until they have been brought to the required grade and alignment. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.
19. Strike-Off and Consolidation. Following the placing of the concrete, it shall be struck off to a cross section and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be in reasonably close conformity with the cross section and elevation shown on the plans or established by the Engineer. Strike-off and consolidation may be done with a mechanical finishing machine, vibrating screed or hand finishing methods when approved by the City Engineer. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. The vibrator shall never be operated longer than 15 seconds in any one location. After the pavement has been struck-off and consolidated, it shall be scraped with a straightedge, 10-feet long, equipped with a handle to permit operation from the edge of the pavement. Any excess water and laitance shall be removed from the surface of the pavement. The straightedge shall be operated parallel to the centerline of the pavement and shall be moved forward one-half its length after each pass. Irregularities shall be corrected by adding or removing concrete. All disturbed places shall be again straightedged. The use of long handled floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment. The hand-operated float shall be a rigid straightedge float with a trowelling or smooth surface, not less than eight (8) inches nor more than twelve (12) inches in width. Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be carefully finished with an edger of the radius shown on the plans.
20. Finishing. A burlap drag or belt drag shall be used for a final finish. The burlap drag shall be at least three (3) feet wide and long enough to cover the pavement width. The belt drag shall be twelve (12) inches

wide and long enough to cover the pavement width. The belt or burlap drag shall be kept clean and damp with water while in use. It shall be laid on the pavement surface and dragged in the direction in which the pavement is being placed. Final surface finishing done by using a see-saw motion of a belt will not be permitted. In general, adding water to the surface of the concrete to assist in finishing operations shall not be permitted. If it is permitted, it shall be applied as a fog spray with approved spray equipment.

Face forms may be removed as soon as the concrete has set sufficiently to retain its shape. The back forms shall be removed within twenty-four (24) hours after the concrete has been placed and any honeycombed areas shall be immediately filled with mortar after which curing compound shall be applied. The edges of all curbs shall be neatly rounded with the required-edging tools. The top and front face shall be thoroughly floated with a moist wooden float, after applying clean water to moisten the surface, until all form marks are removed. The curb surfaces shall be checked with a ten (10) foot straightedge immediately after the removal of the forms and all variations greater than one-fourth (1/4) inch in ten (10) feet from true surface shall be corrected immediately. The final finish shall be obtained by uniformly brushing the entire top and front face of the curb before the concrete sets hard, using a brush and applying clean water during the operation. The brush strokes shall be made up the front face and outward across the top and vice versa. During the finishing operation, the gutters shall be straightedged for their full length to prevent the formation of water pockets or low places. If, after completion, excessive irregularities exist in the gutters, the high spots shall be removed by rubbing with a carborundum stone or sections of pavement shall be removed and replaced to the satisfaction of the Engineer.

21. Surface Tolerances and Test. In order to provide a riding surface of acceptable smoothness, reasonably accurate control shall be maintained in placing, spreading, consolidating and finishing the concrete pavement. The Contractor shall use equipment as may be required to provide a surface tolerance, not to exceed those listed below.

    As soon as the concrete has hardened sufficiently to permit foot traffic, the pavement surface shall be tested with a 10-foot straightedge or other approved device for compliance with the following tolerances. Areas showing high spots exceeding these tolerances shall be removed with an approved grinding tool.

Residential Streets	¼ inch in 10 foot
Collector (minor)	¼ inch in 10 foot
Collector (major)	¼ inch in 10 foot

22. Integral Curb. Integral curbs shall be required along the edges of all street pavement as indicated on the plans, except at such locations as the Engineer may direct. Depressed or lip curbs shall be provided at all driveway entrances and at such other locations as designated by the Engineer. Curbs shall be formed to the cross-section as shown on the drawings with a mule or templates supported on the side forms. Steel curb forms shall be required to form the backs of all curbs except where street returns of small radius or other special sections make the use of steel form impractical. The integral curb shall be constructed immediately following the finishing operation. Special care shall be taken so that the curb construction does not lag the pavement construction and form a “cold joint”. In placing curb concrete, sufficient spading shall be done to secure adequate bond with the paving slab and eliminate all voids in the curb. The finished surface of the curb and gutter shall be checked by the use of the 10 foot straightedge and corrected if necessary.
23. Curing. Concrete shall be cured by protecting it against loss of moisture, rapid temper3ture change, and from rain, flowing water, and mechanical injury for a period of not less than 5 days from the beginning of the curing operations. White liquid membrane compound will be used for curing. Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered by the curing membrane. The edge of concrete slabs exposed by the removal of forms shall be protected immediately to provide these surfaces with continuous curing treatment equal to the method selected

for curing the slab surface and to prevent injury to pavement edges. Minimum rate of application acceptable is one gallon per two hundred (200) square feet. The use of liquid membrane which contains or becomes contaminated with sugar in any form, tannic acid, or other substances considered detrimental to Portland Cement will not be permitted. The initial curing membrane shall be effective and shall be applied so as to prevent checking, cracking, and the appearance of dry spots in the surface of the concrete. The Contractor shall have the equipment needed for adequate curing at hand and ready to install before actual concrete placement begins. Failure to provide sufficient cover material or other failures to comply with curing requirements shall be cause for immediate suspension of concreting operations, unless otherwise specified in the Special Provisions.

24. Liquid Membrane Curing Compound. Pigmented liquid membrane curing compound shall meet the specifications under Section 3.40. The curing compound must be applied to cover the surface completely and uniformly at a rate which will achieve the performance requirement specified in AASHO Specifications M-148. This method of curing shall be applied immediately behind the final finishing operation or after the initial curing when a combination of methods are used. Failure to provide complete and uniform coverage at the required rate will be cause for discontinuance of this method of curing and the substitution of one of the other approved methods. The compound shall be kept agitated to prevent the pigment from settling. Special care shall be taken to apply the curing compound to the pavement edges immediately after the forms have been removed.
25. Joints. All joints shall be constructed perpendicular to the surface of the pavement slab and shall be of the type, dimensions and at the locations shown on the plans. Suitable guides or devices shall be used to assure satisfactory alignment of the joints. When joints are to be sawed, any procedure which results in premature and uncontrolled cracking or undue ravelling, shall be immediately revised by adjusting the time interval between the placing of the concrete and the sawing of the joints. The edges of the pavement and those joints where such edging is shown on the plans shall be rounded with an edger having a radius of not larger than 1/4 inch. Transverse joints except keyed and tied construction joints shall be continuous across the entire paved area including the curb.
26. Transverse Joints. Transverse joints shall be contraction, expansion or construction joints. Contraction and expansion joints shall be placed as indicated on the plans and construction joints wherever construction may require them. They shall make a right angle with the surface of the pavement.
27. Transverse Expansion Joints. Expansion joints shall be used only where shown on the plans. They shall extend the entire width of the pavement and from the subgrade to one (1) inch below the surface of the pavement. They shall be of the dimensions and spacing as shown on the plans. The filler shall be held accurately in place during the placing and finishing of the concrete by a bulkhead, a metal channel cap or other approved method. The filler shall conform to Section 3.37, Subsections 1 and 2. Dowels used in expansion joints as shown on the plans shall conform to Subsection 33. Under no circumstances shall any concrete be left above the expansion material or across the joint at any point. Any concrete spanning the ends of the joint next to the forms shall be carefully cut away after the forms are removed. Before the pavement is opened to traffic, the groove above the filler shall be cleaned and sealed with specified joint sealing material covered under Section 3.37.
28. Transverse Contraction Joints. Transverse contraction joints shall be of the sawed, formed dummy groove or premolded strip type.
29. Transverse Sawed Contraction Joints. When transverse contraction joints are to be formed by sawing, care must be taken to saw the grooves soon after placing to prevent the formation of cracks due to contraction of the slab. All transverse joints shall be sawed at least 1/4 of the slab depth. Any procedure for sawing joints that results in premature and uncontrolled cracking shall be revised immediately by adjusting the time interval between the placing of the concrete and the cutting of the joints.
30. Transverse Formed Dummy Groove Joints. Transverse dummy groove joints shall be formed by a groove or cleft in the top of the slab of the dimensions shown on the plans. The groove made in the plastic concrete by a suitable tooling device and shall extend vertically downward 1/4 of the slab depth from the surface and shall be true to line.
31. Transverse Premolded Strip Joints. Transverse premolded strip joints shall be of the proper dimensions

as shown on the plans. The premolded filler is placed in a vertical groove formed to receive it. The top of the filler should be flush with the pavement surface.

32. Transverse Construction Joints. Transverse construction joints of the type shown on the plans shall be placed wherever the placing of concrete is suspended for more than 30 minutes. A butt type joint with dowels shall be used if the joint occurs at the location of a contraction joint. Keyed joints with tiebars shall be used if the joint occurs at any' other location.
33. Dowels. If joints are to be equipped with dowels, they shall be of the dimension and at the spacing and location indicated on the plans. They shall be firmly supported in place, accurately aligned parallel to the pavement grade and the centerline of the pavement by means of a shop fabricated support which will remain in the pavement and will insure that the dowels are not displaced during construction. One-half of the length of each dowel shall be painted and greased and in expansion joints one end shall be equipped with a tight fitting cap of the dimensions shown on the plans conforming to Section 3.39 of this specification. Dowels shall conform to Section 3.38 of this specification.
34. Longitudinal Joints. Longitudinal joints shall be of the sawed, dummy groove, premolded strip, or the keyed construction type. Joints between construction lanes shall be of the keyed Construction type. When longitudinal joints contain tie bars, the tie bars shall be placed perpendicular to the longitudinal joints by an approved mechanical equipment or rigidly secured by chains or other approved supports that will prevent displacement.
35. Sawed Longitudinal Center Joints. Sawed longitudinal center joints shall be sawed grooves made with a concrete saw after the concrete has hardened. The saw cut shall be at least 1/4 of the slab depth. The joint may be sawed at any time prior to the time the pavement is open to traffic. These joints are otherwise formed in the same manner as the transverse sawed joints, Subsection 29.
36. Longitudinal Formed Dummy Groove Joints. Longitudinal dummy groove joints are formed in the same manner described for Transverse Formed Dummy Groove Joints, Subsection 30.
37. Longitudinal Premolded Strip Joint. Longitudinal premolded strip joints are formed in the same manner described for Transverse Premolded Strip Joints, Subsection 31.
38. Longitudinal Construction Joints. Longitudinal construction joints (i.e., joints between construction lanes) shall be of the dimensions shown on the plans. The key shall be constructed by placing a deformed metal plate against the form when the first lane adjacent to the joint is placed. This metal plate shall be removed with the form. When placing the second slab, care must be taken that no concrete is left to overhang the lip formed in the first slab by the edging tool.
39. Tiebars. Tiebars when shown on the plans shall be of deformed steel in accordance with Section 3.38 and of the dimensions and at the spacing specified. Tiebars shall be firmly supported by the subgrade chairs or so installed as not to be displaced during construction operations.
40. Joint Sealer. After the curing period all sawed and dummy groove joints in the pavement shall be cleaned and sealed with material meeting the requirements of Section 3.37. All foreign material, joint sawing residue, dirt and curing membrane shall be removed. Joints shall be slightly underfilled (about 1/4 inch) to prevent extrusion of sealer. Any excess material should be removed from the pavement surface as soon after sealing as possible.
41. Integral Curb Joints. In the construction of transverse joints of concrete integral curb pavement, special care must be taken to see that all transverse joints extend continuously through the pavement and curb.
42. Structures. All manholes, catch basins, or structures of a permanent nature encountered in the areas to be paved shall be raised or lowered as the case may be, to the surface of the new pavement and the necessary expansion material as specified in Section 3.37, Subsections 1 and 2 placed around each structure for the full depth of the slab and of the thickness shown on the plans.
43. Cold Weather Protection. Except by specific written authorization, concreting shall cease when the air temperature in the shade falls below 40° F. It shall not be resumed until the air temperature in the shade rises to 35° F. When concrete has been placed in cold weather and the temperature may be expected to drop below 35° F., straw, hay, insulated curing blankets, or other suitable material shall be provided along the line of work. Whenever the air temperature may be expected to reach the freezing point during the day or night, the material shall be spread over the concrete deep enough to prevent freezing

of the concrete. Concrete shall be protected from freezing temperatures until it is at least 5 days old. Concrete injured by frost action shall be removed and replaced at the Contractor's expense.

44. Protection and Opening to Traffic. The Contractor shall protect the pavement against all damage prior to final acceptance of the work by the owner. Traffic shall be excluded from the pavement by erecting and maintaining barricades and signs. As a construction expedient, the subgrade planer, concrete finishing machine, and similar equipment may be permitted to ride upon the edges of previously .constructed slabs provided the concrete is more than 72 hours old, and the equipment has rubber-tired wheels to run on the finished slab. Traffic shall be excluded from the newly constructed pavement for a period of 14 days after the concrete is placed or longer if weather conditions make it advisable to extend this time; provided however, that at the discretion of the Engineer the pavement may be open to traffic when specimen beams or cylinders made cured and tested in accordance with Subsection 46, have attained a flexural strength of 600 p.s.i. when tested in accordance with ASTM, C78 or 600 p.s.i. when tested by the midpoint method ASTM C-293 or a compressive strength of 3500 p.s.i. Prior to opening to traffic the pavement shall be cleaned of loose material and the joints shall be filled and trimmed as herein required.

45. Optional Construction Equipment & Methods. Slip-Form Paver. In lieu of the construction methods described in the preceding section of the specifications, the Contractor may use a slip-form paver. When the slip-form paver is used, all reference in the preceding sections of this specification referring to forms shall be deleted.

    Slip-form pavers shall be equipped with vibratory and tamping bar assemblies which are effective over the full width of the pavement. The paver shall also have a metal float with a bullnozed front end for the full width of the pavement, excluding curbs, which will extrude the concrete under pressure. The curb shall be formed by extrusion plates or mules mounted at the rear of the machine.

    Subgrade Construction. The subgrade shall be brought to the proper grade and cross-section by means of a properly designed and operated machine. The subgrade shall comply with Section 3.3 and Subsection 3, 4, and 5, of this specification. If any traffic is allowed to use the prepared subgrade, some device, satisfactory to the Engineer, shall be provided for checking and correcting the subgrade immediately ahead of placing the concrete.

    The subgrade work, especially the path on which the tracks of the paver ride, must be done carefully and accurately as its degree of precision greatly affects the resulting smoothness of the pavement surface.

    Placing Concrete. Concrete shall be of uniform slump and adequately supplied in front of the paver. The rate of progress shall be controlled so that the forward movement of the paver will, be as nearly continuous as practicable. If it is necessary to stop the forward movement of the paver, the vibrator and tamping elements shall also be stopped immediately. Care must be taken to see that a sufficient supply of concrete passes around the float and the belt along the form line to form the integral curb where shown on the plans.

    Finishing. Final finishing operations shall conform to the applicable subsections of this specification, 19 and 20.

46. Test Specimens. It shall be the responsibility of the contractor to furnish evidence to the City that the quality of the materials and workmanship entering into the work complies with the plans and specifications. In order to accomplish this, the minimum schedule of satisfactory tests listed herein shall be performed by a testing laboratory approved by the City. When tests reveal that the quality of materials or workmanship does not meet the requirements of the specifications, additional tests shall be made as directed by the engineer until the number of satisfactory tests called for in the schedule have been made. The cost of all testing provided for in the schedule, including the furnishing and taking of all samples, shall be included in the price bid for the work complete in place, unless otherwise specified.

TEST SCHEDULE

Description	Test Method	Quantity Represented One Test
Concrete Cylinders	AASHO-T-23	600 Sq Yds Concrete
Entrained Air Content	AASHO-T-152	600 Sq Yds Concrete

One test for concrete cylinders shall be construed to mean that at least four test specimens shall be taken in accordance with the above schedule. Two shall be tested at an age of seven days, and two shall be tested at an age of twenty-eight days, and the strength determined from the average of these pairs of test specimens. A minimum of one test (four specimens) shall be taken for each day's work. Beam and cylinder specimens taken in the field shall be made and cured in accordance with AASHTO T23. One test for entrained air content shall be made for each set of four concrete cylinder specimens taken.

47. Strength Requirements. Strength. On delivery to the site of the work, the concrete shall be of a workable, plastic consistency and shall consist of Portland Cement, fine aggregate, coarse aggregate and water, in a mixture that shall have a compressive strength of not less than thirty-five hundred (3,500) pounds per square inch when tested at the age of twenty-eight (28) cays. The making of Compression Test Specimens and the making of Compression Tests shall conform to the requirements of ASTM Methods C31-55 and C39-49 respectively, or subsequent revisions thereof. The test specimens shall be made from concrete taken from the mixture in actual use. The average strength of not less than two (2) test specimens shall be used in determining the strength of the concrete.

    Tolerance in Strength. It is the intent of these specifications that the strength of the concrete shall not be less than that specified. Where any concrete core fails to meet the specified strength, the following rules relative to replacement of the faulty concrete and adjustment of payment shall govern:

    1. For Concrete, the average core strength of which determined as provided above, is equal to or in excess of the specified strength, the contract unit price shall be used in payment.
    2. For Concrete, the average core strength of which determined as provided above, is less than is specified strength but not less than twenty-five hundred (2,500) pounds compressive strength, and adjustment price shall be used in payment, which price shall bear the same ratio to the contract unit price as the strength by actual test bears to the specified strength.
    3. Concrete, the average strength of which, determined as provided above, is less than two thousand five hundred (2,500) pounds compressive strength will not be accepted and the Contractor shall be required to remove same. The Contractor shall then replace the deficient concrete with satisfactory concrete which, when accepted, will be included for payment.

    Should any question arise as to the possible deficiency of the concrete strength at any location in the pavement after the construction of the street pavement is completed, then core specimens shall be taken at these locations in accordance with ASTM C42 or AASHO 124. If the test results show the strength of the concrete pavement in question meets or exceeds the specified strength (3500 lbs. per sq. inch compressive at 28 days), the cost of coring, testing of cores and repair of core holes shall be borne by the City. If the test results show the concrete pavement in question does not meet the specified strength (3500 lbs. per sq. inch compressive at 28 days), the cost of coring, testing of cores and repair of core holes shall be borne by the Contractor.

48. Thickness Tolerance. Tolerance of concrete pavements shall be in accordance with Section 3.11.
49. Measurement and Payment. For City Contracts, concrete pavement will be measured in square yards from back to back of curbs. Integral curb, lip curb or thickened edge will be measured by the linear foot and shall include only that portion of the concrete above or below the specified minimum slab thickness. Concrete pavement, integral and lip curb and thickened edge will be paid for at the contract unit prices and as herein specified. Lip curb shall be paid for at the same unit price as integral curb. Sand base will be measured in square yards from back to back of curbs, plus one (1) foot on each side.

Payment for the sand base shall be made at the contract unit price per square yard in place, which shall include the furnishing, placing and wetting down of the sand. The bid pt-ices shall include the cost of the required construction, expansion and contraction joints including joint filler and seal and all necessary dowel bars and tubes, the required depressions at sewer inlets as shown on the plans and all test core hole repair.

Subgrade preparation as described in Subsection 3 shall be measured in square yards for the width shown on the plans.

3.14 Concrete Curbs and Gutters:

1. Description. This item shall consist of the construction of concrete curbs and gutters, either separate or in combination, for pavements and roadways in accordance with these specifications and in conformity with the lines, grades, and cross-sections shown on the plans. The mixture of the Portland Cement Concrete shall conform to the strength requirements of Section 3.13 Integral Concrete Curb shall be constructed as specified under Portland Cement Concrete Pavement.
2. Materials. All materials shall conform to the requirements of Material Section, or as provided in the Special Provisions or shown on the plans.
3. Construction Methods. Construction shall conform to the following requirements:
   a. Excavation: Excavation shall be made to the required depth below the finished surface in accordance with the cross-section shown on the plans. All soft yielding or other unsuitable material shall be removed and replaced with suitable material and the subgrade shall be compacted thoroughly and finished to a firm, smooth surface.
   b. Forms: The forms shall be of wood or metal, straight and free from warp, and of sufficient strength to resist springing during the process of depositing and tamping the concrete. Straight forms, if of wood, shall be of two (2) inch surface plank, and, if of metal shall be of approved section and shall have a flat surface on top. Curb forms shall be placed on a firm solid subgrade. Forms for use on radii may be of flexible wood or metal, approved by the Engineer. The forms shall be of a depth equal to the depth of the curbing or gutter, and so designed as to permit secure interlocking. They shall be securely staked, braced, held firmly to the required line and grade, using approved spreaders and clamps, and shall be sufficiently tight to prevent the leakage of mortar. All forms shall be cleaned thoroughly and oiled before the concrete is placed against them.
   c. Placing Concrete: The subgrade and forms shall have been checked and approved by the Engineer before concrete is placed. Concrete shall be deposited on a moist grade. During placing, the concrete shall be thoroughly spaded next to the forms to assure a smooth, dense surface and shall be thoroughly spaded next to the forms to assure a smooth, dense surface and shall be carefully tamped, using a tamper approved by the Engineer, in uniform layers not exceeding six (6) inches in depth until a uniformly dense concrete is obtained. Care shall be taken to work the coarse aggregate well beneath the finish surface. As soon as the curb concrete has set sufficiently to retain its shape without support of the face form, the face forms shall be removed and the curb finished as provided in Paragraph “d” below. Within twelve (12) to twenty-four (24) hours after the concrete is placed, unless otherwise required by the Engineer the back and toe form may be removed. Any honeycombed or rough surfaces shall be immediately corrected when the forms are removed, using “C” mortar where necessary. The ends of all expansion joints shall be cleaned out with a chisel until the expansion material is fully exposed.

Where the upper portion of the curb is omitted for driveways or for other cause, the top of the curb shall be constructed slightly higher at the back than at the front, as shown on the plan, or as directed by the Engineer. Such curb may be classified as “Lip Curb” in the Special Provisions or proposal, but unless so classified, shall be considered as regular curb.

   d. Surface Finish: While the concrete is still plastic the top and front face or other exposed portions of curb shall be thoroughly floated with a moist wooden float, applying clean water ahead of the float

when required by the Engineer, and then troweled and brushed. All form marks and other irregularities shall be completely removed. The edges of the curb shall be neatly rounded to the required radii.

The final surface finish shall be obtained by uniformly brushing the surface, using an approved brush, before the concrete sets hard, and applying clean water during the operation. The brush strokes shall be up the front face and outward across the top and vice versa.

Gutter surface and the upper surface of the lip curb or header curbs having the top portion omitted shall be finished uniformly true to grade, using a wooden float. Excessive working of the surface shall be avoided. Excess water, laitance and inert material shall be floated off the surface.

The top and front face of curbs shall be checked for irregularities as soon as the clamps and the face forms have been removed, and gutter surfaces shall be checked during the finishing operation, using a ten (10) foot straightedge. All variations greater than one-fourth (1/4) inch radius edging tool.

e. Joints: All joints in curbs and gutters shall be perpendicular to the subgrade, at right angles to the longitudinal axis of the curb or gutter, and shall entirely separate the adjacent sections of concrete.

   Expansion joints shall be of the thickness and placed at the locations shown on the plans or provided in the Special Provisions. In general, three-fourths (3/4) inch expansion joints shall be placed between new work and any abutting old work. Preformed expansion joint filler shall be used throughout and shall be set as shown on the plan detail.

   Separate curb may be constructed in sections of six (6) feet long, the joints between sections being formed by steel templates not less than one-eighth (1/8) inch nor more than three-sixteenth (3/16) inch in thickness, shaped to conform to the shape of the curb, and placed and securely held in proper position. These templates shall be left in place until the concrete has sufficiently set to hold its shape.

   Provisions shall be made for withdrawing the templates without injuring or marring the concrete. Immediately after removal of the templates, the joints shall be lightly tooled along the face and top of the curb.

   Combination curb and gutter, and separate gutter, shall not be divided into sections with steel templates, provided that templates, as described for separate curb but extending only through the upper portion of the curb may be used. Where there are transverse expansion or contraction joints in the abutting pavement, expansion joints shall in general be placed in the curb, gutter or combination curb and gutter opposite the joints in the pavement.

f. Header, Marginal and Lip Curb: Header, marginal or lip curb when required at the ends or edges of pavement slab shall be constructed as shown on the plans and shall be given a wood float finished as specified for gutters.

g. Placing Down Bars: Where shown on the plans, dowel bars or tie bars shall be placed across joints or for tying curbs and gutters to adjacent curbs or slabs in accordance with the requirement of these specifications.

   The ends of the tie bars which are to protrude from the edge of a slab, curb or gutter may be carefully bent at right angles so as to lie along the form or header when the concrete is placed. As soon as the form is removed the bent and partially embedded portion of the bar shall be carefully pried out and straightened to its proper position, care being taken to disrupt the concrete as little as possible.

h. Curing – Protection – Opening to Traffic: Concrete curbs and gutters shall be cured, protected during cold weather, protected from traffic, and opened to traffic in accordance with the requirements

specified for Portland Cement Concrete Pavement.

i. Backfill: The back side of curbs and gutters shall be backfilled as soon as the forms have been removed and the required finishing operations completed. The backfill shall be of select earth approved by the Engineer, thoroughly compacted in layers not exceeding six (6) inches in depth, and neatly graded off flush with the top of the curb or gutter, or as shown on the plans. Care shall be taken not to damage the concrete in placing or compacting the backfill.

Where the general elevation of the parking area is lower than the top of the curb or gutter, or where there is no curb, the minimum width of the backfill shall be two (2) feet at the level of the top of the curb or gutter, unless otherwise shown on the plans.

4. Tests. The maximum number of concrete cylinder tests to be ordered by the Engineer shall be in accordance with the following schedule. (A test shall consist of four (4) cylinders, two (2) to be tested at seven (7) days and two (2) at twenty-eight (28) days.)

TEST SCHEDULE

Description	Method of Test	Quantity Represented One Test
Concrete Cylinders (Curb and Gutter)	ASTM-C-31-55	800 L.F. Curb and Gutter

One test for entrained air content shall be made for each set of four (4) concrete test cylinders or test beams cast. Air entrainment tests shall- be made in accordance with ASTM Designation C-173 or C-231 or subsequent revisions thereto.

5. Basis of Payment for City Contracts. Concrete curb and gutter will be paid for at the contract unit price per linear foot. The price bid per linear foot shall include the cost of the required depression at sewer inlets as shown on the inlet design of the required construction, expansion and contraction joints including the expansion joint filler and expansion joint filler seal, any reinforcing or dowels required by the plans, and any extra or special height curb required at inlet depressions. Such price shall be full compensation for all labor, materials, tools, equipment, tests and incidentals necessary to complete the work in accordance with the plans and specifications.

3.15 General Construction Requirements for Sewers:

1. Scope. The Division shall apply to the construction of all storm sewers and all storm sewer appurtenances incidental to the construction of pavement.
2. Order of Construction. The construction of all sewers shall begin at the outlet or the low point in the line. Unless otherwise approved by the Engineer, the construction involving the building of main or submain sewers having one or more laterals or tributaries, the construction of tributary lines will not be started until the main or submain sewers have been completed to the point where the tributary or lateral discharges into it. Sewer appurtenances shall be constructed as soon as the sewer which they serve is constructed to their location.
3. Connections to Other Sewers Or to Appurtenances. The connecting of sewers or sewer appurtenances to other sewers or to sewer appurtenances shall be made in accordance with the plans or under the direction of the Engineer. The work shall be done in a workmanlike manner in such a way as not to damage any of the structures involved. No sewer shall project beyond the inside wall line of other sewers or of sewer appurtenances.
4. Sewer Grades. The grade line shown on the plans is the elevation of the invert or flow line of the sewer. The grade line shall be established in the trench by the use of batter boards at grade stakes not farther than fifty (50) feet apart. Not less than three batter boards shall be maintained in correct position continuously during the construction of the sewer. Batter boards shall be of good, straight, sound material, fastened to substantial stakes or uprights. Batter boards eight (8) feet or less in length shall not be smaller than 1 x 4's, and when longer than ten (10) feet shall not be smaller than 2 x 4's. Stakes shall not be smaller than 2 x 4's. Steel stakes with suitable clamps may be used. A suitable fine cord or

wire, shall be stretched tightly between batter boards over the exact center line of the sewer. A graduated pole or rod shall be provided for measuring from the cord stretched between batter boards to the bottom of the trench while the trench is being prepared and to the sewer invert while the sewer is being placed. When the distance from the cord between batter boards to the invert of the sewer exceeds ten (10) feet, a line shall be set in the bottom of the trench for aligning the pipe and establishing the grade. Methods other than that above may be used to establish grade, if approved by the Engineer.

3.16 Portland Cement Mortar:

1. General. Materials shall meet the requirements specified in Section 3.24 Materials.
2. Composition. The mortar for use with brick masonry shall be composed of one part Portland cement, and two parts mortar sand by volume, mixed with sufficient water to form a plastic consistency. The use of hydrated lime not to exceed ten per cent (10%) by volume of the amount of cement will be permitted, but when used shall be added to the cement first and in proportioning the mortar will be considered as cement.

3.17 Storm Sewer Inlets.

1. Construction Methods. Storm sewer inlets shall be constructed at the points designated on the plan and in the manner described by the plans and specifications.
2. Basis of Payment. The cost of pavement, integral curb and/or curb and gutter for storm sewer depressions shall not be included ii the lump sum bid for inlets, but shall be included in the contract unit price bid for pavement, integral curb and curb gutter respectively, complete in place.
3. Payment for Inlets. For the purpose of payment, inlets shall be classified by number of grates and throats and shall be paid for as each inlet constructed of a carbon size or type. The price bid will include all materials, labor and incidentals used in the construction of said inlets.

3.18 Pipe Sewers:

1. Description. The work shall include the construction complete of precast circular pipe sewers as specified herein and in conformity with the lines, grades, dimensions and design shown on the plans.
2. Materials. All materials shall conform to the requirements of Section 3.30. The pipe shall be of the kind and quality shown on the plans or provided in the proposal or Special Provisions.
3. Construction Methods. Construction methods shall conform to the following requirements:
   a. Excavation: The width of trench excavation at the ground line for sewers shall conform to the requirements of the following table:

MAXIMUM WIDTH OF TRENCH AT GROUND LINE

SIZE OF PIPE Internal Diameter	Where No Sheeting or Shoring is Used	Where Sheeting and Shoring is Used
12” and smaller	24”	36”
15” to 2” incl.	Inside diameter plus 12”	Inside diameter plus 24”
24” to 30” incl.	Inside diameter plus 18”	inside diameter plus 30”
33” to 54” incl.	Outside diameter plus 28”	Outside diameter plus 30”
60” and larger	Outside diameter plus 24”	Outside diameter plus 36”

Where only a small amount of sheeting and shoring is required, which in the opinion of the Engineer will not unduly interfere with the work, the maximum trench width shall be the same as where no sheeting and shoring is required. Bell holes or recesses for bells of the pipe shall be excavated at every joint and shall be of sufficient size and depth to relieve the bell of all loads, permitting the barrel to be firmly bedded throughout its length and to provide ample space for forming the joint. Filling and ramming earth or other material beneath the pipe to raise it to grade will not be permitted. Where a complete cradle or refill is shown on the plans or provided in the Special Provisions,

it shall be placed in conformity with the plans and specifications, and shall consist of 200# concrete having a slump of from five (5) to seven (7) inches.

b. Backfill (General). All trenches and excavations shall be backfilled in a reasonable time after the pipes are installed therein, unless other protection of the pipe is directed by the Engineer. The backfill material shall be approved by the Engineer. Backfill material containing stones or rock exceeding three inches (3") shall not be used adjacent to or until the fill over the top of the pipe exceeds one (1) foot. Great care shall be used to obtain thorough compaction under the haunches and along the sides to the top of the pipe.

   The backfilling shall be placed in loose layers not exceeding six (6) inches in depth under and around the pipe and not exceeding eight (8) inches over the pipe. Successive layers shall be added and wetted and thoroughly compacted by hand and pneumatic tampers to a density of 95% of Standard Proctor unless otherwise specified, until the trench is completely filled and brought to the elevation as directed. Backfilling shall be done in such a manner as to avoid injuring top or side pressure on the pipe. Any pipe so damaged shall be removed and replaced at the Contractor's expense.

c. Backfill (Under Pavements). All provisions shall apply to backfill under pavements with the following exceptions:
   1) The backfill material shall be of a PRA Classification of A-2 or better. In the event the material as excavated is of classification other than A-i or A-2, it shall be removed from the site and disposed of as directed by the Engineer. The replacement backfill material shall have a PRA Classification of A-2 or better. After compaction as provided in Article 3, following, the backfill area shall be shaped to conform to the applicable section shown on the plans for either "Existing Paving Base Repair Over Ditches" or "Detail of Reinforcing for New Paving Over Trenches."
   2) No stones or rocks greater than three (3) inches in diameter will be allowed in any portion of the backfill.
   3) The A-2 backfill material shall be placed in lifts not to exceed six (6) inches, moistened and compacted to a density of 95% Standard Proctor.
   4) In lieu of A-2 backfill material clean river sand may be used for backfill as required by the Engineer.

d. Laying Pipe Sewers. No sewer shall be laid unless the foundation is in a condition satisfactory to the Engineer. The laying of pipe in a wet trench shall be done only when and as approved by the Engineer. The spigot end of the pipe shall be laid in the direction of the flow. No bucking in or laying pipe downgrade will be permitted. Pipe shall not be dropped to the bottom of the trench but shall be lowered in a careful manner approved by the Engineer. The inside of the barrel shall be cleared when the pipes are lowered into the trench.

e. Sewer Pipe Joints (General. Joints in a pipe sewer shall be formed in a careful, thorough and workmanlike manner. The spigots and the inside of the bells shall be cleaned at the time the joint is made. Spigots shall be centered in the bells so as to form a concentric joint with no offset on the interior surface of the pipe line. The spigot of the pipe shall be butted tightly against the shoulder of the bell. All superfluous joint material shall be completely removed from the inside of the pipe. On sewers twelve (12) inches in diameter and smaller, a suitable drag or swab shall be kept in the pipe line and pulled forward past each joint immediately after its completion, unless otherwise permitted by the Engineer.

f. Joints for Concrete Storm Sewers. Joints for storm sewers shall be formed in the following manner:
   Cement Mortar Joints. The lower one-third (1/3) of the bell of the pipe shall be partially filled with plastic Class C mortar of sufficient thickness to center the spigot in the bell or hub. After the spigot is fitted into the bell the remainder of the annular space shall be completely filled with mortar and beveled off at an angle of forty-five (45) degrees with the outside of the pipe. The mortar shall be firmly pressed and compacted to a dense, tight joint and all sewers eighteen (18) inches in diameter and larger shall be pointed up and smoothed from the inside.

Mastic Joints. Cold applied mastic type joints will be made in such a manner that the pipe section ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be concentric, reasonably water tight and free from superfluous joint material on the inside of the pipe. Mastic material shall comply with Section 3.31.

g. Joints for Corrugated Steel Storm Sewers and Underdrains. Field joints of corrugated steel pipe and pipe-arch shall preserve the pipe alignment and prevent infiltration of the backfill. Field joints shall be made of the same base metal as the culverts. The bands shall not be less than seven (7) inches wide for diameters of eight (8) inches to thirty (30) inches, inclusive; not less than twelve (12) inches wide for culverts with diameters thirty-six (36) inches to sixty (60) inches inclusive; and not less than twenty-four (24) inches wide for culverts with diameters greater than 60 inches. Such bands shall be so constructed as to lap on an equal portion of each of the culvert sections to be connected and preferably shall be connected at the ends by galvanized angles having minimum dimensions of two (2) inches by two (2) inches by 3/16 inch. The seven (7) inch band shall have at least two galvanized bolts not less than 1/2 inch in diameter. The twelve (12) inch band shall have three and the 24 inch band shall have inch band shall have three and the 24 inch band shall have five 1/2 inch bolts. Other equally effective methods of connecting and coupling bands may be used if approved by the Engineer.

4. Concrete Cradles and Protection. Concrete cradles and protection, where required, shall be constructed as shown on the plan or where not shown on the plan, as directed by the Engineer. Where cradling is constructed beneath the sewer pipe the sub-grade shall be prepared and properly shaped at the required grade and in a like manner as required for the subgrade for the pipe itself. All concrete shall be placed in the dry, unless in the opinion of the Engineer such a method is entirely impracticable. Where concrete is placed in a set trench the work shall be done strictly as directed or approved by the Engineer. The pipes shall be firmly bedded in the concrete to proper grade Concrete placed over or on the pipe as a cradle or protection shall be so placed as not to damage the joints or disrupt any pipe. All pipes shall be blocked to line and grade before placing concrete for cradles.

   Backfilling shall be done in a careful manner and at such time after the concrete is placed as not to damage the concrete in any way; 20O04~ concrete having a slump of from five (5) to seven (7) inches will be used for pipe cradles.

5. Method of Measurement. For City Contracts, pipe sewers shall be measured along the center line of the sewer. The removal and disposal of unsatisfactory backfill material and the A-2 soil for replacement of unsatisfactory subgrade material will be measured in cubic yards. The height used in the computation will be the difference between the flow line elevation of the sewer and the elevation of the subgrade. The width will be that indicated in Sub-Section 3.8, for the diameter of pipe involved. The length will be the length measured along the center line of the sewer along which the unsatisfactory soil condition exists. The volume occupied by the sewer pipe will be deducted from the ditch volume to give a net volume for the purpose of payment for A-2 soil for the replacement of unsatisfactory subgrade material. Reinforcing steel as indicated in the plans titled "Detail of Reinforcing for New Paving Over Trenches" will be measured in pounds.

6. Basis of Payment. For City Contracts, pipe sewers not under paving will be paid for at the contract unit price per linear foot, based on the classification provided for in the proposal and contract. The contract price shall be full compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation and backfill, in accordance with the plans and these specifications.

   Pipe sewers, under paving will be paid for at the contract unit price per linear foot based on the classification provided in the proposal and contract, provided the backfill material is of a PRA Classification of A-1 or A-2. If the material as removed from the trench is of a classification other than A-1 or A-2, additional payment will be allowed for the material so removed and disposed of at the price bid per cubic yard for Removal and Disposal of Unsatisfactory Subgrade Materials. The replacement A-2

backfill will be paid for at the price bid A-2 soil replacement of unsatisfactory subgrade materials.

The additional reinforcing steel required in new paving over trenches will be paid for at the price bid per pound for reinforcing steel. Such compensation as provided above for pipe sewers under pavement will be payment in full for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work including excavation, backfill, and shaping of the surface of the compacted backfill in conformance with the applicable detail shown on the plan for Existing Paving Base Repair Over Ditches or Detail for Reinforcing for New Paving Over Trenches. Concrete cradles or protection will be paid for separately when so classified, or their cost shall be included in the price bid for the sewer when so provided, as the case may be.

3.19 Adjustment to Existing Structures:

1. Description. The item shall consist of the necessary adjustment, alteration or resetting to the required grade and alignment of existing structures, equipment or appurtenances which are not to be removed or abandoned and which are not the property of a private company, firm or corporation required to move their own property.
2. Construction Methods.
   a. General. The materials and workmanship necessary in raising, lowering or otherwise adjusting or resetting existing structures shall conform to the requirements of the owner's Standard Specifications. Whole bricks, salvaged in good condition from structures, may be used in rebuilding such structures provided the bricks are cleaned satisfactory to the Engineer. Existing structures shall be rebuilt accurately to correct grade and alignment and such work shall be completed in advance of the construction of new work abutting, when required by the Engineer.
   b. Water Lines, Valves, Meters, Fire Hydrants, etc. The Contractor shall make complete arrangements with the owner's Water Department for lowering or relocating all water lines and resetting water valves and meters, and fire hydrants; and where the Contractor himself is to perform the actual work such work shall conform strictly to the requirements of the City's Water Department.
   c. Electric Traffic Signals. The Contractor shall make proper arrangements with the Owner for the moving and resetting of any electric traffic signals, conduits, cables, etc. Where the Contractor is to perform the actual work, such work shall conform strictly to the requirements of the owner.
   d. Manholes. Where the tops of manholes are to be lowered to a new grade, the walls shall be removed and rebuilt to an elevation far enough below the new grade so that the maximum batter of the walls does not exceed four (4) inches per foot. Where manholes are to be built up a distance of one (1) foot or less to a new grade, the walls may be carried up vertically.

      Where the walls are to be built up at a distance exceeding one (1) foot, the existing walls shall first be removed to the bottom of the batter section of the walls or to such elevation that the inside diameter of the manhole is not less than three (3) feet six (6) inches. The manhole shall then be rebuilt in conformity with the size and shape of requirements for new manholes.
   e. Parking Meters. Where parking meters are to be moved in areas where the sidewalk is to be removed, the concrete shall be carefully removed from around the base of the meter post and the parking meter then transported by the Contractor to a storage point designated by the City Engineer. Where parking meters are to be moved in areas where the existing sidewalk is to be left in place, the parking meter post shall be cut at a distance above the sidewalk to be designated by the Engineer and the meter then transported to a storage point to be designated by the City Engineer. All parking meters will be reinstalled by the City and the cost of such installation will not be included in this contract.
3. Method of Measurement. For City Contracts, where payment is to be made on the unit price basis, vertical measurements of strictures raised or lowered to grade will include only the actual net distance the structure is raised or lowered and will not include sections of wall removed and rebuilt. There will be no measurement of basement repair as such, however, the concrete used in the repair will be measured

in cubic yards arid the steel in pounds.

4. Basis of Payment. For City Contracts, payment will be made at the contract price, or the unit price, or lump sum price basis, as the case may be, for the adjustment of the particular class of structure involved, other than repair of basements. Basement repair will not be paid for as such but the cost of the repair will be included in the price bid per cubic yard for "Formed Reinforced Concrete in Special Structures", and the price bid per pound for "Reinforcing Steel" used in the repair. Such price or prices shall be compensation in full for all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and these specifications.

3.20 Water Service Lines:

1. Description. This item shall consist of the installation of new water service lines and the extension or replacement of existing water service lines of the size lengths and materials specified, or as directed by the City Water Department or City Engineer.
2. Construction Methods. The Contractor shall make complete arrangements with the City Water Department for the installation of any required water service lines or extensions; and, where the Contractor himself is to perform the actual work, the materials and workmanship shall conform to the requirements of the City's Water Department. Where water service lines are to be laid under pavement slabs, the excavation and backfill shall be made in accordance with the requirements specified under "Excavation for Sewers".
3. Basis of Payment. For City Contracts, the Contractor shall be paid his price bid for such water service lines as are installed in accordance with these specifications and in a manner acceptable to the City Water Department, or where there is no separate contract price the cost of such work shall be included in the price bid for other work to which it is incidental.

3.21 Removal of Paving, Sidewalks, Driveways, Curbs, Etc.:

1. Description. This item shall consist of the removal of existing paving, sidewalks, driveways, curbs, or items of similar nature, composed of concrete, asphalt, brick, or any other material, and the disposal of same all in accordance with these specifications and as shown on the plan, or as directed by the Engineer. For purpose of classification, all gutters, whether combined or separate from curb, shall be considered as paving.
2. Construction Methods. Constructions methods shall comply with the following requirements:
   a. General. In removal of any paving, sidewalks, driveways, curbs, gutters, etc., care shall be taken to leave a straight, smooth edge, perpendicular to the surface of the portion left in place, at the location given by the Engineer. Any breakage outside the lines given by the Engineer shall be replaced by the Contractor at his expense.
   b. Disposal of Materials Removed. All materials designated by the Engineer as salvageable, including broken concrete bricks, manhole frames and grates, catch basin frames and grates, and all sewer and culvert pipe, shall be hauled and stored as directed by the owner. Gravel and macadam surfacing shall, as nearly as practicable, be removed separately from dirt or other materials, and where desired for use on other streets or alleys, shall be disposed of at sites designated by the Engineer. The disposal of all excavated material other than mentioned above shall be at sites designated by the Engineer.
3. Method of Measurement. For City Contract, the various items of this section when classified for payment as contract pay items, will be measured by the unit designated on the plans or as set out in the proposal.
4. Basis of Payment. For City Contracts, the various items of this section when classified for payment will be measured as provided above and will be paid for at the contract unit price for:
   a. Existing paving removed;
   b. Existing asphalt wearing surface removed, variable thickness;
   c. Concrete sidewalk removed;
   d. Existing driveway removed;

e. Existing concrete or limestone curb removed:

as the case may be and such payment shall be full compensation for all materials, equipment, tools, labor and incidentals necessary for completing the removal and disposal of the item specified.

3.22 Incidental Paving Repair and Replacement:

1. Description. This item shall consist of:
   a. The construction of edges or portions of pavement adjacent to new work;
   b. The repair and replacement of paving cuts required for sewer or other ditch construction including the construction of edges or portions for adjacent pavement.
   c. The repair and replacement of base failures in pavement including the reconstruction of edges of adjacent slab, using Portland concrete;
   d. The repair and replacement of base failures in pavement including the reconstruction of edges of adjacent pavement, using asphalt concrete;
   e. Preparation of pavement for resurfacing.
2. Materials. All materials shall conform to the requirements of Section _____. Materials of the Standard Paving Specifications, for the type or class of materials involved.
3. Construction Methods. Construction methods shall conform to the following requirements:
   a. The reconstruction of edges of existing pavement adjacent to new Portland concrete paving construction shall be accomplished as follows: Upon completion of the excavation or slab removal required by the new construction, the subgrade under the edge of the existing slab shall be undercut for a distance and depth as shown on the plans, and the resulting void poured as a unit with the new slab. The edges of the new slab shall be vibrated sufficiently to insure flow of concrete into that undercut area.
   b. The repair and replacement of paving cut required for sewer or other ditch construction shall be accomplished as follows:
      After backfilling operations are complete, the subgrade under the slab edges adjacent to the trench shall be undercut for a distance and depth as shown on the plans. Where reinforcement is required, it shall conform to Section 3.38 of this specification and be placed as shown on the plans. The cut shall then be filled with concrete to the depth indicated on the plan. The concrete shall conform to Section 3.8 of these specifications. The edges of the replacement slab shall be vibrated to insure flow of concrete into the undercut area.
   c. The repair and replacement of base failures in pavement by the use of Portland concrete shall be accomplished by removing the slab over and around the area of the failure as directed by the Engineer, or indicated by the plan. When soft or spongy foundation material is encountered it shall be removed to a depth indicated by the Engineer, and replaced with a soil having an AASHO Classification of A-2 or better. The backfill material shall be moistened and compacted in lifts not to exceed six (6) inches to a density of 95% Standard Proctor.

      When the subgrade repair is of sufficient area to justify the use of a roller, in the opinion of the Engineer, the subgrade shall be rolled with an approved type power roller weighing not less than three (3) and more than five (5) tons. Areas inaccessible to the roller shall be tamped with a mechanical tamper approved by the Engineer.
   d. The repair and replacement of base failures in the existing pavement by the use of asphalt concrete shall be accomplished in those areas as directed by the Engineer and as indicated on the plans. The area to be patched shall be removed to a depth of the thickness of pavement currently existing, except that the minimum depth for residential streets shall be six (6) inches and the minimum for all other streets shall be eight (8) inches.

      If soft and spongy material is encountered below the depth of patch, such material shall be removed as directed by the Engineer. The material below the depth of the patch will be replaced with soil

having an AASHO Classification of A-2 or better (it shall be the option of the Contractor that the additional backfill material may be FABB Meeting the requirements of these specifications).

When the subgrade repair is of sufficient area to justify the use of a roller, in the opinion of the Engineer, the subgrade shall be rolled with an approved type power roller weighing not less than three (3) and more than five (5) tons. Areas inaccessible to the roller shall be tamped with a mechanical tamper approved by the Engineer. The area which is removed shall be in straight lines, either parallel or perpendicular, to the centerline of the road. The face of all sides of the patch shall be vertical. The patch area will be tack coated, including the vertical face. The material to be used for patching shall be that material which is specified for the surface course mix used on the project.

e. The existing pavement shall be prepared for resurfacing as follows: The surface of the pavement shall be thoroughly cleaned of all dirt, dust or other loose, or inert materials by sweeping with approved brooms and flushing with water, using an approved hose and nozzle prior to resurfacing. The hose shall be of sufficient length to reach the entire width and length of the area to be cleaned. The cleaning shall be continued until the surface is in a condition satisfactory to the Engineer. Care shall be taken and the necessary arrangements made to prevent the water used in flushing the pavement from coming in contact with, or interfering with, any new work already in place or being placed. Where the existing paving is of two-course construction, and the surface course is removed, the area from which the surface course was removed shall be thoroughly cleaned of all particles of old surface incidental to this item as such; however, in the event unsatisfactory foundation material is encountered it shall be removed and disposed of as directed by the Engineer. Fine Grading will be measured by the square yard, completed and accepted.

f. No direct measurements will be made for Preparation of Pavement for resurfacing.

5. Basis of Payment. For City Contracts, the following will apply:

a. Payment for reconstruction of edges of existing paving adjacent to new paving construction will not be paid for as such, but the cost of reconstructing the edges of the existing pavement shall be included in the price bid for Thickened Edge for Concrete Paving, including support for existing paving. The price bid per linear foot for thickened edge for concrete paving including support for existing paving in place shall be payment in full for all excavation, labor, material and equipment and performing all work required for the construction of the thickened edge and support for existing paving.

b. Repair and replacement of paving cuts required for sewer or ditch construction will not be paid for as such, but will be included in the prices bid for the following items:

1) Reinforcing Steel
2) High-Early Strength Concrete for base repair. Reinforcing Steel will be paid for at the price bid per pound for reinforcing steel. High-Early Strength Concrete for base repair will be paid for at the price bid per cubic yard. Such compensation shall be payment in full for all labor, material, equipment, and excavation required to complete the repair and replacement of paving cuts for sewer or other ditch construction including support of adjacent slab.

c. The repair and replacement of base failures in pavement, using Portland concrete, including the reconstruction of edges of adjacent slab, will not be paid for as such but shall be included in the price bid for the following items:

1) Existing paving removed
2) Removal and disposal of unsatisfactory subgrade material
3) Soil for replacing unsatisfactory subgrade materials
4) High-Early Strength Portland Cement Concrete for base repair

In the event that the subgrade, after the removal of the pavement, is found to be acceptable by the Engineer, there will be no payment for A-2 Soil for replacing unsatisfactory subgrade material, or removal and disposal of unsatisfactory subgrade material. Existing paving removed will be paid for at the price bid per square yard as provided in Section 3.21 of this specification. Removal and disposal

of unsatisfactory subgrade material will be paid for at the price bid per cubic yard of this item. A-2 Soil for replacing unsatisfactory subgrade material will be paid for at the price bid per cubic yard for this material in place, compacted and accepted. Fine grading shall be paid for at the price bid per square yard for this item. High-Early Strength Portland Cement Concrete for base repair shall be paid at the price bid per cubic yard for this item. Such compensation as outlined above shall be payment in full for furnishing all materials, equipment, labor, excavation, and incidental items necessary to complete in accordance with the plans and specifications, the repair and replacement of base failures, in pavement, including the reconstruction of edges of adjacent slab.

d. The repair and replacement of base failures using asphalt concrete, including the reconstruction of edges of adjacent slab, will not be paid for as such, but shall be included in the price bid for the following items:
   1) Existing paving removed
   2) Removal and disposal of unsatisfactory subgrade material
   3) Soil for replacing unsatisfactory subgrade material
   4) Fine grading
   5) Asphalt concrete for base repair

   In the event that the subgrade, after the removal of the pavement, is found to be acceptable by the Engineer, there will be no payment for A-2 Soil for replacing unsatisfactory subgrade material, or removal and disposal of unsatisfactory subgrade material.

   Existing paving removed will be paid for at the price bid per square yard as provided in Section 3.21 of this specification. Removal and disposal of unsatisfactory subgrade material will be paid for at the price bid per cubic yard for this item. A-2 Soil for replacing unsatisfactory subgrade material will be paid for at the price bid per cubic yard for this material in place, compacted and accepted. Fine grading shall be paid for at the price bid per square yard for this item. Asphalt concrete for base repair shall be paid for at the price bid per ton for this item.

   Such compensation as outlined above shall be payment in full for furnishing all materials, equipment, labor, excavation, and incidental items necessary to complete in accordance with the plans and specifications, the repair and replacement of base failures, in payment, including the reconstruction of edges of adjacent slab.

e. No payment will be made for preparation of pavement for resurfacing as such but the cost of such work shall be included in the cost of Asphalt Concrete Wearing Surface in place.

3.23 Sidewalk and Driveway Construction:

1. Description. This item shall consist of the construction of driveways or the replacement, repair, relating to grade and extensions of sidewalks and driveways incidental to other construction work. Driveways shall be constructed in conformity with the detailed drawings shown on the plans and in accordance with the standard details of the owner for driveway construction. No openings will be left for driveways except where a new driveway, which extends from the curb line to the property line, is constructed as a part of this contract, or where a new driveway, connecting with an existing paved driveway, is constructed as a part of this contract. At locations where there is an existing paved or unpaved driveway actually in use, and where the difference in elevation between the existing driveway and the new pavement is such as to render a driveway at that location feasible, the construction of a new paved driveway, extending to the property line, or a new paved driveway, connecting to the existing paved driveway, is mandatory; unless the owner of the abutting property notifies the City in writing that he intends to permanently abandon the existing driveway. Existing paved or unpaved driveways located where the difference in grades is such as to render a driveway unfeasible, will be abandoned and no curb opening left at such locations, unless the abutting property owner agrees to make such adjustments in the elevation of his property as may be required to permit the construction of a driveway, prior to the

construction of the pavement, and specifically requests that the driveway be constructed as a part of this contract. At locations where no paved or unpaved driveway now exists, owners of the abutting property desiring a driveway will make application therefor to the City Engineer. No deduction in pay quantities shall be made for curb or curb and gutter left out at driveway openings.

2. Materials. All materials for the construction of concrete sidewalks and driveways shall conform to the requirements of Portland Cement Concrete. Concrete shall have a slump of not more than three (3) inches.
3. Construction Methods. Construction methods shall comply with the following requirements:
   a. Excavation. Excavation shall be made to the required depth below the finished surface in accordance with the grades given by the Engineer for the new work. All soft and yielding or other unsuitable material shall be removed and replaced with suitable material and the subgrade shall be compacted thoroughly and finished to a firm, smooth surface. Where filling is required, the material shall be compacted thoroughly in layers not exceeding six (6) inches in depth, measured loose.
   b. Forms. Forms shall be of substantial material having a flat surface on top and of a depth equal to the required thickness of the concrete. They shall be secured staked, braced and held firmly to the required line and grade. All forms shall be cleaned thoroughly and wetted before concrete is placed against them. Forms may be removed within eighteen (18) to twenty-four (24) hours after the concrete is placed.
   c. Placing Concrete. Concrete shall be placed and spread uniformly to the required depth with as little handling as possible, and shall be spaded next to the forms to prevent voids and honeycombed surfaces. The concrete shall be compacted so as to produce a uniformly dense concrete and permit proper finishing. Excess water, laitance or other inert material shall be floated from the surface. Concrete sidewalks and driveways shall have the finished thickness designated, but in no instance shall concrete sidewalks be less than four (4) inches or concrete driveways be less than six (6) inches in thickness.
4. Method of Measurement. For City Contracts, concrete sidewalks will be measured in square yards of the depth specified. Concrete driveways will be measured in square yards of drive of a specified depth. Measurement of driveways adjacent to new curb shall be from the back of said curb.
5. Method of Payment. For City Contracts, payment for concrete sidewalk will be at the price bid per square yard for Portland Cement Concrete Sidewalk in place and accepted by the Engineer. Payment for concrete drives will be at the price bid per square yard for Portland Cement Concrete Driveways in place and accepted by the Engineer. Such compensation shall be payment in full for all excavating, joint material and fine grading incidental to the construction, and for all labor, materials, equipment required to complete the items in accordance with the plans and these specifications.

3.24 Portland Cement, Air-Entraining Portland Cement and Admixtures:

1. Portland Cement.
   a. Materials Covered. These specifications cover three types of Portland Cement, as follows:

      Type I. For use in concrete for general concrete construction. When white Portland Cement is required, it shall meet the requirements of Type I.

      Type II. For use in concrete exposed to moderate sulphate action or moderate heat of hydration, when specified on the plans or in the proposal.

      Type III. For use when High-Early-Strength Concrete is required.

   b. Specifications. Portland Cement shall conform to the requirements of AASHO M 85. Unless otherwise permitted by the Engineer, the product of only one mill of any one brand and type of Portland Cement shall be used on the project, except for reduction of any excessive air-entrainment where air-entraining cement is used.
   c. Storage. The Contractor shall provide suitable means for storing and protecting the cement against

dampness. Cement, which, for any reason, has become partially set or which contains lumps of caked cement, will be rejected Cement salvaged from discarded or used bags shall not be used.

d. Methods of Sampling and Test. All methods shall be in accordance with the requirements of AASHO M 85.

2. Air-Entraining Portland Cement.

a. Materials Covered. These specifications cover three types of air-entraining Portland Cement for use where air-entrainment is desired, as follows:
Type IA. For use in concrete for general concrete construction.

Type IIA. For use in concrete exposed to moderate sulphate action or moderate heat of hydration, when specified on the plans or in the proposal.

Type IIA. For use when High-Early-Strength Concrete is required.

Unless otherwise permitted by the Engineer, the product of only one mill of any one brand and type of Portland Cement shall be used on the project, except for reduction of any excessive air-entrainment.

b. Specifications. Air-Entraining Portland Cement shall be of a standard brand and shall conform to all of the requirements of AASHO M 134 for the particular type being used.

c. Storage. Storage shall conform to Subsection 1.

3. Air-Entraining Admixtures. Air-entraining admixtures for air-entrained concrete shall be those approved by the Engineer. The Engineer has on file a list of approved commercial air-entraining admixtures. Materials not now on the approved list may be accepted if the manufacturer presents certified evidence that a given admixture meets all the requirements of AASHO M 154 or ASTM 260. An exception to the above requirement may be granted in the case of admixtures manufactured by neutralizing Vinsol resin with Caustic Soda provided the manufacturer furnishes certification that the product is Neutralized Vinsol resin and contains no other additive.

4. Chemical Admixtures. When a particular type of chemical admixture is specified, it shall conform to AASHO M 194. Compliance with AASHO M 194 as evidenced by certified copies of test reports conducted by an independent laboratory and filed with the Engineer is required for qualification of each commercially named chemical admixture proposed for use under these specifications.

The Contractor shall furnish the Engineer a written statement from the manufacturer with each lot or shipment to the effect that the admixture supplied for use in the work is identical in all essential respects, including concentration to the admixture tested under these specifications.

3.25 Water:

1. Water for Use with Cement.

a. Quality. All water used in mixing or curing Portland Cement Concrete or cement treated base shall be clean and practically free from oil, salt, acid, alkali, organic matter or other substances injurious to the finished product.

b. Tests. When required by the Engineer, the quality of the mixing water shall be determined in accordance with AASHO T 26.

c. Deleterious Substances. The amount of deleterious substance shall not exceed the following limits:

Clay lumps (wet on No. 4 sieve)	0.5%
Coal and lignite	1.0%
Material passing No. 200 sieve	3.0%

d. Organic Impurities. All fine aggregate shall be free from injurious organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test ~as specified in (e). Should the aggregate show a darker color than that originally approved for the work, its use shall be withheld

until tests satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.

e. Mortar Strength. When subjected to the mortar strength test, the fine aggregate shall develop a compression strength at the age of three (3) days when using Type III cement or at seven (7) days when using Type I or Type II cement of not less than ninety (90) percent of the strength developed by mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.4 ± 0.10. Types I, II, and III cement are prescribed in the Standard Specifications for Portland Cement.

f. Gradation. The fine aggregate shall be well graded from coarse to fine, and when tested by means of laboratory sieves, shall conform to the following requirements:

When tests are made comparing the water with water of known satisfactory quality, any indication of unsoundness, marked change in time or set, or reduction in mortar strength shall be sufficient cause for rejection of the water under test. Water from city water supply may be accepted without being tested. Water from doubtful sources shall not be used until tested and approved.

3.26 Mineral Aggregates

1. Fine Aggregate for Portland Cement Concrete and Mortar.

a. Materials Covered. These specifications cover the quality and size of fine aggregates for Portland cement 0ncrete pavements or bases, highway bridges and incidental structures.

b. General Requirements. Fine aggregate shall consist of natural sand, or subject to approval, combinations of manufactured sand and natural sand, having hard, strong, durable particles and shall conform to these specifications. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix, without permission from the Engineer, or as provided herein for manufactured sand.

When manufactured sand is approved for use in combination with natural sand, at least 50% of the total fined aggregate by weight shall be natural sand. The two materials shall conform to the requirements of these specifications, except that the mortar strength test shall be made on the blend of materials proposed for use.

c. Deleterious Substances. The amount of deleterious substance shall not exceed the following limits:

Clay lumps (wet on No. 4 sieve)	0.5%
Coal and lignite	1.0%
Material passing Ho. 200 sieve	3.0%

d. Organic Impurities. All fine aggregate shall be free from injurious organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified in (e). Should the aggregate show a darker color than that originally approved for the work, its use shall be withheld until tests satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.

e. Mortar Strength. When subjected to the mortar strength test, the fine aggregate shall develop a compression strength at the age of 3 days when using Type III cement or at 7 days when using Type I or II cement of not less than 90 percent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 ± 0.10. Types I, II, and III cement are prescribed in the Standard Specifications for Portland Cement.

f. Gradation. The fine aggregate shall be well graded from coarse to fine, and when tested by means of laboratory sieves, shall conform to the following requirements:

1. Fine Aggregates	Percent
Passing 3/8 inch	100
Passing No. 4	95 to 100
Passing No. 16	45 to 85

Passing No. 50	5 to 30
Passing No. 100	0 to 10

2. Mortar Sand — Percent

Passing No. 8	100
Passing No. 50	15 to 40
Passing No. 100	0 to 10

g. Methods of Sampling and Testing. Sampling and Testing of find aggregate shall be in accordance with the following methods of ASSHO except as noted:

Sampling	T 2
Clay lumps (wet on No. 4 sieve)	OHDL – 9
Coal and lignite	T 113
Amount of material passing the No. 200 sieve	T 11
Organic Impurities	T 21
Mortar Strength Tests	OHDL – 19
Sieve Analysis	T 27

h. Stockpiles. Separate stockpiles shall be provided for fine aggregates secured from different sources. Areas for stockpiles shall be grubbed, cleaned and compacted before storing fine aggregate. Stockpiles shall be built in such manner as to prevent segregation and to insure reasonably uniform gradation throughout the pile.

2. Coarse Aggregate for Portland Cement Concrete.

a. Material Covered. These specifications cover the quality and size of coarse aggregate for use in Portland Cement concrete pavements or bases, highway bridges, and incidental structures.

b. General Requirements. Coarse aggregates shall be a gravel or crushed stone, which shall conform to the requirements of these specifications. Crushed stone for coarse aggregate shall be obtained from clean, tough, sound, and durable rock, and shall consist of angular fragments of uniform quality throughout. Gravel for coarse aggregate shall consist of clean, tough, durable. pebbles, practically free from clay, coatings of any character, disintegrated or soft pieces, conglomerates, mud balls, sticks, salt, alkali, or vegetable matter.

c. Deleterious Substances. The maximum percentages of deleterious substances shall not exceed the following values:

Material passing No. 200 sieve (wash)	2.0% by weight
Coal or lignite	0.5% by weight
Clay lumps (wet on #4 in. sieve)	0.5% by weight
Light weight particles (less than 1.95 Sp. Gr.)	1.0% by weight

d. Physical Properties. The coarse aggregate shall conform to the following Los Angeles abrasion requirements:

100 revolutions – not more than 10%

500 revolutions – not more than 40%

e. Sampling and Testing. Coarse aggregate shall be well graded between the limits specified and the size or sizes designated shall conform to the requirements given in the following table:

Percentage by weight passing laboratory sieves having square openings in inches.

Sieve Size	#3 (2” to 1”)	#57 (1” to No. 4)	#357 (2” to No. 4)	#7 (½” to No. 4)
2 ½	100		100	
2	95 – 100		95 – 100	
1 ½	35 – 70	100		
1	0 – 15	90 – 100*	35 – 70	
¾				100

½	0 – 5	25 – 60	10 – 30	90 – 100
3/8				40 – 70
No. 4		0 – 10	0 – 5	0 – 15
No. 8		0 – 5		0 – 5

1. Coarse aggregate for pavements and base courses shall be finished, either in two separate sizes, the #3 (2 in. to 1 in.) and the #57 (1 in. to No. 4). When two separate sizes are used, the batch requirement of each size shall not be less than 35 percent nor more than 65 percent of the total quantity of coarse aggregate required for each batch.
2. Coarse aggregate for Class "A" (A(AE)) and Class "AA" (AA(AE)) Concrete shall be furnished in one size, the #57 (1 in. to No. 4 size).
3. Coarse aggregate for Class B Concrete and Massive Class "A" Concrete shall be furnished in one size, the #357 (2 in. to No. 4) size. Coarse aggregate for Class C Concrete may be either #57 or #357.
4. Coarse aggregate for Thin Section concrete shall be furnished in one size, the #7 (½ in. to No. 4) size.

* Simplified Practice Recommendations modified on the one inch sieve.

f. Sampling and Testing. Sampling and testing of the coarse aggregate shall be in accordance with the following methods of the AASHO except as noted.

Sampling	T 2
Material passing No. 200 sieve (wash)	T 11
Clay lumps (wet on NO. 4 sieve)	OHD L-9
Light weight particles (less than 1.95 Sp. Gr.)	T 150
Abrasion for Coarse Aggregate	T 96
Unit Weight	T 19
Sieve Analysis	T 27

g. Mixing Aggregate. Crushed stone, or gravel, from different sources of supply may be combined in the mix when batched separately in recommended proportions upon written permission of the Engineer.

h. Stockpiles. Sites for stockpiles shall be grubbed and cleaned and compacted prior to storing materials. The stockpiles shall be built in layers not exceeding 3 feet in height, and each layer shall be completely in place before the next layer is started. The material shall be deposited in such a manner as to prevent coning. Material which becomes segregated to such an extent that it will no longer pass the specifications for grading shall be re-combined so that it will pass the grading specifications before being used in concrete. Aggregates from the different sources shall be stored in separate stockpiles.

3.27 Sand for Sand Cushion Subbase

1. Materials. These specifications cover the material for use as sand cushion for concrete pavement. Sand cushion shall all pass a 1/2 inch sieve and shall contain 0% to 50% of material passing the No. 200 sieve. A-3 soil may be modified by the addition of soil binder to meet these requirements. The final material shall have a liquid limit of 35 or less and a plasticity index not to exceed 6.

3.28 Mixtures for Plant Mix, Bituminous Bases and Surfaces

1. Mixtures for Asphalt Concrete. Description. This sub-section covers the material requirement, composition of mixtures and test methods for asphalt concrete pavements (Section 3.12).
   a. Materials.
      1) Approval of Materials: Prior to use samples of all materials proposed to be used under these specifications shall be submitted to an approved laboratory for test and for preparation of trial mixtures to determine the initial job-mix formula.

Local materials in whole or in part will be approved for use when meeting the gradation or other requirements specified herein.

2) Mineral Aggregate. Mineral aggregate shall be composed of coarse aggregate, fine aggregate and mineral filler. The coarse aggregate shall be that part of the aggregate retained on the No. 10 sieve and shall consist of clean, tough, durable particles of crushed stone, crushed gravel, or any combination thereof. It shall be practically free from clay, organic or other injurious matter occurring either free or as a coating on the aggregate. When used as a surface course, the material retained on the No. 4 sieve shall be 100% crushed limestone having at least 2 fractured faces.

Fine aggregate shall be that part of the aggregate passing No. 10 sieve and crushed gravel, mine chat, or jig sand, or any combination of these materials. Natural sand will be fed to the drier as a separate aggregate. In no case will the blending of crushed and natural material in the same storage be permitted.

When in a wearing course, the material in the natural sand passing the 200 sieve shall be less than 50% of the minus 200 material contained in the combined aggregate.

Mineral filler, when required in addition to that naturally contained in the aggregate, shall consist of thoroughly dry limestone dust, volcanic ash, Portland cement, hydrated lime or other approved inert mineral matter. As delivered to the mixer, mineral filler shall be free from lumps or loosely bonded aggregations.

Deleterious Substances. The mineral aggregate, in stockpile at the plant site, shall be free of deleterious substances, in excess of the following limits by weight, as samples:

Mud, clay balls, sand clusters, or sand balls, Retained on the No. 4 sieve (wet weight)	1.5%
Stock or roots (net weight)	0.5%

Physical Properties. The aggregate shall conform to the following requirements:

The percentage of wear, Los Angeles Abrasion Test, shall not exceed 10 for 100 revolutions, and 40 for 500 revolutions.

This requirement applies to materials from each source used in the combined aggregate.

The Sand Equivalent of the combined aggregate exclusive of added mineral filler shall be not less than 40 when used in a base or binder course and not less than 45 when used in the wearing course. The course aggregate to be used in the wearing course shall have a durability factor of not less than 40 when tested in accordance with AASHO T 210.

3) Asphalt. All asphalt materials shall meet the requirements of the latest Standard Specifications for Highway Construction of the Oklahoma State Highway Commission and will be 85-100 penetration asphalt, unless otherwise specified.

b. The paving mixtures shall consist of a uniform mixture of the combined aggregates and asphalt cement and shall conform to the following table of mixtures designated on the plans in the proposal:

TABLE OF MIXTURES				
Mix No.	A	B	C	D
Use	Binder	Surface	Surface	Thin Overlays
Compacted Depth	2” – 4”	1 ½“ – 3”	1” – 2”	½ “ – 1”
Sieve Size		Percent by Weight Passing		
1 ½	100			

1	80 - 100			
5/8		100		
½	60 - 80	84 - 100	100	
3/8		74 - 92	80 - 100	100
#4	40 - 55	55 - 73	55 - 75	80 - 100
#10	30 - 45	38 - 54	40 - 55	58 - 85
#40	15 - 30	18 - 32	18 - 33	25 - 45
#80	8 - 20	8 - 20	10 - 22	12 - 28
#200	2 - 8	2 - 8	4 - 10	6 - 14
%AC	4 – 6.5	5 - 7	5 – 7.5	6 - 10

The final gradation determined by the laboratory within the job-mix formula shall be uniformly graded from coarse to fine. It shall not vary from the top limit on any sieve to the bottom limit of the adjacent sieve or vice versa. No production of material for use under these specifications shall be started until the job-mix formula has been approved by the Engineer. The mixture shall be designed by the laboratory to have a laboratory molded density of not less than 94% nor more than 98% of its maximum theoretical density. The stability value for all mixtures other than surface courses shall have a minimum of 35 Hveem.

When used as surface courses for residential streets, mixtures shall be designed for Hveem stability of not less than 40. Surface courses for arterial streets shall have a Hveem stability of not less than 45. Surface courses for mix design purposes only for all arterial streets shall also have a minimum Marshall Stability value of 1,200.

The job-mix formula for each mixture with the allowable tolerances shall be within the master range shown in the table of mixtures. The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve, a single percentage of asphalt to be added to the aggregate and a single temperature at which the mixture is to be delivered at point of discharge. The job-mix formula for each mixture shall be in effect until modified in writing by the Engineer.

c. Tolerances. The paving mixture as produced shall conform to the job-mix formula within the following range of tolerances:

Passing No. 4 and larger sieves	± 5 percent
Passing No. 10 sieve to No. 100 sieve (incl.)	± 4 percent
Passing No. 200 sieve	± 2 percent
Asphalt content	-0.2 to +0.4 percent
Temperature of mix as discharged from pugmill	±20° F

The above variations from the job-mix formula shall not permit the use of any mix which would be outside of the specification limits through the application of the variations. Should a change in the source 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 establish a new job-mix formula.

e. Sampling and Testing. Sampling and testing shall be done in accordance with AASHO Methods except as noted:

Aggregate:

Sampling	T 2
Sieve Analysis	T 27
Material passing No. 200 sieve	T 11
Wear (Los Angeles Abrasion)	T 95
Mud, clay balls, sand clusters, sticks and roots, retained on No. 4 sieve	OHD L-9

Sand Equivalent	T 176
Durability factor (Plastic fines in aggregates)	T 210
Asphalt (See Section 715, OHD Standard Specifications):	
Sampling -- Plant Site	OHD L-5
Mixtures:	
Mechanical Analysis of extracted aggregate	T 30
Sampling	T 168
Bitumen Content	
By Centrifuge	T 164
By Reflux Extractor	T 184
Mix Design:	
Bulk Impregnated So. Gr. of Aggregates	OHD L-7
Compacting Materials for Stabilometer Value (Texas Gyratory)	OHD L-8
Sp. Gravity and Wt. per C.F. of Compressed Bituminous Mixture	OHD L-14
Test for Stabilometer Value (Hveem)	OHD L-16
Test for Marshall Stability	ASTM-D-1559

2. Mixtures for Bituminous Base, Fine Aggregate Type. Description. This sub-section covers material requirements, composition of mixtures and test methods for plant mix bituminous base-fine aggregate type. (Section 3.7)
   a. Materials.
      1. Approval of materials. Prior to use, samples of all materials proposed to be used under these specifications shall be submitted to the Engineer for test and for preparation of trial mixtures to determine the initial job formula. The Contractor may submit a job-mix formula for consideration by the Engineer. After the plant is in operation, a satisfactory job-mix formula will be determined.

      Local materials, in whole or in part, will be approved for use when meeting the gradation and other requirements specified herein.

      2. Mineral Aggregate. The aggregate shall be mineral aggregate composed of natural sand, gravel, stone screenings or any combination of these materials with or without mineral filler.

      As delivered to the mixer, the material shall be free of clay lumps, loosely bonded aggregations, organic material or other foreign material. Natural sand shall consist of clean, tough, moderately sharp grains. Gravel shall have a percent of wear not to exceed 50. Stone screening shall be derived from a material having a percent of wear not to exceed 40. The combined aggregate shall have a sand equivalent of not less than 25 (sampled after all processing except additional mineral filler).

      Mineral filler, when required in addition to that naturally contained in the aggregate, shall consist of thoroughly dry limestone dust, volcanic ash, portland cement, hydrated lime or other inert mineral materials. As delivered to the mixer, mineral filler shall be free from lumps or loosely bonded aggregations.

      3. Asphalt. The asphalt cement shall be 85-100 penetration asphalt meeting the requirements of the Standard Specifications for Highway Construction of the Oklahoma State Highway Commission.
   b. Composition of Mixture. The mixture shall consist of a uniform mixture of combined aggregate and asphalt cement within the following limits:

SIEVE SIZE	PERCENT PASSING
1 Inch	100
No. 4	75 – 100
No. 10	55 – 100
No. 40	25 – 85
No. 200	5 – 20

Asphalt content 3.0% to 8.0%

The mixture shall be designed for a laboratory molded density of not less than 82% of its maximum theoretical density. The mixture shall be designed for a Hveem stability value based on the table below for the axle load or type of facility and the cover (thickness of material of higher quality to be placed on top of the mixture) as follows:

AXLE LOAD	COVER	MIN. STABILITY
6000#	2”	20
(Residential)	3”+	17
9000#	2”	25
(Collector)	3”	20
	4”+	17
12000#	3”	25
(Arterial)	4”	20
	5”+	17

The job-mix formula for the mixture with the allowable tolerances shall be within the mixture range specified herein. The job-mix formula for the mixture shall establish a single percentage of aggregate passing each required sieve, a single percentage of asphalt to be added to the aggregate and a single temperature at which the mixture is to be delivered at point of discharge. The job-mix formula for each mixture shall be in effect until notified in writing by Engineer.

c. Tolerances. The paving mixture as produced shall conform to the job-mix formula within the following range of tolerances:

Passing No. 200 and larger sieves	±5%
Asphalt content:	±0.5%

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 of other conditions make it necessary, the Engineer may establish a new job-mix formula.

3.29 Nonreinforced Concrete Sewer Pipe:

1. Description. Cement concrete sewer pipe, sizes four (4) inches to twelve (12) inches, shall conform to the Standard Specifications for Cement Concrete Sewer Pipe, Serial Designation C 14-65 of the ASTM and subsequent revisions thereof.

3.30 Reinforced Concrete Sewer Pipe:

1. Description. Reinforced concrete sewer pipe in fifteen (15) inch and larger sizes and classes shall conform to the requirements of C 76-65T, depending on whether reinforced concrete sewer pipe or reinforced concrete culvert pipe is designated in the Proposal, Special Provisions or on the plans.

3.31 Mastic Joint:

1. Description. This cold applied mastic type compound, when applied according to the manufacturer’s directions, shall be resilient and adhesive and maintain an effective seal through repeated cycles of expansion and contraction. The material shall comply specifically with the following requirements:

	Min.	Max.
Specific Gravity 25°C/25°C	1.290	1.350

Pounds per Gallon	10.75	11.25
Percent Bitumen Soluble in CS_2	45.0	---
Percent Ash	50.0	55.0
Percent Water by Volume	---	0
Penetration (Standard Cone)		
150 gr., 5 sec., 25°C	175.0	200.0

3.32 Sewer Brick:

1. Description. Sewer bricks shall be made from clay or shale, and shall conform to the requirements of the ASTM Specifications for Sewer Brick, Serial Designation C 32-50.

3.33 Casting for Sewer Manholes and Inlets:

1. Description. This item shall consist of manhole frames and covers, sewer inlet frames and gratings, and steps for manholes and inlets. All castings shall conform strictly to the standard design or designs designated, or to special designs when required. Castings shall be of cast iron or cast steel as designated.
2. Quality. Steel castings shall conform to the requirements of the Standard Specifications of Steel Casings Serial Designation A 27-55 of the ASTM and subsequent revisions thereof. Steel castings shall be C1ass B, Hard Grade, unless otherwise specified. Iron castings shall conform to the Standard Specifications for Gray Iron Castings. Serial Designation A 48-58 of the ASTM and subsequent revisions thereof.

   Castings shall be free from pouring faults, sponginess, cracks, blow holes and other defects in locations affecting the strength and value of the castings for the service intended, shall be filleted at angles and the arises shall be sharp and true. All castings shall be free from warp and seat uniformly and solidly. Where weight is specified or shown on the plans, castings shall conform to such requirements. Accessories such as bolts, rivets, spacers, small I-beams, channels, plates, etc., used for assembling or supporting gratings in multiple grating sewer inlet installations shall be first quality standard, commercial materials, free from defects which affect their value for the service intended.

3.34 Corrugated Steel Sewer Pipe:

1. Description. Structural plate pipe, pipe arch and arch in sizes sixty (60) inches and larger shall conform to AASHO designation M167, current revision. Where project plans and specifications require bituminous coating and/or invert paving, such coating and/or paving shall conform to AASHO designation M190, current revision.

3.35 Structure Plate Pipe, Pipe-Arch and Arch:

1. Description. Structural plate pipe, pipe arch and arch in sizes sixty (60) inches and larger shall conform to AASHO designation M167, current revision. Where project plans and specifications require bituminous coating and/or invert paving, such coating and/or paving shall conform to AASHO designation M190, current revision.

3.36 Corrugated Steel Underdrains:

1. Description. Structural plate pipe, pipe arch and arch in sizes six (6) inch through twenty-one (21) inch shall conform to &ASHO designation Ml36, current revision. Where project plans and specification require bituminous coating, such coating shall conform to AASHO designation M190 current revision.

3.37 Joint Fillers and Sealers for Portland Cement Concrete:

Description. This section establishes the requirements for Joint Fillers and Seals for Portland Cement Concrete.

1. Preformed Expansion Joint Filler (Bituminous Type). General Requirements. This joint filler shall conform to the requirements of AASHO M 33.
2. Preformed Expansion Joint Filler (Non-Extruding and Resilient Types). General Requirements. This joint filler shall conform to the requirements of AASHO M 153.

3. Hot Poured Sealing Filler for Expansion, Contraction and Longitudinal Joints. General Requirements. This joint sealer shall conform to the requirements of AASHO M 173.
4. Ready Mixed Cold Applied Joint Sealer for Expansion, Contraction, and Longitudinal Joints.
   a. Description. The Ready Mixed Cold Applied Joint Sealer shall consist of a rubbery, resilient and adhesive internal set-up mastic joint sealer. The sealer shall have the quality of bonding perfectly to fresh concrete.
   b. Material. The joint sealing compound furnished and used under this specification shall be a cold applied, ready-mixed material consisting of a homogenous blend of asphalt, rubber, inert filler and a suitable solvent or solvents. The sealing compound shall contain not less than 5% virgin rubber and the Contractor shall furnish manufacturer's certified statement of compliance with this requirement. When installed in accordance with the manufacturer's recommendations, the material shall be a resilient, adhesive compound capable of effectively sealing properly cleaned joints and cracks in concrete pavements against the infiltration of moisture throughout repeated cycles of contraction and expansion, and which will not flow from the joints or be picked up by vehicle tires particularly at summer temperatures. When approved by the Materials Engineer, the manufacturer's test results showing compliance with these specifications may be used as a basis for acceptance.
   c. Requirements. The compound furnished under this specification when tested in accordance with the methods hereinafter described, shall conform with the following requirements:

      Penetration:

      At 77° F. (As received) 150 gm., 5 sec. — Minimum 2.75 cm. Maximum 3.50 cm.

      (After evaporation of solvent) 150 gm., 5 sec. — Minimum 1.30 cm. Maximum 1.90 cm.

      At 32° F. (After evaporation of solvent) 200 gm., 60 sec. — Minimum 1.30 cm. Maximum 1.90 cm.

      Flow: 24 hrs. at 77°F., 5 hrs. 140°, not more than 0.5 cm.

      Bond: Separate tests conducted on wet and dry mortar blocks. There shall be no cracking of the filler or failure in the bond between the sealer and the mortar test blocks through 5 cycles.
   d. Testing. Testing shall be in accordance with OHD-L-22.
5. Catalytica11y Blown Asphalt Joint Sealing Compound. Description and General Requirements. This sealer shall be a catalytically blown asphalt material, uniformly blended with approximately 10% diotomaceous earth which passes the 325 mesh sieve. When tested by Standard AASHO Test Methods, it shall meet the requirements below:

   (Section 715)

Penetration at 77° F., 100 gm., 5 sec	68-88
Penetration at 32° F., 200 gm., 60 sec	38+
Penetration at 1150 F., 50 gm., 5 sec	160-
Flash, (Cleveland open cup) °F	500+
Softening Point (Ring & Ball) °F	175-200
Ductility at 77° F., Cm	5+
Flow, 5 hrs., 140° F., 75° Incline; cm	0.5-
Ash,%	8+
Settlement Ratio, AASHO T 109	1.02-
Brittleness test; 0.32 cm. film at 32° F., 180° bend around 3/8 inc. diameter mandrel	No cracking

This material is intended for use in sealing cracks in asphalt or concrete pavements or resealing joints in concrete pavements. It shall be melted (in small batches) in a regular asphalt kettle to a temperature not to exceed 475° F. as proper bonding is not obtained at a lower temperature.

6. Preformed Elastomeric Compression Joint Sealer.
   a. Description. These specifications cover preformed elastomeric compression joint sealers for use in Portland Cement concrete pavements and concrete bridge floors.
   b. Materials.
      1) Preformed Joint Seals. The joint seals shall be manufactured from an elastometric material that is resistant to heat, oil, jet fuel and ozone. The material shall be compatible with concrete and shall conform to the physical requirements given in Table I. All tests will be made on samples taken from the preformed joint sealer.
      2) Shape and Dimensions. The molded joint seals shall be of cross sectional dimensions, lengths and tolerances shown on the plans. The sealer shall be one piece for the full length of the transverse joint and in practical lengths for longitudinal joints.
      3) Samples. Two 2-foot long pieces of each size of sealer to be used shall be submitted to the Materials Division for tests as warranted.
      4) Inspection. Representative sections of each lot shall be subject to surface and dimensional inspection by the Engineer to determine visual compliance with applicable requirements of this specification which do not require physical tests.
      5) Lubricant-Adhesive. Any lubricant-adhesive used shall be compatible with the sealer and the concrete and relatively unaffected by the normal moisture in the concrete. The lubricant-adhesive shall be a compound consisting of the same base polymer as the sealer, blended with a suitable volatile solvent. It shall maintain a suitable consistency at a temperature at which the seal is installed.
      6) Manufacturer's Certification. The Contractor shall furnish the manufacturer's certification that the material proposed for use in compliance with the specification requirements and include copies of the required tests by an approved laboratory.

         The Contractor shall also furnish manufacturer's certification that a stipulated quantity of material, with identification, furnished for the specific project, is identical in all essential respects to the material tested under these specifications.

         The Engineer may perform any of the specified tests as may be warranted.

TABLE I		
Property Determined on Actual Seals	**Test Method**	**Physical Requirements**
Tensile Strength, psi, min.	ASTM D 412	2000
Elongation at Break, % min.	ASTM D 412	250
Hardness, Durometer A	ASTM D 2240	55+5
Ozone Resistance, 20% elongation	ASTM D 1149	
330 ppm in air		
70 hrs at 104° F		
Wipe with solvent to remove surface contamination		No Cracks
Heat Aging, 70 hrs. at 212° F	ASTM D 573	
Tensile Strength, change, max. %		-30
Elongation, change, max. %		-40
Hardness, points change, max.		+10
High Temperature Recovery (70 hrs. at 202°F. under 50% deflection)	Refer to Test Procedure, Sub-section 722.07(C)	Min. 85% Recovery
Low Temperature Recovery (72 Hrs. at +14° F. under 50% deflection)	Refer to Test Procedure, Sub-section 722.07(C)	Min. 88% Recovery
Low Temperature Recovery (22 Hrs. at -20° F. under 50% deflection)	Refer to Test Procedure,	Min. 83% Recovery

	Sub-section 722.07(C)	
Oil Swell, ASTM Oil #3 70 Hrs at 202° F.	ASTM D 471	
Max. Volume Change		+65
Max. Wt. Increase at Specific Gravity 1.35+ .03		+40
Flame Resistance	Fetter Flame Test	Must not propogate flame

c. Low and High Temperature Recovery Tests.

1. Apparatus

1.1 Compression Clamp: A compression clamp consists of 2 or more flat steel plates known as a Method "B" ASTM compression clamp (ASTM D 395); or a vise having parallel plates on jaws; or any basic device by which uniform compression can be applied to a specimen. The device should be capable of accepting a 5-inch long specimen.

1.2 Steel Spacers: If compression clamps are used, steel spacer bars will be required to allow proper spacing of the steel plates.

1.3 Air Oven: This piece of apparatus shall meet the requirements of ASTM E 145, Type II, Grade A. The oven shall be provided with proper temperature control to maintain the specified temperature within a permissible variation of ± 2° F.

1.4 Low Temperature Box: This piece of apparatus can be any refrigerated box capable of maintaining a temperature variation of ±2° F. on temperature settings within the range of +20° F. to -20° F.

1.5 Dial Gauge-Vernier Caliper-Micrometer: A dial gauge, vernier caliper, or micrometer graduated in thousandths of an inch shall be used for measurements.

1.6 Samples for Recovery Tests: Samples of fabricated seals shall be approximately 5 inches long and shall be taken at random from each new shipment of seals.

2. Test Procedure

2.1 In the heat tests the material shall be tested as furnished in production. There should be no talcing of internal surfaces of the seal. Outside surfaces may be dusted to prevent sticking to the steel compression plates. In cold tests, talcing of internal seal surfaces may be desirable.

2.2 Deflect the sample between parallel plates to 5O~ of original top width. Width measurement shall be taken in the center of the 5-inch length. Prior to compression the sample shall be placed in a horizontal position in such a manner that the plane between the lip tips is perpendicular to the compression plates. As the sample is being compressed, care should be taken to insure that the "V" section of the sample top be folded so that it projects inward toward the inner web section.

2.3 High Temperature: Expose the clamp assembly and compressed sample in an oven for 70 hours at 212° F. ±2°. Do not preheat the clamp assembly. When the oven aging period is completed, remove the clamp assembly and immediately unclamp the test specimen. Cool the test specimen at room temperature (73° +4) on a wooden surface for one hour before measuring the heat aged recovery width. The measurement shall be made at the location at which the original width was determined.

Low Temperature: Expose the clamp assembly and compressed sample in a low temperature box for the time and temperature specified. When the cold aging period is completed, unclamp the: test specimen at the test temperature; allow it to recover in a free state at the test temperature for one hour. At this point measure the recovery width at the test temperature. The measurements shall be made at the location at which the original width was determined.

2.4 Calculations: Calculate the recovery, expressed as a percentage of the original width, as follows:

$$\text{Percent Recovery} = \frac{\text{Recovered Width} \times 100}{\text{Original Width}}$$

2.5 Any cracking visible after recovery testing is basis for rejection.

7. Polymer Type, Two Component Cold Applied Machine Extruded and Pourable Joint Sealer.

a. Description. These specifications cover two component, polymer type rubberlike, cold applied joint sealing compounds for use in Portland Cement concrete pavements and bridge floors. A primer, when recommended by the manufacturer, shall be used in accordance with the manufacturer's recommendation.

b. Materials.

1. General.

1.1 Inspection. Each batch of the joint sealer manufactured shall be subject to inspection and approval by the Materials Division before acceptance or shipment. The State reserves the right to have an inspector present to observe the manufacturing process.

1.2 Packaging. The joint sealer shall be packaged in sealed containers identified by the name of the manufacturer, the manufacturer's lot number, the date of manufacture and shall bear instructions for mixing and application. Containers including the curing agent shall be marked "A" and containers including the polymer shall be marked "B". Proper instructions for use of the primer shall be given on its container.

1.3 Sampling: Samples selected by the Engineer, of each component and the primer of each lot of material, shall be submitted to the Laboratory for test purposes at least 3 weeks before use. Regardless of previous tests, material that has not been used within 6 months shall be resampled and retested. Additional tests may be made at the discretion of the Engineer. For the extrusion machine type, a 5-gallon sample of each component shall be furnished. The unused portion will be returned. For the pourable type, a 1-quart sample of Component "B" and the proper quantity and mixing ratio of Component "A" shall be furnished. If a primer is required, a 1/4 pint sample shall be furnished.

1.4 Tests: Tests shall be made in accordance with OHD L-21.

1.5 When approved by the Materials Engineer, the manufacturer's test results showing compliance with these specifications may be used as a basis for acceptance.

2. Machine Extruded Joint Sealer:

2.1 General. The joint sealer shall be a modified polysulfide polymer consisting or 2 components to be machine mixed in a 1:1 ratio by volume and machine extruded directly into the joints. Upon opening, Component "B" shall not exhibit more than a slight degree of skinning.

2.2 Properties of Unmixed Material.

Determination	Requirements
*Viscosity of Components	150 to 800 poises

*The viscosity of either component shall not be more than 2½ times the viscosity of the other component.

2.3 Properties of Laboratory Mixed Material.

Determination		Requirements
Penetration at 77° F.		50 to 120
Penetration at 158° F.		1.5 x Penetration at 77° F.
Cold Flow	3 minutes	¾ inch minimum
	40 minutes	½ inch maximum
Resilience at 77° F.		70% minimum
		**60% minimum
Resilience of oven aged sample at 7 days		70% minimum
		**60% minimum
Resilience at 158° F.		60% minimum
		**50% minimum
Bond to Concrete[1], 100% extension, dry, at -20° F.		No failure
Bond to Concrete, 100% extension, wet, at -20° F.		No failure
Non-Volatile content		88% minimum

**This requirement applies if penetration at 77° F. is 90 to 120.

[1]Cure sample for 24 hours at 77° F., then oven age at 158° ± 2° F. for 77° F. for 7 days before testing.

3. Pourable Joint Sealer:

3.1 General. The joint sealer shall be a polymeric material consisting of 2 components to be uniformly mixed and poured directly into the joints. The weight of Component "A" in the mixture shall be not less than 10 percent of the weight used of Component "B". Upon opening, neither component shall exhibit more than a slight degree of skinning.

3.2 Properties of Laboratory-Mixed Material.

Determination	Requirements
Viscosity, 5 minutes after mixing	200 to 350 poises
Application time (pot life or time to reach 200 poises at 77° F.)	1 Hr minimum

Determination	Requirements
*Penetration at 77° F. after 24 hours aging at 77° F.	150 maximum
*Penetration at 77° F.	50 t0 100
*Penetration at 158° F.	1.5 x Penetration at 77° F.
*Resilience at 77° F.	70% minimum
	**60% minimum
*Resilience at 158° F.	60% minimum
	**50% minimum
Resilience at oven aged sample at 7 days.	70% minimum
	**60% minimum
*Bond to Concrete[1];	
100% extension, dry, at -20° F.	No failure
100% extension, wet, at -20° F.	No failure
Non-Volatile content	88% minimum

*After 96 hours aging at 77° F.

**This requirement applies if penetration at 77° F. after 96 hours aging at 77° F. is 90 to 120.

[1]Cure sample for 24 hours at 77° F., then oven age at 158° ± 2° F. for 77° F. for 7 days before testing.

3.38 Reinforcing Steel:

1. Reinforcing Steel.
   a. Materials Covered. These specifications cover plain and deformed steel bars for concrete reinforcement, and shall apply to all bar used in the work.
   b. Requirements. Billet-steel reinforcement bars shall conform to ASTM A 15 and A 305, with the following modifications:
      1) All steel bars shall conform to the requirements for intermediate grade steel.
      2) Bars for reinforced concrete shall be deformed bars meeting the above specification for bar reinforcement.
      3) Dowel bars across transverse joints shall be smooth round bars meeting the above specifications for bar reinforcement.
   c. Sampling and Testing. A sample shall consist of two bars, not less than 24 inches in length, from each lot of bars in the shipment. The term "lot" used in this paragraph means all bars of one size bearing one manufacturer's roll mark. Testing shall be in accordance with ASTM E 8.

2. Reinforcing Steel (Axle Steel):
   a. Materials Covered. This specification covers plain and deformed axle-steel bars for concrete reinforcement, which may be used in lieu of billet-steel bars, as specified in Subsection 1(a).
   b. Requirements. Axle-steel shall conform to the requirements of ASTM A 160 and A 305, except the steel shall pass the physical tests specified for ASTM A 15, and Subsection 1(b), including the requirements that the physical bend test shall be as specified for intermediate grade steel.
   c. Sampling an Testing. Sampling and Testing shall conform to Subsection 1(c).
3. Wire Fabric Reinforcement:
   a. Materials Covered. These specifications cover metal parting strips for use in forming longitudinal joints in concrete pavement or concrete base courses.
   b. General Requirements. Metal parting strips shall be shaped from metal of a gauge shown on the plans and shall be free from bends and kinks, it shall conform to the dimensions and be punched for pins and tie bars as shown on the plans. Punching for pins may not be farther apart than 3 feet center to center. Sections of metal parting strips shall not be less than 10 feet in length and so designated that adjoining sections may be securely fastened together by lapping and pinning, by means of a slip joint, or other approved method.

3.40 Curing Agents for Concrete:

1. Description. Concrete curing agent shall be pigmented membrane curing compound. The curing agent shall be reasonably free from ingredients which may damage or be detrimental to the surface of the concrete, and unless otherwise specified, shall conform with the requirements of these specifications.
2. White Pigmented Membrane Curing Compound.
   a. General Requirements.
      1) Material. The material shall be a membrane curing compound of the highest quality capable of high water retention, and shall consist of finely ground pigment in the curing vehicle.
      2) Color. The compound, when applied to a new concrete surface at the specified coverage, shall provide a uniformly white appearance arid shall effectively obscure the original color of concrete.
      3) Containers. Curing compound shall be shipped in barrels, upon which shall be plainly stenciled the manufacturer's none and a lot number indicating the particular batch of which the contents are a part. A jobber's name or brand may be supplemented, but shall not replace, the manufacturer's name and lot number. Quantities smaller than a barrel may be shipped in a suitable container, providing the manufacturer's name and lot number appear on the label.
   b. Special Requirements.
      1) Hiding Power. After the compound has dried in a curing cabinet for 24 hours, it shall have an apparent daylight reflectance of not less than 65 percent compared to magnesium oxide as determined by ASTM E 97.
      2) Viscosity. The viscosity of the material furnished shall be such as to enable it to be used at atmospheric temperatures above 40° F. It will be applied to the concrete as a fine mist by means of an atomizing nozzle at an air pressure of 50 pounds or less.
      3) Reaction with Concrete. There shall be no deleterious reaction between the concrete and the curing compound.
      4) Drying Time. The material shall dry to touch on moist concrete in one to four hours under ordinary conditions. The resulting surface shall not be tacky or slippery when walked upon.
      5) Adherence. The material, when sprayed on moist concrete, either vertical or horizontal, shall adhere to the moist surface and make a tight bond to the concrete. The dry membrane shall not disintegrate or peel within 30 days; however, by the end of 60 days it is expected that the membrane will chalk away due to weather and erosion.
      6) Moisture Retention. When tested in accordance with OHD L-17, the curing compound shall have a water retention of at least 90 percent.

7) Storage. Membrane curing compounds, particularly those containing paraffin or similar wax, should be stored inside where they will not freeze. Freezing may cause hard deposits of wax or resin difficult to redissolve. Storage temperatures of 60° F. or higher are desirable.
8) Mixing. The compound shall be thoroughly mixed by air jet or by mechanical stirring before use in the field.

SECTION 4

TECHNICAL SPECIFICATIONS

FOR

SANITARY SEWER

AND

WATER SYSTEMS

4.0 TECHNICAL SPECIFICATIONS FOR SANITARY SEWER AND WATER SYSTEMS.

4.1 Right-of-Way Clearing and Restoring:

1. Description: Work under this item shall include the removal and reconstruction or replacement of all obstructions affected by the construction of the project, including, but not limited to fences, retaining walls, patios, trash burners, signs, mail boxes, outbuildings, landscaping, sidewalks, driveways, parking lot surfacing, curbs, street and alley surfacing and the like. Any such obstructions which are not to be reconstructed are so designated on the drawings. Such shall be removed and disposed of by the contractor. All obstructions to be replaced or reconstructed shall be restored to substantially the same condition as existed prior to the construction, except as otherwise noted.
2. Construction Methods: Sidewalks, driveways, parking lots, and other paved areas all or partially composed of concrete, asphaltic concrete or bituminous material shall be saw cut, removed, and replaced to at least the standard trench width if the project crossing is at right angles to the obstruction. Diagonal crossings shall be squared by saw cutting at right angles to the paved area or curb edge. If a construction joint is within two feet of any proposed sawed line, the cut shall be extended to the joint, or as directed by the Engineer. Any paved area, composed of bituminous material other than asphaltic concrete, shall be cut, removed and replaced to at least the standard trench width. Oiled surfaces shall be re-oiled. Gravel or macadamized surfaces shall be replaced with some. All sidewalk, driveway and parking lot replacement shall be of at least equal quality, thickness, sub-grade, base course and surface course as that removed or damaged. The applicable standard for construction in Section 3 "Technical Specifications for Paving and Drainage" shall govern.

   The Contractor shall remove and dispose of all debris, restore the grade of the surface of the earth as reasonably as may be done to the grade existing prior to construction, and upon completion of the work shall leave the site in as neat, clean and orderly condition as nearly as it was prior to construction as may be reasonably done.

   Passable surfaces across or along the construction vicinity shall be maintained at all times with gravel, steel mat or plate, or temporary bituminous surfacing material where a sidewalk, driveway, parking lot, Street or alley previously existed.

   Backfill under sidewalks, driveways, parking lots, curbs, streets, or alleys shall be thoroughly compacted to prevent settlement. Settlement or other failure of backfill or restored right-of-way shall be corrected immediately. The method of correction shall be as directed by the Engineer.
3. Notification and Permits. If an obstruction is of public ownership, the Contractor shall notify the appropriate agency and obtain any necessary permit or license forty-eight hours before beginning any operations affecting the obstruction. All work shall conform to the current standards and specifications of that agency and shall be approved by the agency before completion of the project.
4. Method of Measurement. For City Contracts, when shown on the plans or proposal as a pay item, Right-of-Way Clearing and Restoring shall not be measured but shall be paid for by lump sum for the project. Where the contract does not specifically provide for payment, the work or construction will not be paid for directly and will be considered incidental construction with the cost included in other items of work.
5. Basis of Payment. For City Contracts, accepted Right-of-Way Clearing and Restoring measured as provided above will be paid at the contract unit price for:

   Right-of-Way Clearing and Restoring . . . . L.S. which shall be full compensation for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

4.2 Excavation and Backfill.

1. Description. The work under this item shall include all earth, shale, gravel, loose rock, solid rock, debris, junk and/or other material excavated or otherwise removed in the preparation of the trench all work in connection with the excavation, removal and subsequent handling and disposal of such material,

regardless of its type, character, composition, or condition; subgrade preparation, all sheeting, piling, shoring, bracing; and dewatering of trenches; protection of adjacent property; backfilling; sand cushion; grade base stabilization; all specified backfill consolidation; and other work necessary or required.

2. Construction Methods. The trench shall be excavated so that the pipe can be laid to the alignment and grades shown on the drawings, or as directed by the city. It shall be excavated a maximum of one hundred feet in advance of pipe laying, or less. Opening of trenches in excess of the maximum requires specific approval of the City Engineer. Trenches shall be dry when the trench bottom is prepared. The trench bottom shall be shaped so that even bearing is obtained for the barrel of the pipe, with the bells unsupported. The trench widths shall conform to Subsection 3 of these specifications. If for any reason the trench exceeds the permitted width and if the Inspector shall determine that cradling or encasement then is required, said concrete cradle or encasement shall be installed at the expense of the contractor. Any part of the bottom of the trench excavated more than four inches below the specified grade shall be corrected with approved material thoroughly compacted as directed by the City. In the event suitable material is not available, sand shall be used. When rock is encountered and sand cushion is required, it shall be excavated six inches below the bottom of the pipe and the trench refilled to grade. When quicksand or other unstable earth is encountered, the Contractor shall excavate to sufficient depth to permit backfilling with crushed stone in order to provide a stable base for the pipe.

   When the type of backfill material is not indicated on the Drawings or specified, the backfill may be made with the excavated material, provided that such material, in the opinion the excavated material is not suitable, sand or other approved material shall be used. The first 12 inches of backfill above the pipe shall be backfilled by hand or by mechanical methods approved by the Inspector. Special care shall be used in placing this portion of the backfill to avoid damaging or moving the pipe. The remainder of the trench may be backfilled by mechanical methods. Backfilling operation shall be completed within one hundred feet or less of the finished line at all times, or as directed by the Inspector.

   All trenches excavated across any sidewalk, driveway, parking lot or other paved area shall be backfilled in accordance with Section 4.1, Subsection 2. Trenches across any travelled portion of unpaved streets or alleys, across any proposed roadways or proposed roadway fills, and as shown on the drawings shall be backfilled and compacted to the same density as the existing soil adjacent to the side of the trench, but shall not be less than 90% Standard Proctor Density, provided the excavated material consists of soil that can be readily compacted at the optimum moisture. If the excavated material consists of mostly clay or silt containing an excess of moisture, such excavated material shall be removed from the site of the work and the trench filled with sand or other material that will meet the soil classification of A -2 or better. If the backfilling has been completed and the backfill material does not meet the requirements for compaction, all the material shall be removed and hauled from the job site and the trenches refilled with material as specified above.

   Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Engineer. No backfill, fill or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill or embankment.

   The Contractor shall remove all trees (marked for removal), underbrush, stumps, roots and other combustible materials entirely from the site and dispose of same at such locations as determined by the Contractor. Burning to duly dispose of combustile debris along the project shall not be permitted.

   Excavations for manholes and similar structures constructed of masonry units shall have such horizontal dimensions that not less than 6 inches clearance is provided for outside plastering.

3. Trenching. The trenches shall be no wider than necessary for proper installation of the pipe and joints. In general and under average soil conditions, trench widths shall be within the limits stipulated in the following table:

Pipe Diameter	Minimum Trench Width Center of Pipe	Maximum Width of Trench 12” Above Top of Pipe
6”	18”	24”
15”	28”	32”
18”	35”	46”
24”	44”	52”
30”	54”	62”
36”	64”	72”
42”	73”	82”
48”	80”	92”
54”	97”	100”
60”	106”	121”

Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes which shall not extend lower than one foot above the top of the pipe. Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in the foregoing paragraph, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the expense of the Contractor.

The use of mechanical equipment will not be permitted in locations where its operation in the opinion of the Engineer would cause damage to trees, buildings, culverts or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated, that. the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalls are obtained at least from an elevation one foot above the top of the installed pipe to the bottom of the trench, and that trench alignment is such that pipe when accurately laid to specified alignment will be centered in the trench with adequate clearance between the pipe and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will be permitted.

Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, to provide for the installation of 3 inch of granular fill pipe foundation material.

Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular fill when the pipe is jointed.

4. Placement and Compaction of Backfill. A 3-inch layer of granular fill material or sand shall be used for the bedding of all pipe unless rock is encountered. In the event of rock, a 6-inch layer of sand shall be placed under, over and on both sides of the pipe. Approved rock-free soil shall be placed for one foot above the granular fill and existing approved materials may be used to complete the backfill; however, no rocks larger than 8 inches measured in any direction shall be placed in the trench. All granular fill material beneath the pipe shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes and pipe joints. It will be permissible to slightly disturb the finished subgrade surface by the withdrawal of pipe slings or other lifting tackle.

   After each pipe has been graded, aligned, and placed in final position on the bedding material, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing, embedment and backfilling operations.

Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement

Tamped backfill materials shall be placed in uniform layers of not more than 6 inches and shall have a moisture content which will insure that maximum density will be obtained with the compaction method used. Tamped backfill shall be required for one foot above the pipe or one foot above the granular fill if rock is encountered.

Uncompacted earth backfill material to be placed above tamped backfill shall be free of brush, roots more than 2 inches in diameter, debris and junk, but may contain rubble and detritus from rock excavation, stones, and boulders, in certain portions of the trench depth.

Uncornpacted backfill material above embedments may be placed by any method, approved by the Engineer, which will not impose' excessive concentrated or unbalanced loads, shock, or impact on, and which will not result in displacement of installed pipe.

Compacted masses of still clay or other consolidated material more than one cubic foot in volume shall not be permitted to fall more than 5 feet into the trench unless cushioned by at least 2 feet of loose backfill above pipe embedment.

No uncompacted trench backfill material containing rock or rock excavation detritus shall, be placed in the upper 18 inches of the trench except with specific permission of the Engineer, nor shall any hard rock, or stone or boulder larger than 8 inches in its greatest dimension be placed within 3 feet of the top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

Backfill around manholes shall be compacted to the extent necessary to prevent future settlement, by tamping or other means approved by the Engineer. Water settlement will be permitted only where no damage to the work could be caused thereby.

Material for backfill shall be composed of earth only and shall contain no wood, grass, roots, broken concrete, stones, trash, or debris of any kind. No tamped or otherwise mechanically compacted backfill shall be deposited or compacted in water.

The Contractor shall be responsible for all settlement of backfill which may occur within one year after final completion of the contract under which the backfilling work was performed.

The Contractor shall make, or cause to be made, all necessary backfill replacements and repairs or replacements appurtenant thereto, within thirty (30) days after notice by the Engineer or Owner.

5. Sheeting and Shoring. Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, and shored as necessary to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheeting, bracing and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining shape and position under all circumstances.

   Sheeting, shoring, and bracing shall not be left in place unless otherwise shown in the plans or authorized by the Engineer. Removal of sheeting, shoring, and bracing shall be done in such a manner as to avoid damage or danger to the work, to adjacent property, or to personnel.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

6. Stabilization. Subgrades for manholes and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

   Subgrade for manholes or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with one or more layers of crushed stone or gravel. Not more than 1/2 inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding material is placed thereon. The finished elevation of stabilized subgrades for manholes shall not be above subgrade elevations shown on the plans.

   All stabilization work shall be performed by and at the expense of the Contractor.

7. Removal of Water. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the manhole to be built, or the pipe to be installed, therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

   All excavations for manholes or trenches which extend down to or below static ground water elevations shall be dewatered by lowering and maintaining the ground water surface beneath such excavations a distance of not less than 12 inches below the bottom of the excavation.

   Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

   The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

8. Blasting. If blasting operations are necessary, the Contractor shall comply with all laws, ordinances, applicable safety code requirements, and regulations relative to the handling, storage and use of explosives and the protection of life and property. He shall be responsible for all damage caused by his blasting operations.

   All explosives shall be stored in a secure manner, and all storage places shall be clearly marked "DANGEROUS EXPLOSIVES", and shall be in the care of competent watchmen at all times. The storage of explosives shall conform to federal, state and local laws and regulations.

   The use of explosives shall be performed by competent experienced personnel. The Contractor shall submit the name or names of the personnel in charge of explosives to the Engineer prior to beginning of the use of explosives, and they must demonstrate their ability to perform such work, or be replaced with others to the satisfaction of the Engineer at the expense of the Contractor.

   The spacing of holes, loading and anticipated results of such use shall be submitted to the Engineer in writing prior to use of explosives. The method of use shall be revised if satisfactory results are not obtained. The revisions shall include spacing, loading and personnel to the extent required to achieve the acceptable results, and the expense in achieving the results shall be borne by the Contractor. The Contractor shall, if required, use horizontal and/or vertical delays to obtain a pattern that will provide the desired results with the required control.

The Contractor shall notify the Engineer, the proper representatives of public service corporations, company or individual that may be damaged by blasting, at least eight hours in advance of any blasting.

9. Drainage Maintenance. Trenches across roadways, driveways, walks, or other traffic ways adjacent to drainage ditches or water courses shall not be backfilled prior to completion or backfilling the trench on the upstream side of the trafficway to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other water courses crossed by the line of trench shall be removed immediately after backfilling is completed and the original section, grades and contours of ditches of water courses shall be restored. Surface drainage shall not be obstructed longer than necessary.
10. Protection of Trench Backfill in Drainage Courses. Where trenches are constructed in ditches or other water courses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds one percent, ditch checks shall be installed. Unless otherwise shown on the plans or directed by the Engineer, ditch checks shall be concrete. 'Ditch checks shall extend not less than 2 feet below the original ditch or water course bottom for the full bottom width and at least 18 inches into the side slopes and shall be at least 18 inches thick.
11. Disposal of Excess Excavated Materials. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site of the work. Excavated rock in excess of the amount permitted to be actually installed in trench backfill, junk and debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site of the work.

    Excess earth from excavations located in unimproved property shall be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of 6 inches above the original ground surface elevation at and across the trench and sloping uniformly each way. Material thus wasted shall be carefully finished with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road or highway right-of-way. The disposal of waste and excess excavated materials, including hauling, handling, leveling and surfacing, shall be a subsidiary obligation of the Contractor and no separate payment will be made therefor.
12. Private Property. If it is necessary or desirable that the Contractor use land outside of the Owner's right-of-way, the Contractor shall obtain consent from and shall execute a written agreement with, the owner and tenant of the land. The Contractor shall not enter for pipe delivery or occupy for any other purpose with men, tools, equipment, construction materials, or with materials excavated from the pipe trench, any private property outside the designated right-of-way boundaries without written permission from the Owner and Tenant.
13. Protection of Public and Private Property. The Contractor shall protect, shore, brace, support and maintain all underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by the construction work performed by him. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, fences and other surface structures affected by construction operations, together with all sod and shrubs in yards and parkings, shall be restored to their original condition as determined and approved by the Engineer, whether within or outside of the Owner's right-of-way. All replacement shall be made with new materials.

    The Contractor shall take precautions to avoid damage to trees not directly interfering with construction. Any questions concerning which trees are to be removed shall be resolved by the Engineer.

    The Contractor shall be responsible for all damage to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges and other public or private property, regardless of location or character, which may be caused by transporting equipment, materials, or men to or from the work or any part of site thereof, whether by him or his subcontractors. The Contractor shall make satisfactory and

acceptable arrangements, with the Owner of, or the Agency or Authority having jurisdiction over, the damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage.

14. Method of Measurement. For City Contracts when trench excavation is shown on the plans or proposal as a pay item, the volume in cubic yards shall be computed as follows: The average trench width of minimum and maximum widths as specified in Subsection 3 of these specifications will be used. The - length will be that measured for pipe conduit. Depth of excavation as the actual depth of ditch from the original land surface to the flow line of pipe. Average end-area method of computing volume will be used. No payment for excavation will be made for material excavated outside the neat lines as defined above. No additional payment will be made for: sand cushion; backfilling; compaction of backfill; sand used for backfill under existing and/or proposed roadways; roadway fills, streets, alleys, driveways, sidewalks, parking lots or as shown on the drawings;. removing and replacing of topsoils and obstructions, trees, storm sewers or other obstructions; blasting; bracing arid shoring; dewatering; pumping and draining; grade base stabilization; removal of excess excavated material; or restoration of the site. It is mutually understood that subterranean water, quick sand, or other unstable earth may be encountered and the Contractor has taken such into consideration in making this bid. Where such is encountered, Contractor will be required to excavate to sufficient depth to permit backfilling with crushed stone in order to provide a stable base for the pipe. Extra payment will not be made because of such additional excavation or because it is necessary to excavate wider than the trench width as in attached Standard Details; or for crushed stone.

    Where the contractor or proposal does not specifically provide for payment the work or construction will not be paid for directly and will be considered incidental construction with, the cost included in other items of work.

15. Basis of Payment. For City Contracts accepted trench excavation measured as provided above will be paid at the contract unit price for:

    Trench Excavation . . . . C.Y. which shall be full compensation for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

4.3 Polyvinyl Chloride Pipe (P.V.C.) for Sewer.

1. Description. The work under this item shall include furnishing, hauling, and placing and jointing of Polyvinyl Chloride Pipe (P.V.C.) and fittings in the trench in specific conformity with the line and grades as shown on the plans and in these specifications.
2. Materials. All materials shall conform to the requirements of Section _____.
3. Testing. The pipe manufacturer shall furnish, upon written request by the City, the results of the following tests:
    a. Vise Test – Place between two flat parallel plates a 2-inch long ring and compress in less than 1 minute to 100 percent flattening. There shall be no evidence of shattering or splitting.
4. Equipment. Equipment necessary for the proper construction of the work shall be on the job, in first class working condition, before construction operations commence. The City shall have the right to reject any equipment which is not capable of producing desired results. Rejected equipment shall be replaced, with approved equipment.
5. Construction Methods. The pipe shall be laid on 3-inch granular material in accordance with the following:

    The construction of all sewers shall begin at the outlet or the low point in the line. When the construction involves the building of main or sub-main sewers having one (1) or more laterals or tributaries, the construction of tributary lines will not be started until the main or sub-main sewer has been completed to the point where the tributary or laterals discharge into it. Sewer appurtenances shall be constructed as soon as the sewer which they serve is constructed to their location. The postponing of the construction of appurtenances until the sewer line has been completed, or the building of appurtenances in advance of the construction of the sewer line will not be permitted. In general, the construction of

sewers in advance of appurtenances will not exceed six hundred (600) feet unless authorized by the Engineer.

The connecting of sewers or sewer appurtenances to other sewers or to sewer appurtenances shall be made in accordance with the plans or under the direction of the Engineer. The work shall be done in a workmanlike manner in such a way as not to damage any of the structures involved. No sewer shall project beyond the inside wall of other sewers or of sewer appurtenances. The grade line shown on the plans is the elevation of the invert of flow line of the sewer. The grade line shall be established in the trench by the use of batter boards set at grade stakes not further than fifty (50) feet apart. No less than three (3) batter boards shall be maintained in correct position continuously during the construction of the sewer. Batter boards shall be of good, straight, sound material, fastened to substantial stakes or uprights. Batter boards ten (10) feet or less in length shall not be smaller than 1 x 4, and when longer than ten (10) feet shall not be smaller than 1 x 6. Steel stakes with suitable clamps may be used when approved by the Engineer. A suitable fine cord or wire, approved by the Engineer, shall be stretched tightly between batter boards over the 'exact center line of the sewer. A graduated pole or rod shall be provided for the measuring from the cord stretched between batter boards to the bottom of the trench while the trench is being prepared, and to the sewer invert while the sewer is being placed. When the distance from the cord between batter boards to the invert of the sewer exceeds ten (10) feet, a line shall be set in the bottom of the trench for aligning the pipe and establishing the grade. The laser beam method may be used. Templates shall be used for shaping the bottom of all trenches for circular sewers eighteen (18) inches in diameter and larger. The shape of the template and the precision of the work shall be such as to provide a uniform bed exactly the shape of the bottom for the lower one-third (1/3) of the circumference of all circular sewers eighteen (18) inches in diameter and larger.

No sewer shall be laid unless the foundation is in a condition satisfactory to the Engineer. The laying of pipe in a wet trench shall be done only when and as approved by the Engineer. The spigot end of the pipe shall be laid in the direction of the flow. No buckling in or laying pipe downgrade will be permitted. Pipe shall not be dropped to the bottom of the trench, but shall be lowered in a careful manner approved by the Engineer. The inside of the barrel shall be cleaned when the pipes are lowered into the trench. As the work progresses, the interior of the sewer shall be cleared of all dirt and superfluous materials of every description. Where cleaning after laying is difficult because of small pipe size, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed. All joints shall be the rubber ring type or equivalent made in strict accordance with the particular joint manufacturer's instruction and recommendations.

It is the intent to secure as near as practicable, a watertight joint; and the workmanship must be in full accordance therewith. The tightness of the joints will be judged by the amount of infiltration. If, in the opinion of the Engineer the pipe shows a significant amount of leakage, the pipe shall be re-laid until a water-tight sewer is secured. All visible leaking joints shall be repaired to the satisfaction of the Engineer.

The rubber ring assembly is a sliding assembly in which the lubricated spigot and slides under the rubber ring and is seated into a coupling or bell, and the following methods of installation shall apply.

The rubber ring for sewer service shall be supplied with the pipe by the pipe manufacturer.

Make certain the ring groove in the coupling or bell is clean, with no dirt or foreign material that could interfere with proper seating of the ring.

Set ring in groove with color marking facing out. Smooth the ring so that it sets evenly all around and is free from twists. Ring insertion for 1½" and 2" diameter pipe can be made easier by dipping the ring in clean water before inserting it. Do not use trench water or any lubricant for this purpose.

Make sure pipe end is clean. Wipe with a clean dry cloth around the entire circumference from the end to one inch beyond the reference mark.

Lubricate the spigot end of the pipe, using only the lubricant supplied by the pipe manufacturer.

Insert the bevel end into the coupling or bell so that it is in contact with the ring. Hold the pipe lengths being joined close to the ground to keep the lengths in proper alignment. Brace the coupling or bell while the bevel end is pushed in under the ring, so that previously completed joints in the line will not be closed up.

Push the spigot end in until the reference mark on the spigot end is flush with the end of the coupling or bell.

If undue resistance to insertion of the bevel end is encountered or the reference mark does not reach the flush position, disassemble the joint, and check the position of the ring. If it is twisted or pushed out of its seat, clean the ring, coupling or bell and bevel end and repeat the assembly steps. Be sure both lengths are in proper alignment. If the ring was not out of position, measure the distance between the reference mark and the bevel end. Relocate the reference mark if it is out of position.

The plastic pipe must be handled with reasonable care so that it is not crimped or damaged when placed in the trench.

The trench walls should be straight with a minimum trench width of three times the diameter of the pipe. The manufacturer's recommendation as to setting time, etc. shall be used in lowering the pipe in the trench.

If the pipe is to be laid in a trench having a rock bottom, a sand cushion shall be provided. The sand cushion shall consist of 6 inches of bedding below the pipe, 6 inches on each side and 6 inches above the pipe. The sand bottom shall be prepared before the pipe is lowered into the trench. All backfilling shall be carefully placed to avoid dropping rocks or large clods on the pipe.

Where it is necessary to connect P.V.C. to vitrified clay sewer pipe, it shall be done in the following manner:

The plain end of P.V.C. pipe shall be inserted and carefully centered in the bell end of vitrified clay sewer pipe, and the joint made in the same manner and with the same materials as specified for jointing sewer pipe. After this is done, the entire joint shall be encased in concrete at least six (6) inches in thickness and twenty-four (24) inches long.

Where the spigot end of P.V.C. pipe is to be connected to V.C.P., the bell end of the P.V.C. pipe shall be cut off, the plain ends of both pipes carefully centered and butted against each other, and held in place by a bond of fourteen (14) gauge steel twelve (12) inches in width bolted around the ends of the pipe. The joint shall then be caulked as for sewer pipe, and the entire sleeve assembly shall be encased in concrete as set out above.

Factory fabricated joints shall be installed strictly in accordance with the manufacturer's instructions and recommendations.

6. Dead Ends and Plugs. Dead ends of all sewers, wyes, tees, and other fittings shall be closed with approved stoppers securely cemented in place. When shown on the plans or required by the Engineer, such openings shall be tightly walled up with brick masonry. Tight fitting stoppers or bulkheads shall be securely placed in or across the end of each day's work or for any other cause. When work is stopped

temporarily on sewers twenty-four (24) inches in diameter and smaller, the end of the pipe shall be closed to prevent trash or debris from entering the pipe. Such stoppers need not be watertight.

7. Concrete Cradles and Protection. Concrete cradles and protection, where required, shall be constructed as shown on the plans or, where not shown on the plans, as directed by the Engineer. Where cradling is constructed beneath the sewer pipe, the subgrade shall be prepared and properly shaped at the required grade and in a like manner as required for the subgrade for the pipe itself. All concrete shall be placed in the dry, unless in the opinion of the Engineer, such a method is entirely impracticable. Where concrete is placed in a wet trench, the work shall be done strictly as directed or approved by the Engineer. The pipes shall e firmly bedded in the concrete to proper grade. Concrete placed over or on the pipe as a cradle or protection, shall be so placed as not to damage the joints or disrupt any pipes. Backfilling shall be done in a careful manner and at such time after the concrete is placed, as not to damage the concrete.
8. Field Cutting and Beveling. Cutting: A square cut is essential to insure ease of assembly. Use either a tubing cutter or a miter box and carpenter's fine-toothed hand saw or hacksaw. (Do not use standard pipe cutters. The cutting wheel will crush or damage the pipe.)

   Beveling: Use a factory-finished beveled end as a guide to determine the angle and length of taper. The end may be beveled using a Pilot beveling tool which will cut the correct taper automatically or a thin steel, "cheese-grater" type of hand tool, Stanley "Surform" No. 399.

   This is a fast-cutting and self-cleaning (chips pass through the performations) tool that cuts a smooth surface.

   Reference Marking: With a pencil or crayon, locate the reference mark at the proper distance from the bevel end as indicated by the pipe manufacturer.
9. Infiltration. As a measure of proper workmanship in the laying of pipe and construction of joints, it is required that in no instance shall the infiltration of ground water exceed a rate of twenty-four (24) hours regardless of diameter of the sewer. Tests for infiltration may be made by the Engineer at any time and at any point or points along the sewer, prior to the termination of the contract. When the infiltration exceeds the specified amount, correction shall be made to the satisfaction of the Engineer.
10. Markings. Pipe markings shall include the following, marked continuously down the length:
    Manufacturer's Name,
    Nominal Size,
    Cell Classification,
    Legend,
    ASTM Designation.
11. Method of Measurement. For City Contracts, pipe conduit will be measured by the linear foot along the centerline of the conduit actually laid. Deductions will not be made for wye branches or standard manholes. No fittings shall be measured for payment.
12. Basis of Payment. For City Contracts, the accepted quantities of P.V.C. sewer pipe for the size specified, measured as above, will be paid for at the contract unit price for:
    P.V.C. Sewer Pipe L. F.
    which shall be full compensation for furnishing .all materials, equipment, labor and incidentals to complete the work as specified.

4.4 Vitrified Clay Pipe (V.C.P.).

1. Description. The work under this item shall include furnishing, hauling, and placing and jointing of Vitrified Clay Pipe (V.C.P.) and fittings in the trench in specific conformity with the line and grades as shown on the plans and in these specifications.
2. Materials. All materials shall conform to the requirements of Section _____.
3. Equipment. Equipment necessary for the proper construction of the work shall be on the job, in first class working condition, before construction operations commence. The City shall have the right to reject

any equipment which is not capable of producing desired results. Rejected equipment shall be replaced with approved equipment.

4. Construction Methods. The pipe shall be laid on 3-inch granular material in accordance with the following:

The construction of all sewers shall begin at the outlet or the low point in the line. When the construction involves the building of main or sub-main sewers having one (1) or more will not be started until the main or sub-main sewer has been completed to the point where the tributary or laterals discharge into it. Sewer appurtenances shall be constructed as soon as the sewer which they serve is constructed to their location. The postponing of the construction of appurtenances until- the sewer line has been completed, or the building of appurtenances in advance of the construction of the sewer line will not be permitted. In general, the constructor of sewers in advance of appurtenances will not exceed six hundred (600) feet unless authorized by the Engineer.

The connecting of sewers or sewer appurtenances to other sewers or to sewer appurtenances shall be made in accordance with the plans or under the direction of the Engineer. The work shall be done in a workmanlike manner in such a way as not to damage any of the structures involved. No sewer shall' project beyond the inside wall line of other sewers or of sewer appurtenances.

The grade line shown on the plans is the elevation of the invert of flow line of the sewer. The grade line shall be established in the trench by the use of batter boards set at grade stakes not further than fifty (50) feet apart. No less than three (3) batter boards shall be maintained in correct position continuously during the construction of the sewer. Batter boards shall be of good, straight, sound material, fastened to substantial stakes or uprights. Batter boards ten (10) feet or less in length shall not be smaller than 1 x 4, and when longer than ten (10) feet shall not be smaller than 1 x 6. Steel stakes with suitable clamps may be used when approved by the Engineer. A suitable fine cord or wire; approved by the Engineer, shall be stretched tightly between batter boards over, the exact center line of the sewer. A graduated pole or rod shall be provided for the measuring from the cord stretched between batter boards to the bottom of the trench while the trench is being prepared, and to the sewer invert while the sewer is being placed. When the distance from the cord between batter boards to the invert of the sewer exceeds ten (10) feet, a line shall be set in the bottom of the trench for aligning the pipe and establishing the grade. The laser beam method may be used.

Templates shall be used for shaping the bottom of all trenches for circular sewers eighteen (18) inches in diameter and larger. The shape of the template and the precision of the work shall be such as to provide a uniform bed exactly the shape of the bottom for the lower one-third (1/3) of the circumference of all circular sewers eighteen (18) inches in diameter and larger.

No sewer shall be laid unless the foundation is in a condition satisfactory to the Engineer. The laying of pipe in a wet trench shall be done only when and as approved by the Engineer. The spigot end of the pipe shall be laid in the direction of the flow. No buckling in or laying pipe downgrade will be

If the pipe is to be laid in a trench having a rock bottom, a sand cushion shall be provided. The sand cushion shall consist of 6 inches of bedding below the pipe, 6 inches on each side, and 6 inches above the pipe. The sand bottom shall be prepared before the pipe is lowered into the trench. All backfilling shall be carefully placed to avoid dropping rocks or large clods on the pipe.

Where it is necessary to connect C.I.P. to vitrified clay sewer pipe, it shall be done in the following manner: The plain end of C.I.P. shall be inserted and carefully centered in the bell end of vitrified clay sewer pipe, and the joint made in the same manner and with the same materials as specified for jointing

sewer pipe. After this is done, the entire joint shall be encased in concrete at least six (6) inches in thickness and twenty-four (24) inches long.

Where the spigot end of V.C.P. is to be connected to C.I.P., the bell end of the C.I.P. shall be cut off, the plain ends of both pipes carefully centered and butted against each other, and held in place by a bond of fourteen (14) gauge steel twelve (12) inches in width bolted around the ends of the pipe. The joint shall then be caulked as for sewer pipe, and the entire sleeve assembly shall be encased in concrete as set out above.

Factory fabricated joints shall be installed strictly in accordance with the manufacturer's instructions and recommendations.

5. Dead Ends and Plugs. Dead ends of all sewers, wyes, tees, and other fittings shall be closed with approved stoppers securely cemented in place. When shown on the plans or required by the Engineer, such openings shall be tightly walled up with brick masonry. Tight fitting stoppers or bulkheads shall be securely placed in or across the end of each day's work or for any other cause. When work is stopped temporarily on sewers twenty-four (24) inches in diameter and smaller, the end of the pipe shall be closed to prevent trash or debris from entering the pipe. Such stoppers need not be water-tight.
6. Concrete Cradles and Protection. Concrete cradles and protection, where required, shall be constructed as shown on the plans or, where not shown on the plans, as directed by the Engineer. Where cradling is constructed beneath the sewer pipe, the subgrade shall be prepared and properly shaped at the required grade and in a like manner as required for the subgrade for the pipe itself. All concrete shall be placed in the dry, unless in the opinion of the Engineer, such a method is entirely impracticable. Where concrete is placed in a wet trench, the' work shall be done strictly as directed or approved by the Engineer. The pipes shall be firmly bedded in the concrete to proper grade. Concrete placed over or on the pipe as a cradle or protection, shall be so placed as not to damage the joints or disrupt any pipes. Backfilling shall be done in a careful manner and at such time after the concrete is placed, as not to damage the concrete.
7. Infiltration. As a measure of proper workmanship in the laying of pipe and construction of joints, it is required that in no instance shall the infiltration of ground water exceed a rate of twenty-eight hundred (2800) gallons per mile of sewer per twenty-four (24) hours regard1ess of the diameter of the sewer. Tests for infiltration may be made by the Engineer at any time and at any point or points along the sewer, prior to the termination of the contract. When the infiltration exceeds the specified amount, correction shall be made to the satisfaction of the Engineer.
8. Method of Measurement. For City Contracts, pipe conduit will be measured by the linear foot along the centerline of the conduit actually laid. Deductions will not be made for wye branches or standard manholes. No fittings shall be measured for payment.
9. Basis of Payment. For City Contracts, the accepted quantities of P.V.C. sewer pipe of the size specified, measured as above, will be paid for at the contract unit price for

   V.C.P. Sewer Pipe L.F.

   which shall be full compensation for furnishing all materia1s, equipment, labor and incidentals to complete the work as specified.

4.5 Sanitary Sewer Manholes.

1. Description. The work under this item shall include all excavation, furnishing all materials required, construction, pipe connections, vertical pipes and fittings required for drop manholes, finishing and backfilling of new standard and drop manholes. Construction of manholes shall progress as rapidly as installation of the lines permit or as directed by .the Engineer.
2. Materials. All materials shall conform to the requirements of the following sections for the various items listed:

   Concrete
   Castings
   Brick

3. Construction Methods. Manholes may either be built of plastered brick and mortar construction or may be precast or of slip form concrete construction.
   a. Brick Manholes. All essential details of construction of brick manholes are shown on drawings accompanying these specifications; these drawings must be followed entirely. Bricks must be laid in full, close shove joints of mortar, according to best work standards, the mortar being of one part of Portland Cement to three parts of sand. A reasonable number of bats, not smaller than half-bricks, will be allowed; chips of brick will be allowed for filling the angular spaces between the bricks in the circular walls. Brick manholes shall be plastered inside and outside with a coating of equal parts of cement and sand mortar one-half (1/2) inch thick and worked to a smooth surface.

      Short bell pieces of pipe of such sizes as may be required shall be built into the brick work of the manholes for the incoming and outgoing sewers indicated in the general plan for either immediate or future construction; the brick work shall be built arched over these pipes. Such of these bell pieces where sewers are not built immediately, must be securely closed with a stopper of such type as can be removed without damage to the pipe. These bell pieces shall be of the same materials as the sewers of which they form a part. Sewer manholes must be built in full conformity with the drawings; special attention must be paid to the method of forming the inverts, the arching of bricks over the bell pieces set in the walls and the height of the vertical part of the walls.
   b. Slip Form or Cast-In-Place Concrete Manholes. Concrete manholes may be used but shall conform to dimensions and thicknesses as specified in the plans and shall be constructed of concrete conforming to A.S.T.M. Specifications for Class A concrete and Section _____. Concrete manholes shall be coated on the inside with asphalt or mastic. If slip form construction is used for manholes, all cold joints shall be dowelled with 30” lengths of #4 rebar spaced at intervals of 18” or less. Details shall be submitted to the City Engineer for approval prior to construction of any precast, slip form or cast-in-place concrete manhole.

   c. General Requirements. The walls shall be built vertical up to the top of the arch over the highest connecting sewer which comes in without a drop pipe, from this point the walls shall taper uniformly as per plan. The walls shall be nine inches (9”) thick and thicker as shown on the plans. The prices bid for manholes of various depths must take these wall thicknesses into consideration. No extra payment will be allowed for the added thickness that is here specified.

      Where in any sewer manhole, the vertical distance from the flow line of the outgoing sewer to the invert of the incoming sewer exceeds eighteen inches (18”), the Engineer may require a drop pipe to be built for the incoming sewer; typical drop pipes are shown on the manhole drawings. Drop pipes for 8” sewers will be six inches in diameter.

      Each sewer manhole shall preferably be completely built as the sewer is laid up to it. No sewer shall be laid out of a manhole until the manhole has been constructed to an elevation above the top of the bell piece for that outgoing sewer.

      One bell and spigot joint (in clay) on the incoming side of each sewer manhole may be permitted by the Engineer in order to properly locate the manhole and to provide the required connection in the manhole wall. For this one joint, the use of an asphaltic base, cold plastic sewer joint compound as approved by the Engineer may be used. This joint to be made according to the manufacturer’s specifications. Manhole steps shall be in accordance with the details as indicated on the plans.

      Manholes shall be constructed only when temperature is above thirty-two degrees (32°) F. and all work shall be protected from freezing. The joints on the inside face of exposed face of the masonry shall be rubbed full and cut as the brick work is built up.

The masonry shall be built up in level courses, true to line, grade and dimension. Bats shall be used only when necessary to close joints. All brick shall be thoroughly wet down immediately before being placed. All work shall be completed and finished in a careful workmanlike manner. Old brick masonry shall be thoroughly cleaned and wetted before joining new masonry thereto. To prevent infiltration, a mortar coating shall be required and shall have a minimum thickness of 1/2" as shown on the plans, and shall be troweled and retroweled until a uniform, smooth and impervious surface is o5tained. All pipes which extend through manhole walls shall be tightly sealed in the wall with mortar throughout the circumference of the pipe. The mortar shall be pressed in and troweled off flush with the face of the wall.

d. Manhole Bottoms. All manholes shall rest on a concrete slab conforming to approved drawings shown on the plans. The tensile strength of the concrete shall be 3500 lbs./sq. inch. Manhole slabs shall rest on a minimum of 6" of compacted sand and shall be set to provide the invert elevations as shown on the contract drawings.

   In case the excavation for any structure is carried below the grade established by the Engineer, the Contractor shall fill the bottom of the excavation up to grade with compacted sand and in a manner acceptable to the Engineer, without compensation for either the excavation or the backfilling. Manhole slabs shall be reinforced with #4 rebar on 16" centers. Two courses at right angles shall be used.

e. Stubouts. Stubouts shall be constructed from all manholes as directed by the Engineer where future extension is likely. The same care shall be taken in setting stubouts as in forming inverts for manholes. Stubouts shall be included in price bid for manholes.

4. Field Tests. After joints have been inspected and approved and trench backfilled as specified, the Engineer shall flash a light between manholes or manhole locations. Any misplaced pipe detected shall be corrected to line and grade at the Contractor's expense.
5. Method of Measurement. For City Contracts, the accepted number of manholes complete in place that do not exceed 6 feet in depth as measured 'from the top of the frame cover casting to the flow line of the outlet lead shall be measured for payment as "Manhole" and shall include the bottom, walls, frame and cover, steps and miscellaneous pipes and fittings required for a complete and workable system. Manholes exceeding 6 feet in depth will be measured as set out above and the depth in excess of 6 feet will be measured by the vertical foot of wall and classified for payment as "Additional Manhole Wall".
6. Basis of Payment. For City Contracts, accepted quantities measured as provided above, will be paid for at the contract unit price for:

Manhole	EA.
Additional Manhole Wall	V.F.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 5

STANDARD DETAIL DRAWINGS

NOT INCLUDED